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The Worst Inflation Outbreak in 40 Years

Distilling Lessons from the COVID Era

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PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

POLICY BRIEF

26-3 The COVID Era Inflation Surge: Causes, Consequences, and Policy Lessons

Karen Dynan and David Wilcox
January 2026

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1. INTRODUCTION

In the wake of the COVID-19 pandemic, inflation surged in the United States and across much of the globe. In the United States, the 12-month change in prices, as measured by the personal consumption expenditures (PCE) price index, rose to a peak above 7 percent in mid-2022, marking the most significant outbreak of inflation since the early 1980s.[1] Inflation also reached levels not seen in decades across much of Europe, the United Kingdom, and a range of other advanced economies and emerging markets, as shown in figure 1. The outbreak was particularly unsettling because it followed 40 years of generally low and stable inflation in many of these countries. Inflation has receded markedly from its peak in most economies. In the euro area, it has returned to the European Central Bank's target, but in many other countries, it remains above target, and concerns about the durability of the disinflation persist.

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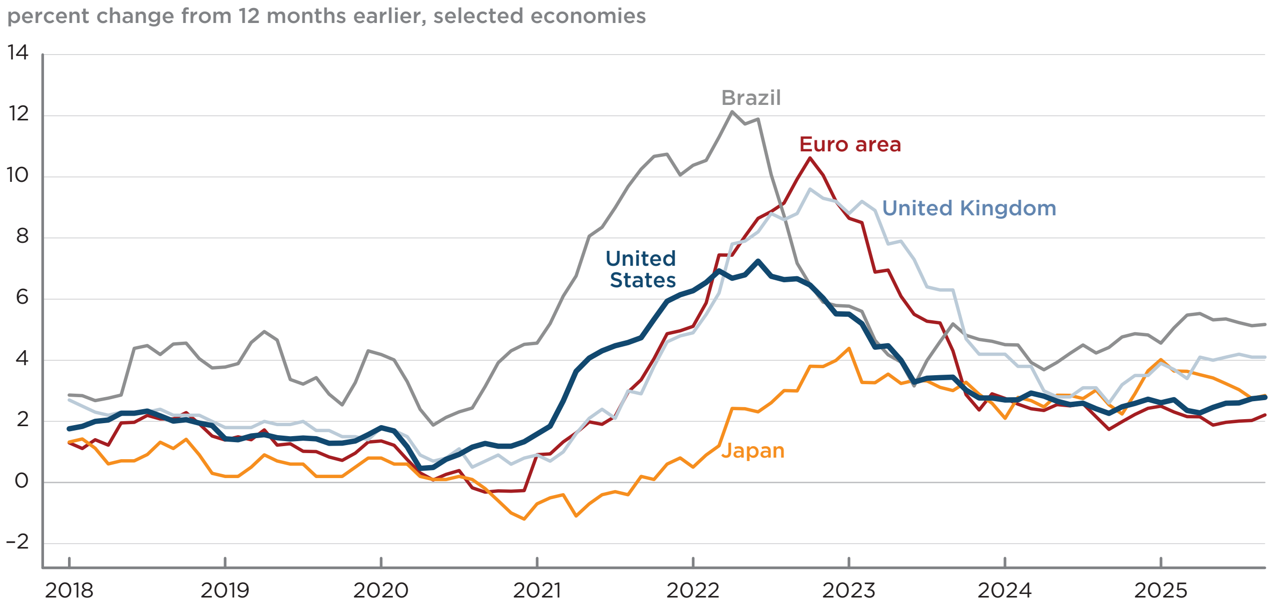
The burst of inflation was enormously costly for both businesses and—especially—households. Even where nominal wages accelerated on average, they lagged behind price increases for many households, eroding real incomes and living standards. Uncertainty about the persistence of high inflation made financial planning more difficult for households and firms. Although the decline in inflation from its peak occurred faster, and with less collateral damage to employment and output than most experts had expected, the episode left lasting scars. In particular, the cumulative rise in prices appears to have become an

1 Throughout this Policy Brief, we focus on inflation measures emphasized by each economy's respective monetary authority: the personal consumption expenditures (PCE) price index for the United States, the harmonized index of consumer prices (HICP) for the euro area, and the consumer price index (CPI) for many other countries.

Figure 1

Inflation surged after the pandemic in many economies, January 2018–September 2025



Note: Figure shows each economy's primary policy-relevant measure of consumer prices: personal consumption expenditures (PCE) price index for the United States, harmonized index of consumer prices (HICP) for 19 euro area economies, and consumer price index (CPI) for the United Kingdom, Japan, and Brazil. Data are reported through September 2025.

Sources: US: Bureau of Economic Analysis via Federal Reserve Economic Data (FRED); euro area: Eurostat; UK: Office for National Statistics (ONS); Japan: Statistics Bureau Japan; Brazil: Instituto Brasileiro de Geografia e Estatística.

enduring source of hardship for some households and a broader source of public dissatisfaction, shaping perceptions of economic performance even as headline inflation has come down.

Motivation and Objectives

This Policy Brief aims to synthesize and distill lessons from a broad body of work produced as part of the Peterson Institute for International Economics' *Understanding the COVID Era Inflation* project. The published papers are presented in this PIIE Briefing. The project brought together an extensive group of experts to examine different facets of the inflation surge, including supply-side disruptions, demand dynamics, labor markets, fiscal and monetary policy interactions, and international spillovers. The primary aim of the overall project is to equip decision-makers in the future with a well-grounded understanding of the post-pandemic inflation experience, so they can make informed choices if and when they confront an undesirable rise in inflation—whether or not the surrounding circumstances resemble those of the early 2020s. The COVID era episode was shaped by an unusual confluence of shocks and policy responses, but it nonetheless raises enduring questions about the interaction of demand, supply, expectations, and policy frameworks that are likely to recur in different forms.

For fiscal policymakers, a central question is whether pandemic-era decision-makers erred in providing too much support for demand, especially given the excess saving that appeared to have accumulated in the early part of the pandemic and the uncertainty about how quickly supply could ramp up to meet a surge in demand. Many analysts concluded—with the benefit of hindsight—that fiscal stimulus during the Great Recession of 2007–09 had been too timid and was withdrawn too quickly. Policymakers responding to the economic collapse triggered by COVID-19 were determined not to repeat that mistake. Assessing whether that determination contributed to an overshooting of demand is essential for evaluating fiscal policy choices in future downturns. It will also be important not to overlearn the lesson of the COVID era and reproduce the sluggish recovery from the global financial crisis.

Monetary policymakers, for their part, erred—again, with the benefit of hindsight—in depending so heavily on the presumption that inflation would prove "transitory." Many observers (notably including Fed Chair Jerome Powell)[2] concluded that the rate-hiking campaign was launched later than it should have been. At the same time, inflation has declined considerably from its peak, while labor-market conditions remained relatively resilient through at least mid-2025. The outcome thus far is clearly better than seemed likely in mid-2022, when inflation was at its peak. This raises important questions about how to interpret the episode. Is the outcome best seen as a one-time fluke, reflecting favorable supply developments or good luck? How much of a difference would it have made if policymakers had begun tightening significantly earlier? A final issue is whether the anchoring of inflation expectations—which likely played an important role in the relatively painless disinflation—is now less secure than at the beginning of the episode because households and businesses may have come to sense that high inflation is not an impossibility.

Among the key lessons from the project:

- **Inflation is deeply unpopular, and its social and political costs can be large even when labor market damage is limited**. The experience of this episode suggests that policymakers should weigh the costs of inflation carefully when evaluating trade-offs during periods of strong demand, within existing policy frameworks, recognizing that inflation can generate outsized welfare and political consequences.
- **Inflation surged globally, but its specific underlying drivers differed across economies, with implications for policy**. Countries were affected to differing degrees by demand- and supply-side forces—an important distinction because the appropriate policy response depends critically on which forces are dominant in a given national context.
- **In the United States, excess demand combined with inelastic supply to generate the inflation surge**. The scale and timing of US fiscal support, particularly the $1.9 trillion American Rescue Plan (ARP) in 2021, pushed aggregate demand up against short-run supply constraints—though in real time there was uncertainty about the appropriate magnitude of support, and many policymakers regretted that more fiscal support had not been provided during the financial crisis era.
- **On the fiscal side, the difficulty of identifying real-time capacity constraints strengthens the case for greater reliance on automatic stabilizers**. Automatic stabilizers and rules-based fiscal mechanisms can help modulate support

2 Rachel Siegel, "Fed Chair says Interest Rates Should Have Gone Up Sooner," *Washington Post*, May 12, 2022.

as conditions change, reducing the likelihood that fiscal policy provides too much or too little economic support.

- **On the monetary side, in contrast, policy flexibility is especially critical in environments when uncertainty is elevated, and forecasting errors are likely**. The COVID era experience illustrates how difficult it can be to assess, in real time, the future evolution of inflation, especially when truly extraordinary shocks—far outside the range of experience of forecasting models—are hitting the economy.
- **Anchored inflation expectations played a critical role in enabling rapid disinflation in the early 2020s—but they cannot be taken for granted going forward**. Repeated or prolonged inflation shocks could weaken that anchor in the future, leading to higher inflation than otherwise and requiring tougher policy measures to combat price pressures.

Beyond macroeconomic stabilization policy, policymakers of all varieties will need to assess whether the nation's ability to measure inflation is up to the task in the context of an increasingly digital and immaterial economy. The measurement situation is particularly worrisome given the growing resistance of both households and businesses to respond to traditional surveys, as well as the severe funding constraints and staffing shortages facing statistical agencies in some countries, including the United States. Weaknesses in inflation measurement complicate real-time decision-making and may distort assessments of both economic conditions and policy effectiveness.

Finally, researchers will need to take stock of what has been learned to date about this episode and identify where important questions remain unanswered. Clarifying the boundaries of current understanding is essential for guiding future empirical work and for ensuring that the lessons drawn from the COVID era inflation experience contribute to better policy decisions going forward.

We provide a synthetic overview of the COVID era inflation experience, with a focus on its origins, the policy responses it elicited, and its economic consequences. This Policy Brief brings together insights from across the individual contributions to the project—as collected in this PIIE Briefing—to highlight common themes, areas of agreement and disagreement, and the key tradeoffs facing policymakers.

Section 2 recounts how the inflation surge unfolded. Section 3 evaluates key proposed contributors to the inflation surge. In section 4, we discuss the limits and strengths of policymakers' tools for economic analysis. Section 5 concludes with the key lessons for policymakers in the future.

Our goal is not to offer a definitive account of this episode but rather to distill the main lessons that emerge from the project as a whole and to clarify what they imply for future policymakers and researchers confronting inflationary pressures in different circumstances.

2. THE ECONOMIC BACKDROP: HOW THE INFLATION SURGE UNFOLDED

This section briefly recounts how the surge in inflation emerged and evolved during the economic recovery from the COVID-19 shock, providing a factual backdrop for the analysis that follows. The goal is not to adjudicate competing explanations at this stage, but rather to establish a common chronology and to highlight patterns that are relevant for evaluating different theories of the inflation surge.

The Initial Inflation Surge

In the United States, inflation moved above the Fed's 2 percent target in early 2021 as the economy was rebounding from an episode of extraordinary economic disruption. The onset of the COVID-19 pandemic a year earlier triggered abrupt shutdowns, a collapse in economic activity, and massive job losses, placing millions of American households under severe financial strain. With the slow and painful recovery from the 2007–09 Great Recession still fresh in policymakers' minds, their response was swift and forceful. A powerful combination of fiscal support, highly accommodative monetary policy, and financial market interventions was deployed to stabilize incomes, sustain demand, and limit lasting damage to the economy.

US policy remained strongly supportive in early 2021. Although economic activity was continuing to recover at a rapid pace as vaccination rates increased and public health restrictions eased, there was still considerable uncertainty about the effectiveness of vaccines against emerging variants and thus the durability of the recovery. Against this backdrop, monetary policy remained accommodative, and fiscal support was extended substantially further. In March 2021, Congress enacted and President Joseph R. Biden Jr. signed the American Rescue Plan, providing an additional $1.9 trillion of fiscal support—roughly 8 percent of 2021 US GDP.

US PCE inflation on a 12-month basis had sunk further below the Federal Reserve's target in the early pandemic period. It remained below target through February 2021 but then began to move up swiftly. By the middle of the summer of 2021, core inflation had risen to around 4 percent, with overall inflation higher still. Inflation continued to climb through the second half of 2021 and into 2022, with core inflation peaking around 5½ percent and overall inflation topping out around 7 percent by the middle of that year.

In *The Inflation Surge in Europe* (2024), Patrick Honohan shows that the contour of inflation in Europe was broadly similar, albeit with some differences in timing and composition. As in the United States, inflation rose sharply during the post-pandemic recovery, with price pressures spreading across major components of consumer spending. Inflation in the euro area built more slowly at first, reflecting a more gradual recovery in demand and less expansive fiscal support, but it subsequently reached a higher annual peak rate than in the United States. Energy and food prices played a particularly prominent role, with Europe's heavy reliance on imported natural gas—especially from Russia—leaving the region especially exposed to the surge in global energy prices following the invasion of Ukraine. Despite these differences in timing and proximate drivers, cumulative inflation over the four years ending in 2023 was only slightly lower in the euro area than in the United States. Inflation outcomes also varied widely across European countries, even within the euro area, shaped by differences in energy exposure and in national fiscal measures designed to shield households from rising costs. Inflation was markedly lower in Switzerland than in the other countries.

Inflation Across Components: A Sectoral Perspective

A useful way to understand how inflation took hold is to trace its progression across major components of consumer spending. In *The Trinity of COVID Era Inflation in G7 Economies* (2024), Joseph Gagnon and Asher Rose examine this evolution across the Group of Seven (G7) economies and identify a common sequencing in the behavior of prices for durable goods, nondurable goods, and services. Despite important cross-country differences in institutions, energy exposure, and policy responses, they find broadly similar patterns in the timing and composition of inflation across advanced economies. The discussion below draws heavily on their sectoral chronology and emphasis on cross-country commonalities, while also incorporating additional interpretation where relevant for understanding country-specific experiences. This sectoral chronology provides additional context for understanding the drivers of the inflation surge and helps discipline competing explanations by highlighting where—and when—price pressures first emerged.

The first sector to experience upward pressure on inflation, early in 2021, was durable goods. With household incomes supported by large-scale countercyclical policy measures, consumers had ample wherewithal to spend. At the same time, restrictions on in-person activity sharply constrained spending on some services, such as dining out and travel. As a result, consumers redirected spending toward durable goods, producing a rapid and unusually large shift in the composition of demand.

Production capacity and supply chains proved less able to scale up quickly than many had expected. When sharply rising demand for durable goods met relatively inflexible production and delivery channels, prices rose rapidly, contributing to a sharp increase in durable goods inflation.

As Gagnon and Rose emphasize, these dynamics were especially pronounced in motor vehicles in the United States. Early in the pandemic, many automakers canceled orders for the semiconductors that had become ubiquitous in modern vehicles, fearing a prolonged collapse in demand. When the decline in vehicle demand proved short-lived, automakers found themselves desperately short of this critical component—a shortage that could not quickly be reversed because chip makers by that time had committed much of their productive capacity to other customers. At the same time, used cars were also in short supply because rental car companies had purchased far fewer vehicles in 2020 due to the collapse in travel, leaving fewer late-model cars to sell into the used car market in 2021. Prices surged for both new and used vehicles.

A second major source of inflationary pressure was nondurable goods. In the United States, prices in these categories began to accelerate in the spring of 2021, a few months after inflation began to pick up in durable goods. More broadly in G7 countries, although prices of nondurables rebounded in 2021 from their sharp drop in 2020, it was not until Russia's invasion of Ukraine in February 2022 caused a spike in global commodity prices that inflation in these categories truly surged. The effects of the commodity shock were especially pronounced in Europe, where the cutoff of natural gas supplies caused severe hardship for households and businesses. Consumers in the United States and Canada were much less affected by the natural gas shock than their European counterparts, largely because the North American natural gas market was not closely integrated with the European market. Even so, energy and food prices rose in North America as well, contributing to a further rise in nondurable goods inflation.

Inflation in services also began to pick up in the spring of 2021 in the United States, particularly outside of housing-related components. Given the labor-intensive nature of many service industries, tight labor markets were a likely source of upward pressure on prices. Even though the unemployment rate—the most commonly cited measure of labor market slack—had not fallen sharply by that point, other evidence, including rising job openings and voluntary quits, suggested that labor market conditions were becoming taut. Wage growth accelerated, particularly in labor-intensive service industries, and employers passed these higher labor costs on to consumers. While services inflation did not rise as sharply as goods inflation, it proved more persistent over time.

From Peak Inflation to Disinflation

As inflation rose rapidly in 2021 and 2022, many observers feared that bringing it back down would require a prolonged period of economic weakness and a sharp increase in unemployment. In the event, inflation abated more quickly than many experts had anticipated, both in the United States and in Europe.

In the United States, inflation peaked in mid-2022 and then declined steadily over the next year and a half. Overall PCE inflation (measured on a 12-month basis) fell below 3 percent in late 2023 and core PCE inflation fell below that mark in the spring of 2024. Notably, the disinflation process occurred without the kind of pronounced downturn in employment and output that had often accompanied past efforts to bring inflation under control. Since early 2024, the disinflationary process has essentially stalled out, with both the overall and core measures remaining noticeably above the Fed’s 2 percent target.

In Europe, inflation peaked later than in the United States, reflecting the larger and more persistent impact of energy price shocks. However, inflation fell rapidly as those shocks began to reverse. By late 2023, euro area inflation had moved back to roughly 2.5 percent. Since mid-2025, it has been essentially back at the ECB’s 2 percent target.

The relatively rapid decline in inflation likely reflected a combination of forces. Aggregate demand softened as central banks tightened monetary policy (beginning in March 2022 in the United States and July 2022 in Europe) and as pandemic-era fiscal stimulus faded. At the same time, supply-side pressures eased as supply chains normalized, the composition of demand reverted more toward pre-COVID patterns, and commodities prices retreated from their peaks.

Even though inflation ultimately came down more quickly, and with less damage to the labor market, than many had feared, it nonetheless proved costly both economically and politically. Joanne Hsu provides a striking illustration of this point in her paper, *The Influence of Gasoline and Food Prices on Consumer Expectations and Attitudes in the COVID Era* (2024). At the end of a 15-year rise in inflation culminating in 1979—when inflation reached levels considerably higher than those seen during the COVID era episode—21 percent of consumers reported hearing negative news about inflation. By contrast, in June 2023, nearly twice as many consumers reported hearing negative news about inflation, even though inflation rates were much lower than in the earlier period. It is not clear whether the difference somehow reflected a greater vulnerability to inflation, a drastic change in the media environment, or a combination of both.

The broader costs may be larger still. In 2025, extensive media coverage of the Trump administration’s tariff actions appears to have heightened concerns among many American households that inflation could surge again in the near future. If a legacy of the COVID era inflation episode is that inflation expectations are now less firmly anchored than before, that would represent an additional and potentially substantial cost of the experience.

3. POTENTIAL DRIVERS OF THE INFLATION SURGE

The COVID era inflation surge has been the subject of intense debate over its causes, with a range of proposed explanations attracting both adherents and critics. This section uses the evidence assembled in this Briefing to evaluate several of the main candidates put forward as drivers of the surge. Although the findings resonate with parts of the broader literature, the value of this exercise lies in bringing together complementary perspectives and empirical approaches to shed new light on the relative roles of different forces.

Fiscal Policy

Fiscal policy has been among the most debated potential drivers of the COVID era inflation surge. Many countries mounted aggressive fiscal responses to the pandemic, which played a crucial role in protecting household incomes and buffering the initial economic shock. At the same time, these policies sparked a debate about whether the scale of support contributed to excess demand and thereby fueled inflation. Nowhere has that debate been more intense than in the United States, where fiscal stimulus amounted to roughly 23 percent of pre-pandemic GDP (Swagel 2021)—more than double the size of the response to the global financial crisis and substantially larger than the support enacted in most other advanced economies. Relative to many other advanced economies, US fiscal support was not only larger but also delivered more quickly and directed more heavily toward households, increasing the likelihood that it would translate into near-term demand pressures.

In *Fiscal Policy and the Pandemic-Era Surge in US Inflation: Lessons for the Future* (2024), Karen Dynan and Douglas Elmendorf examine the US experience, with particular attention to the $1.9 trillion American Rescue Plan (ARP) enacted in March 2021. Their analysis of contemporaneous projections from the Congressional Budget Office, the Federal Open Market Committee (FOMC), and private-sector forecasters shows that most analysts expected the additional stimulus to hasten the recovery without materially raising inflation. In retrospect, however, the assumption that supply would expand smoothly to meet the additional demand appears questionable. The ARP was substantially larger than contemporaneous estimates of the remaining output gap, and the economy was already on a trajectory of continued rebound at the time it was enacted.

The authors present a range of evidence suggesting that the inflation surge was driven primarily by excess demand encountering inelastic supply, rather than by adverse supply shocks alone. A closer examination of several prominent supply-side explanations—including the pandemic-related decline in labor force participation, semiconductor shortages, and the effects of the war in Ukraine—indicates that these factors likely contributed less to inflation than is often assumed. The timing and breadth of the price acceleration further support the centrality of a broad-based demand shock. Core PCE inflation rose sharply in early 2021, and by late summer even 12-month trimmed-mean PCE inflation, which excludes extreme price movements, was running materially above its range of the previous decade. At the same time, price increases across a wide range of categories rose well above their historical norms, consistent with a broad-based demand shock rather than a limited set of adverse supply developments.

Drawing these strands together, Dynan and Elmendorf emphasize the importance of accounting for supply inelasticity when designing fiscal policy.

Even when output appears to be below potential, pushing demand too aggressively can generate outsized inflationary pressures if the economy is already operating close to capacity or facing constraints on its ability to expand supply. They also stress the importance of assessing whether the scale of a proposed intervention is appropriate given the estimated shortfall in demand relative to supply.

Supply Chain Breakdowns

Discussions of post-pandemic inflation have frequently emphasized "supply shocks," but the term is often used imprecisely. Dynan and Elmendorf draw an important distinction between true supply shocks and supply constraints. They define supply shocks as idiosyncratic and often temporary shifts in the aggregate supply curve that raise prices at any given level of output. By contrast, supply constraints arise when strong demand pushes the economy onto a steeper portion of the supply curve, so that additional demand translates disproportionately into higher prices rather than higher output. This distinction matters for evaluating policy trade-offs because inflation driven by adverse supply shocks can present policymakers with harder choices given that such shocks may reverse in short order and that restraining demand to offset their inflationary effects risks exacerbating any shock-induced losses in output and employment. As discussed earlier, Dynan and Elmendorf argue that classic supply shocks played a limited role in fueling post-pandemic inflation.

Did Supply Chains Deliver Pandemic-Era Inflation? (2024) by Phil Levy provides a more detailed and focused examination of supply chains and their role in the inflation episode. Levy challenges the widely held narrative that breakdowns in supply chains were a primary driver of pandemic-era inflation. He shows that, despite highly visible strains—such as shipping delays, port congestion, and empty shelves—the volume of goods delivered to US consumers increased sharply. Real consumption of durable goods rose by more than 30 percent between early 2020 and 2021, and real imports expanded by 19 percent between late 2019 and mid-2022. These patterns are difficult to reconcile with a negative supply shock. Instead, they point to a large and sustained surge in demand overwhelming a constrained but fundamentally functioning logistics system. Levy notes that the highly visible indicators of strain made supply chain failures a compelling explanation for inflation, even though the underlying quantity data point instead to demand overwhelming a stressed but operational system.

Levy also considers what lessons this experience offers for improving supply chains, but he tempers expectations about what can realistically be achieved—and at what cost. Incremental efficiency gains, such as better coordination and smoother logistics, may yield benefits at the margin. However, large-scale investments aimed at maintaining excess capacity are unlikely to be economically viable. Expanding capacity in response to sudden demand surges, whether by ordering new ships or building semiconductor fabrication plants, typically takes years and often comes online after the peak in demand has passed. For this reason, Levy concludes that better demand management, rather than attempts to engineer large buffers of spare capacity, is essential for reducing the risk of similar inflationary episodes in the future.

Monetary Policy

Many central banks, especially the Federal Reserve, have been criticized for having been slow to recognize how serious and persistent the COVID era inflation surge would prove to be. In the United States, the Federal Reserve did not raise its policy rate above the effective lower bound until mid-March 2022. At that point, the most recent readings on PCE inflation (for the 12 months ending in January 2022) were 6.1 percent (overall) and 5.2 percent (core)—well above the Fed's 2 percent target.[3]

Monetary policymakers were slow to react in part because they believed for much of 2021 that the inflationary impulse would be merely transitory.[4] That assessment turned out to be seriously mistaken. An important question nonetheless remains: How much difference would it have made if policymakers at the Fed and elsewhere had recognized earlier the scale and persistence of the inflationary pressures that lay ahead?

In *US Monetary Policy and the Recent Surge in Inflation*, David Reifschneider addresses this question for the United States by conducting counterfactual simulations using FRB/US, one of the Federal Reserve staff's principal macroeconomic models. His analysis is based on an evolving historical baseline that incorporates incoming economic data and surveyed financial market expectations for real activity, inflation, and interest rates, updated each quarter as published data and survey assessments of medium-to-long-term outlooks change. He then assumes that beginning in early 2021 the FOMC followed a Taylor-style policy rule of the sort it had historically followed prior to the pandemic. This rule "would have called for raising the federal funds rate appreciably earlier than the FOMC did, and over time by considerably more, in response to both the surge in inflation and evidence that the labor market was far more overheated than the unemployment rate alone suggested" (p. 2).

Reifschneider further assumes that the FOMC provided forward guidance that it would strictly follow this policy rule from then on and would also curtail its large-scale asset purchases earlier and at a lower level than it did in practice (and than was anticipated by financial market participants). To estimate the potential effectiveness of this much less accommodative strategy, Reifschneider assumes that the FOMC's counterfactual forward guidance would have been completely credible and that agents would have revised their expectations accordingly.

To gauge the robustness of his findings regarding the potential effects of tighter monetary policy, Reifschneider conducted simulations using four different specifications of inflation dynamics in the United States, calibrated to take account of a range of published estimates of the slope of the US Phillips curve and the persistence of actual and expected inflation.[5] He also ran simulations of a modified version of the FRB/US model in which aggregate spending is twice as sensitive to movements in interest rates and other financial factors.

3 These estimates correspond to the data available at the time. Estimates for inflation in January 2022 have since been revised up a bit—to 6.3 percent and 5.4 percent for the overall and core categories, respectively.

4 See Powell (2024) for a discussion of the Federal Reserve's thinking along these lines.

5 These specifications include the inflation dynamics native to FRB/US, as well as those used in three other recent empirical studies of US inflation dynamics: Bernanke and Blanchard (2023), Cecchetti et al. (2023), and Gagnon and Collins (2019).

Reifschneider's key finding is that "across almost all the permutations of the Phillips curve and other simulation assumptions, the counterfactual monetary policy does little to check inflation in 2021 and reduces it by only a few tenths of a percentage point in 2022, although the simulations do show PCE inflation moving somewhat more quickly back to the FOMC's 2 percent target in 2023 and 2024" (p. 3). These results do not entirely exonerate the Federal Reserve—nor the other central banks that were similarly late to tighten their respective policies—but they do suggest that an earlier and much more aggressive tightening would likely have had only quite limited effects on the inflation surge itself. In this sense, the simulations point to forces outside the direct control of monetary policy as having played the dominant role in driving inflation higher.

In *Was Something Structurally Wrong at the FOMC?* (2024), Alan Blinder examines the related issue of why the FOMC was slow in beginning to tighten the stance of monetary policy. He starts by rejecting the common explanations that the committee had become excessively dovish and that policymaking committees are inherently slow to act. More likely, Blinder argues, the delay in raising the federal funds rate stemmed from a forecasting error, specifically a belief that inflation would not rise to the levels it ultimately reached and would recede more quickly than it did.

Digging one layer deeper, Blinder considers the possible role of the new monetary policy "framework" that the FOMC adopted in August 2020. He highlights two features that may have made the committee more inclined to underreact to the buildup of inflation. First, the framework stated that the committee would respond only to "shortfalls" of employment from maximum employment, rather than to "deviations" in either direction. Second, the framework indicated that following periods in which inflation had persistently undershot its 2 percent target, the committee would allow inflation to overshoot "moderately…for some time." Arguably, both of these changes could have tilted the committee toward a less vigorous policy response.

While acknowledging the plausibility of the argument that the framework made the situation worse, Blinder ultimately downplays its likely significance. As he puts it, "The case that dovish asymmetries in the new framework played a role in the policy error seems obvious, and there is no doubt some truth to it. But I think the blame has been exaggerated" (p. 10). Instead, he argues that the bulk of the inflation surge reflected supply shocks and supply constraints, and that monetary policy itself likely played a secondary role. In support of this view, he points to Reifschneider's counterfactual simulations.

Even if the framework was not the principal source of the policy delay, Blinder nonetheless argues that some adjustments to the 2020 framework may have been warranted. He recommends that the committee drop its inclination to allow inflation to run moderately above target following sustained undershoots. He also suggests replacing the current point target of 2 percent with a target range between 1.5 and 2.5 percent. In his view, such a range would have three advantages: it would eliminate the appearance of false precision in inflation control; it would reduce the need for forward guidance, as market participants would understand that the committee would lean against inflation approaching either end of the range; and it would reinforce symmetry in the conduct of monetary policy. In its subsequent framework review, the FOMC modified its framework in line with Blinder's first recommendation, replacing the tendency to allow an inflation overshoot with a more neutral statement that it would be "prepared to act forcefully to ensure that longer-term inflation expectations remain well anchored."[6] However, the committee retained a point inflation target rather than adopting a range.

As Patrick Honohan notes in *The Inflation Surge in Europe*, the European Central Bank (ECB) began tightening policy later than the Federal Reserve, broadly in line with the fact that the rise in inflation in Europe lagged that in the United States by roughly half a year. As in the United States, this timing naturally raised questions about whether policymakers had been slow to appreciate how persistent inflationary pressures would prove to be.

By the time Honohan was writing in early 2024, however, attention had shifted to a different question: whether the ECB had subsequently tightened policy too aggressively. As he put it, "Did [the ECB] persist in this tightening for too long, bringing interest rates to too high a level? Would inflation have slowed sufficiently, and with less damage to the level of economic activity if the ECB's action had been less aggressive?" (p. 11). Indeed, the ECB then started to lower rates sooner than the Fed, and by late 2024 inflation was back down to its target, where it has been since and is expected to remain through 2027.

At the same time, despite geopolitical shocks, the average euro area unemployment rate was below 6½ percent, more than a percentage point below its pre-pandemic level. As in the United States, the euro area appears to have achieved disinflation with remarkably little increase in unemployment, an outcome that seemed far from assured when inflation was near its peak.

Inflation Expectations

The COVID era inflation surge also raised concerns about whether inflation expectations might become less firmly anchored. Expectations are influenced by many factors, including public beliefs about whether policymakers have both the tools and the resolve to bring inflation back to target. If confidence in that capacity were to erode (regardless of whether those beliefs accurately reflect policymakers' true capabilities or intentions), expectations could become a source of inflation persistence in their own right.

In *The Influence of Gasoline and Food Prices on Consumer Expectations and Attitudes in the COVID Era* (2024), Joanne Hsu presents evidence suggesting that inflation expectations, as measured by the Surveys of Consumers at the University of Michigan, did not become less firmly anchored. Historically, inflation expectations have tended to move with realized inflation. Hsu shows, however, that the sensitivity of inflation expectations to actual inflation outcomes was lower in recent years than it had been over the period since 1978 during which the University of Michigan has collected such data. By this metric, inflation expectations appear to have remained relatively well anchored despite the unusually large and persistent inflation shock.

At the same time, Hsu documents a striking contrast in how consumers responded along other dimensions. While inflation expectations themselves

6 Board of Governors of the Federal Reserve System, 2025 Statement on Longer-Run Goals and Monetary Policy Strategy, adopted effective January 24, 2012; as amended effective August 22, 2025.

became less responsive to realized inflation, the survey's headline consumer sentiment index became more responsive. Between 2020 and 2023, a 1-percentage-point increase in core inflation was associated with a roughly 2.5-point decline in consumer sentiment—more than three times the average sensitivity observed over the full 1978–2023 sample.

A different perspective on inflation expectations is provided by Joseph Gagnon and Asher Rose in *Why did Inflation Rise and Fall So Rapidly? Lessons from the Korean War* (2025), who compare the COVID era inflation episode to earlier surges, particularly those during the Korean War era and the 1970s. They note that inflation subsided quickly after the Korean War without a rise in unemployment—an outcome they attribute to strong fiscal discipline and confidence in the Federal Reserve's commitment to price stability. By contrast, the inflation surges of the 1970s were prolonged and receded only after painful increases in unemployment, in part because the Fed lacked a clear anti-inflation mandate and allowed expectations to drift upward in response to repeated policy missteps.

The Korean War and 1970s episodes illustrate how the credibility of the monetary regime can determine whether inflation shocks dissipate or become entrenched. Gagnon and Rose argue that the Federal Reserve's strong credibility in recent decades helped prevent expectations from becoming unmoored during the COVID era surge, contributing to the broader set of factors that enabled inflation to decline without a sharp rise in unemployment.

While central bank credibility has been documented to play an important role in anchoring inflation expectations, less is known about the other forces that shape them. In *The Role of Long Histories of "Lived Experience" in the COVID-Era Inflationary Surge*, Joseph Gagnon and Steven Kamin present a cross-country analysis that suggests that expectations are influenced not only by recent inflation or institutional frameworks, but also by deeper, longer-term historical experience. They show that countries with higher inflation during the 2000–2015 period experienced significantly larger inflation surges during the COVID era—even after controlling for more recent inflation, output gaps, and policy characteristics such as inflation targets and central bank independence. These results are robust across country samples and alternative specifications, and complementary evidence from long-term bond yields and surveys of professional forecasters points to a similar role for long inflation histories in shaping expectations.

Gagnon and Kamin argue that in times of volatility and uncertainty, households and firms rely more heavily on their "lived experience" with inflation to form expectations—especially when that experience includes high inflation. While the United States entered the COVID era with strong inflation credibility, the findings raise a cautionary note: repeated or prolonged inflation shocks could erode the hard-won anchor.

4. TOOLS OF ECONOMIC ANALYSIS

The pandemic-era inflation surge also exposed the limits—and strengths—of the tools policymakers rely on to monitor the economy and assess risks in real time. Papers in this series address a few of these issues, including how well official price statistics performed under extraordinary conditions, whether alternative indicators offer better signals of underlying pressures, and how existing models capture key nonlinearities in inflation dynamics. Taken together, this work highlights both the resilience of core statistical infrastructure and the need for continued methodological and data innovation.

A central contribution in this area is provided by *Modernizing Price Measurement and Evaluating Recent Critiques of the Consumer Price Index*, in which Daniel Sichel and Christopher Mackie examine a number of allegations that were leveled at the two principal US price indexes—the CPI and the PCE price index—during the COVID era inflation surge. Drawing on a recent National Academies report (National Academies of Sciences, Engineering, and Medicine 2022), Sichel and Mackie carefully evaluate these critiques and conclude that the basic methodology underlying these measures is sound. They argue that while some critiques raised legitimate issues, others were clearly misplaced.

One critique with some substance concerns the expenditure weights used to aggregate detailed prices into the overall index. When the pandemic hit, the CPI relied on weights that reflected purchasing patterns from roughly 36 months earlier, on average. Because spending patterns shifted extraordinarily rapidly during the pandemic, these pre-pandemic weights became unrepresentative in some cases. The Bureau of Labor Statistics (BLS) has since adjusted its methodology to reduce this lag, but as Sichel and Mackie note, the CPI still relies on weights based on spending patterns from about 24 months earlier, on average. Addressing this issue more decisively would require a more fundamental overhaul of the index's underlying methodology—an effort that would demand additional resources and sustained investment in the statistical agencies. As they emphasize, progress on this front will be difficult if Congress and the president continue to constrict agency budgets.

By contrast, Sichel and Mackie argue that some other prominent critiques have little or no merit. In particular, some analysts pointed to the divergence during the inflation surge between the CPI's housing components and private-sector indexes based on newly signed leases. Sichel and Mackie explain that this divergence largely reflects differences in measurement objectives rather than flaws in the official data. The CPI is designed to capture the rent experience of all households, not just those entering into new leases at a given moment. Given that objective—which they view as appropriate—the CPI's housing components are sensibly designed and competently executed.

Sichel and Mackie conclude that while there is room for improvement, the CPI is conceptually sound and performed well during the recent inflation surge—no small accomplishment. Even when much of the country was locked down, the BLS continued to publish the CPI on time and with a high degree of accuracy. More broadly, they argue that the core economic statistical agencies—the BLS, the Bureau of Economic Analysis, and the Census Bureau—served the nation well during an extraordinarily challenging period.

Another paper in the series focuses on indicators and models used to assess labor market tightness and wage pressures—key inputs into inflation analysis. In *Labor Market Tightness and Inflation Before and After the COVID-19 Pandemic*, Justin Bloesch evaluates the wage Phillips curve (the relationship between labor market tightness and nominal wage growth) and argues that the quits rate provides a more reliable measure of labor market tightness than traditional indicators such as the unemployment gap or the vacancies-to-unemployment ratio. Using both time-series regressions and structural modeling, he shows that the quits rate consistently outperforms alternative measures in explaining movements in nominal wage growth, including during the post-pandemic period when standard indicators sent mixed signals. The strong empirical relationship between the quits rate and wage growth as measured by the Employment Cost Index held up even as other labor market metrics became less informative.

As part of this analysis, Bloesch also emphasizes the importance of nonlinearities in key labor market relationships, including the wage Phillips curve and the Beveridge curve (the relationship between job openings and unemployment). In his framework, the post-pandemic recovery pushed the economy onto steep portions of these curves, implying larger increases in wage pressures when labor markets were tight. As demand eased, however, wage growth moderated with only modest increases in unemployment. This nonlinear perspective helps rationalize the combination of elevated inflation followed by a relatively soft landing and is consistent with broader arguments in the series—most notably by Dynan and Elmendorf—that inelastic supply and nonlinear responses can generate large price movements even in the absence of large changes in measured slack.

Finally, in *US Wage Patterns During and After the Pandemic*, Jeff Nezaj, Nela Richardson, and Liv Wang highlight the potential value of new, private-sector data sources for improving real-time economic analysis. Using high-frequency, worker-level payroll data from ADP, they examine wage and employment dynamics during and after the pandemic. Their analysis shows that much of the volatility in average wages reflected compositional shifts in the workforce—such as changes in industry mix, age distribution, and job-switching behavior—rather than underlying wage pressure. These findings underscore the importance of tools and models that explicitly account for composition effects when interpreting wage data, particularly during periods of rapid labor market churn.

More broadly, the paper illustrates how private-sector administrative data can be especially valuable during periods of rapid economic change. Such data can often be available with much shorter lags and at higher frequency and greater granularity than traditional official time series. At the same time, as the authors themselves emphasize, proprietary datasets such as ADP—while covering more than 26 million workers, or roughly one-fifth of the US private-sector workforce—reflect the experiences of a particular client base rather than a representative cross-section of the economy; for this reason, private data are best viewed as a complement to official statistics rather than a substitute (see also Kolko 2025).

5. LESSONS

Taken together, the papers in this project provide a detailed account of the causes, dynamics, and consequences of the COVID era inflation surge. While many uncertainties remain, the evidence assembled here supports a set of lessons that are relevant for future policy design and conduct. These lessons are necessarily conditional, given the idiosyncratic nature of the episode, but they nonetheless point to several principles that are likely to have broader application than just this one historical episode.

- **Inflation is deeply unpopular, and its social and political costs can be large even when labor market damage is limited**. Consumer sentiment deteriorated sharply as inflation rose, and some measures have remained weaker than would be suggested by traditional economic fundamentals even as inflation has receded. The experience of this episode reiterates a phenomenon that Stanley Fischer and John Huizinga noted more than 40 years ago—that everyday consumers dislike inflation with an intensity that economists find, if anything, difficult to understand (Fischer and Huizinga 1982). This pattern suggests that policymakers should weigh the costs of inflation carefully when evaluating trade-offs during periods of strong demand, within existing policy frameworks, recognizing that inflation can generate outsized welfare and political consequences.

- **The inflation surge was global in scope, but its specific underlying drivers differed in important ways across countries, with implications for policy**. To be sure, the pandemic was a common shock, and many economies were later affected by similar commodity price shocks. At the same time, countries differed markedly in their fiscal responses to the pandemic, exposure to global energy markets, labor market institutions, and economic structures. This diversity cautions against relying on a single explanatory narrative. It is likely that countries were affected to differing degrees by demand- and supply-side forces—a distinction that is particularly important because the appropriate policy response depends critically on which forces are dominant in a given national context.
- **In the United States, the evidence points to a central role for excess demand interacting with inelastic supply**. The scale and timing of US fiscal support, particularly the American Rescue Plan, pushed aggregate demand against short-run supply constraints in an economy already recovering rapidly. Analyses by Dynan and Elmendorf, reinforced by Levy's evidence that supply chains delivered historically large quantities of goods despite visible strain, support the conclusion that excess demand was a key driver of the US inflation surge. This assessment does not imply that the appropriate scale of fiscal support was obvious in real time: Policymakers faced uncertainty about the trajectory of the pandemic, the degree of economic slack, and the speed with which supply constraints would ease. Many were also likely influenced by the experience of the global financial crisis era, when fiscal support was too small and withdrawn too quickly.
- **While the specific circumstances of the COVID era are unlikely to recur, the episode highlights a more general lesson about nonlinearities in aggregate supply**. Even when some slack appears to remain by some measures, pushing demand too far and too fast can trigger disproportionately large inflationary responses once the economy moves onto a steep portion of the aggregate supply curve or labor market Phillips curve. In such regions, relatively small additional increases in demand can translate into large price movements. Although it is extremely difficult to identify these thresholds in real time, the risk of crossing them is one that both monetary and fiscal policymakers need to take into account.
- **On the fiscal side, the difficulty of identifying real-time capacity constraints strengthens the case for policy frameworks with greater automatic adjustment features**. When demand is evolving rapidly and supply conditions are uncertain, discretionary fiscal interventions calibrated under substantial

uncertainty are at high risk of either providing too little support (as happened in the wake of the global financial crisis) or too much (in the case of the COVID episode). Automatic stabilizers and rules-based fiscal mechanisms can help modulate support as conditions change, reducing the likelihood that policy inadvertently misses the mark in terms of adequately addressing demand shortfalls, but not going overboard. Automatic stabilizers would also reduce reliance on discretionary judgments about the appropriate scale of stimulus in periods when estimates of the demand shortfall are subject to high uncertainty as they were in the COVID era. The formula used to calibrate the size of fiscal support could also take into account the pace of inflation relative to the central bank's target.

- **Monetary policy flexibility is critical in environments where inflation risks are outsized, and forecasting errors are likely**. The COVID era experience illustrates how difficult it can be to assess, in real time, the future evolution of inflation, especially when truly extraordinary shocks—far outside the range of experience of forecasting models—are hitting the economy. Counterfactual simulations using the FRB/US model suggest that even substantially earlier and more aggressive tightening would likely have had only modest effects on inflation in 2021 and 2022, though it might have brought inflation back to target somewhat sooner thereafter. An even worse outcome was prevented by the willingness of monetary policymakers to aggressively adjust the stance of their policy once the scale and persistence of inflation became clearer. That adjustment contributed to restoring price stability without precipitating a severe downturn, underscoring the value of policy frameworks that allow for timely recalibration in the face of evolving evidence—and the willingness of policymakers to change their minds in light of changing circumstances.
- **Anchored inflation expectations played a critical role in enabling rapid disinflation in the early 2020s—but they cannot be taken for granted going forward**. Historical analysis by Gagnon and Rose underscores how central bank credibility shaped the very different inflation outcomes following the Korean War and during the 1970s. Their work, together with Gagnon and Kamin's analysis of "lived experience," suggests that expectations are influenced not only by recent inflation experience and institutional frameworks but also by longer-term historical memory. While US inflation expectations remained anchored during the COVID era surge, repeated or prolonged inflation shocks could weaken that anchor in the future, leading to higher future inflation and increasing the economic costs of policies to restore price stability. Against that backdrop, it is disquieting that inflation has not yet returned to its 2 percent target level in the United States—though it has in Europe.
- **The rise in some measures of inflation expectations in 2025 serves as a cautionary signal for the future**. Following announcements of dramatically higher tariff rates, both short- and longer-term inflation expectations as measured by the University of Michigan's Surveys of Consumers rose materially. Although the runup has largely been reversed, it illustrates how expectations can respond quickly to perceived policy shifts. Maintaining credibility and clear communication will therefore remain essential as monetary policymakers confront future shocks.

- **Official inflation statistics performed well during the COVID era, but continued investment in measurement capacity is essential.** The CPI and PCE price indexes captured the broad contours of inflation during the pandemic era, and no credible evidence suggests otherwise. At the same time, the episode highlighted the importance of ongoing modernization of statistical systems. Private-sector data can be valuable as complements—especially for timeliness and granularity—but cannot substitute for the representativeness, continuity, and public accountability of official statistics.

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PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

POLICY BRIEF

24-2 The Inflation Surge in Europe

Patrick Honohan

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INTRODUCTION

For most of the decade before the COVID-19 pandemic, undershooting rather than overshooting had been the main inflation problem of the European Central Bank (ECB). During 2020, consumer prices in the euro area were falling; by the end of that year, average inflation since the start of the euro two decades earlier stood at only 1.6 percent per year. Things began to snowball in 2021. The 12-month inflation rate steadily accelerated. It reached double digits in the final quarter of 2022—more than twice the level it had ever reached since the euro's introduction in 1999.

Four striking features emerge from a review of the unexpected surge in European inflation since 2021:

- The ECB's monetary policy response lagged behind that of the Federal Reserve, reflecting the more gradual evolution of inflation in the euro area and its distinct pattern of causes.
- The range of inflation rates across different euro area countries has been unprecedented. This largely reflects the differential impact of war-related energy shocks (especially for natural gas piped from Russia) as well as the differential fiscal response by national governments partially insulating consumers from these shocks.
- Not all households were net losers from the inflation, with some benefiting from the fact that inflation reduced the real value of their indebtedness.
- The speed with which inflation was returning toward target during 2023 prompted concerns that the ECB's monetary tightening might have been pushed too far, prolonging the output slowdown.

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Given the dominance within Europe of the euro—the home currency for about 350 million people—the main focus of this brief review is on the euro area. I also make some reference to the three next-largest advanced economies of the continent, namely those of the United Kingdom, Switzerland, and Sweden.

THE PATTERN OF THE INFLATION SURGE IN EUROPE

Although some of the preconditions and some of the drivers of euro area inflation were similar to those in the United States, the timing was different, reflecting transatlantic contrasts. The lag between the increase in inflation in the United States and that in the euro area was about half a year. For example, euro area 12-month inflation remained below 5 percent until December 2021, whereas that level had already been breached in the corresponding US (HICP) index six months previously.[1] Peak 12-month inflation in the euro area at 10.6 percent was slightly higher in the euro area than in the US (10.1 percent) and was reached only in October 2022. (As discussed later, some individual small euro area countries registered much higher peaks).[2]

To take a broad view, it is informative to look at the *cumulative* inflation between the end of 2019 and the end of 2023. In the euro area, cumulative inflation over those 48 months was 17.7 percent, compared with 18.8 percent in the United States.

Of the other advanced European economies outside the euro area, the United Kingdom recorded somewhat higher cumulative inflation (21.8 percent) than the euro area. At 18.7 percent, Sweden was closer to the euro area average. In sharp contrast was the price stability maintained by Switzerland, where cumulative inflation during the four years to end-2023 was only 5.2 percent (figure 1).

CAUSES

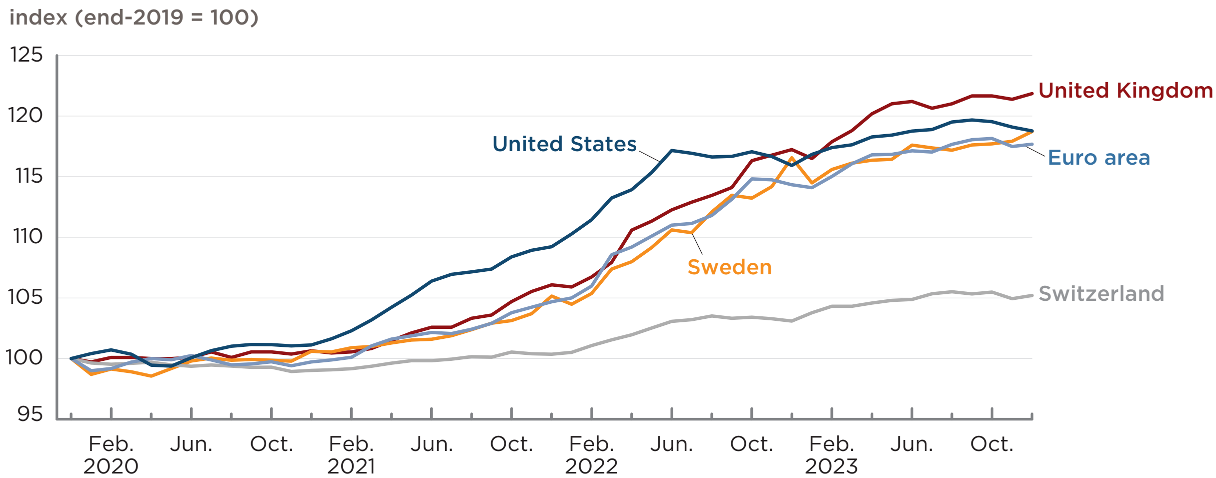
The most striking impulses to inflation in Europe during 2021 and 2022 came from the supply side: global pandemic-related disruption to supply chains, energy price increases, and exchange rate changes.

The *supply chain bottlenecks* were similar to those in the United States. Some came directly from the pandemic, including constraints on manufacturing from shutdowns in China and other supplier countries. The global supply response to shifting demand patterns for semiconductors and some other products was sluggish. Further factors included the shift in demand during 2020–21 from (partly unavailable) services to goods, especially durables, and the transportation bottlenecks to deliver the increased quantity of manufactured goods now demanded. These shifts in the structure of demand happened in Europe as

1 We use the European Harmonized Index of Consumer Prices (HICP) concept. For the United States, this is the research series R-HICP constructed by the US Bureau of Labor Statistics (https://www.bls.gov/cpi/research-series/r-hicp-home.htm). It differs from the US consumer price index (CPI) mainly in the treatment of owner-occupier housing (which the HICP largely excludes). But the uptick in the R-HICP and in the US CPI occurred at the same time. The US price index targeted by the Federal Reserve, namely for personal consumption expenditures (PCEPI), rose less, but with a similar time pattern to that of the R-HICP. The United Kingdom no longer publishes the HICP, but its CPI is based on the same definition.

2 Central and eastern European countries outside the euro area also registered high 12-month peaks, for example, 26 percent for Hungary and 19 percent for Czechia.

Figure 1
Consumer price index (HICP) relative to end-2019 US and selected European currencies



HICP = Harmonized Index of Consumer Prices
Note: The euro area is defined as the 20 countries that used the euro as of December 2023: Austria, Belgium, Croatia, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.
Source: Eurostat.

well as in the United States (Bobasu and Gareis 2023). The global supply chain bottlenecks contributed to inflation on both sides of the Atlantic, even though European ports were not as congested as those in the United States. Whether measured by the Federal Reserve Bank of New York's Global Supply Chain Pressure Index or the ECB's bottleneck indicators, supply chain bottlenecks increased fairly steadily from late 2020 until late 2021 or early 2022.

Reflecting these supply chain bottlenecks, it was the price of goods that first accelerated; indeed, in Europe, services inflation was much slower to catch up with that in goods than was the case in the United States.

Supply-side effects show up partly in rising unit costs but also in a growing net operating surplus of the euro area business sector during 2022 (Hahn 2023, Hansen et al. 2023).

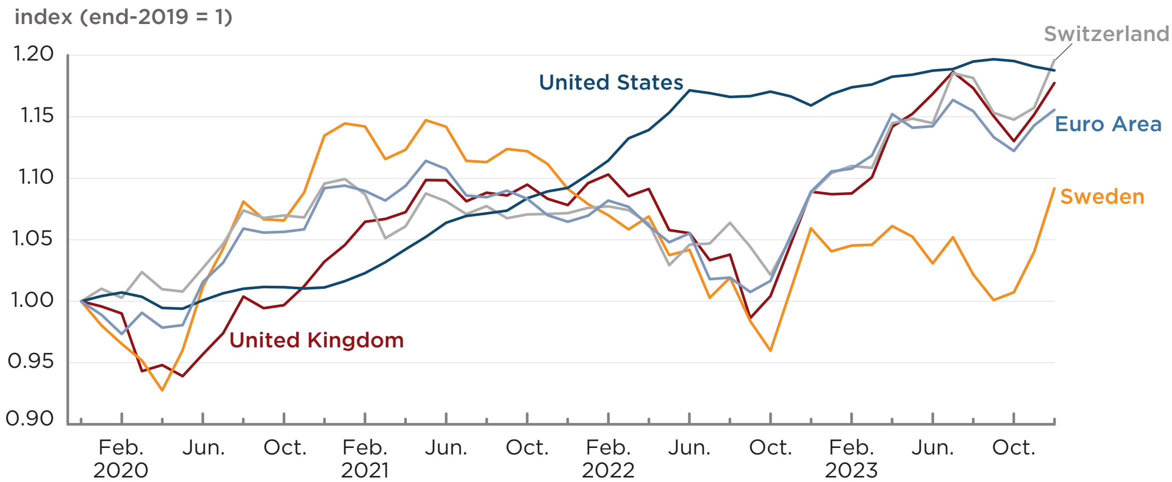
After 2022, supply chain bottlenecks eased considerably.

Exogenous *energy price* increases, already evident throughout 2021, spiked after Russia's invasion of Ukraine in February 2022. They contributed to a much stronger inflation surge in Europe than in the United States. This was due to Europe's higher dependence on natural gas imported in pipelines from Russia, for which close substitutes were not immediately available. Increases in food prices in global markets (also partly associated with the war in Ukraine) added a further upward supply pressure on consumer prices from mid-2022 (ECB 2024, figure 9).

Thus, a major contrast with the United States is the fact that Europe's aggregate terms of trade deteriorated during this period due to its dependence on imported fossil fuels. The decline was most pronounced in 2021 and early 2022, with some rebound in 2023. (In contrast, the sharp increase in the relative price of energy meant that the terms of trade favored the energy-rich United States.) Average living standards in the euro area barely changed in 2021–23 (this being another contrast with the United States). The development of alternative

Figure 2

Consumer prices measured in a common currency (US dollars) in the euro area, United States, and other selected countries, 2020–23



Note: In this figure, the euro area excludes Croatia, which adopted the common currency only in 2023.
Source: Author's calculations based on Eurostat.

energy sources and the lowering of prices during 2023 eased this situation considerably and contributed to disinflation.

Exchange rate movements must be taken into account to understand European inflation dynamics. Of course, this is a two-way process, with actual and expected inflation, as well as interest rate differentials, influencing the market determination of exchange rates. But safe-haven flows, exogenous to European inflation, contributed to the appreciation of the US dollar against the euro and sterling.

These exchange rate movements seem to have added an additional nominal cost-push in European countries with depreciating currencies from mid-2021 through late 2022. (Here, too, there was a subsequent partial reversal.)

The much lower inflation recorded by Switzerland may also be partly due to a safe-haven exchange rate effect in 2022. Indeed, deviations from purchasing power parity between the euro, the Swiss franc, and the pound sterling over the four years 2020–23 were remarkably small. For example, figure 2 shows that, despite much lower inflation in Switzerland, its price level in a common currency closely tracks those in the larger euro area and UK economies during this four-year period, showing the operation of a purchasing power parity mechanism).

Demand factors were also relevant to the inflation surge, but they were a greater driving factor in the United States. As relative prices changed, the accumulation of household savings (fueled in part by sizable unspent fiscal supports during the pandemic) and the ample bank liquidity (thanks to a decade of monetary ease) created an accommodating environment for price increases on both sides of the Atlantic. This meant that there was little or no countervailing demand limitation to dampen overall inflation.

Still, whereas the continuation of expansive fiscal policy in the United States in 2021 likely contributed an important inflationary impulse in that country, this channel was less prominent in the euro area because of its lower fiscal impulse. Thus, the excess household savings that accumulated in Europe were somewhat smaller and were not substantially drawn down during 2021–22 (Battistini, Di Nino, and Gareis 2023; Jordà and Nechio 2023).[3] Based on European Commission staff estimates, the euro area output gap in 2022–23 was close to zero.

A number of econometric studies have sought to pinpoint the relative importance of various components of supply and demand in euro area inflation, fitting their models to data running back some decades. For example, Bańbura, Bobeica, and Martínez Hernández (2023) use a vector autoregressive (VAR) structure with zero and sign restrictions designed to identify the different types of shock. Their findings in regard to which shocks have contributed most to the 2021–23 surge are qualitatively consistent with the above narrative emphasizing supply shocks and exchange rate movements, especially because "demand shocks" in their methodology include all shocks that have an effect through the exchange rate. Interestingly, they find that energy price shocks have a considerable impact on *core* inflation even though energy prices are not directly measured in the core.[4]

DISTRIBUTIONAL ASPECTS AND SECTORAL ASPIRATIONS

Despite 20 European countries sharing a common currency, there was considerable variation between the experience of different euro area countries.

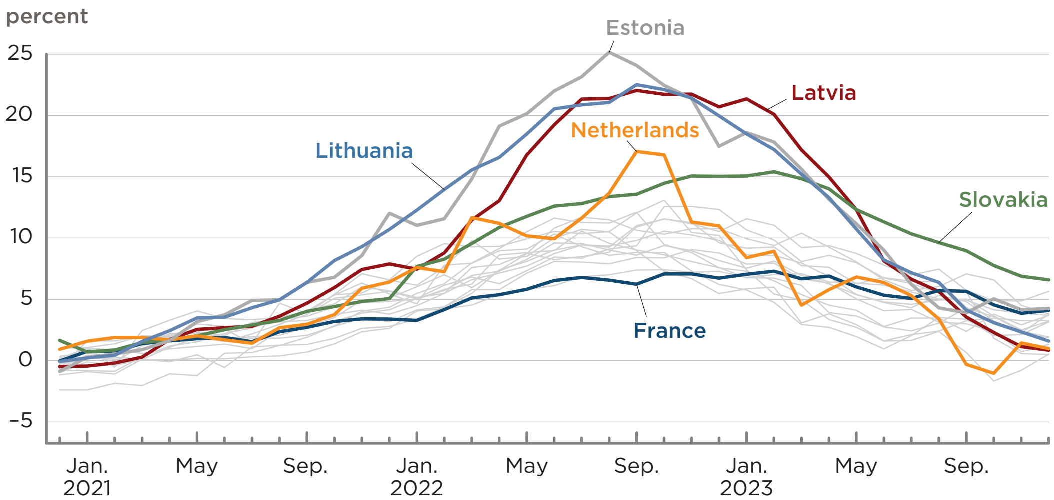
In August 2022, the 12-month inflation rate in Estonia was 25.2 percent, but it was only 6.6 percent in France, a remarkable and unprecedented gap of almost 19 percentage points. And Estonia was not alone: Latvia and Lithuania recorded 12-month peaks of more than 22 percent. By end-2023 the spread had shrunk, but only to just below 6 percentage points (now the largest gap is between Slovakia and Italy; figure 3). (The standard deviation increased across the euro area countries, from below 1 percentage point before the inflation surge to 5 percentage points in September 2022, before falling back to below 2 percentage points by end-2023).

These inflation differentials between euro area countries were also sustained. The countries with the lowest cumulative inflation in the euro area during the four years from end-2019 were Greece and Finland, with less than 14 percent. Once again, smaller euro area countries in central and eastern Europe recorded much higher cumulatives: 36 percent for Estonia (just across the gulf from Finland) and over 30 percent for Lithuania, Slovakia, and Latvia.

3 The potential role of fiscal policy is stressed by Bianchi and Barro (2023); their regressions do not show a significant effect of individual country fiscal impacts in the euro area, but only of the aggregate euro area fiscal stance.

4 Likewise, the econometric models of di Giovanni et al. (2022, 2023) find that supply shocks were relatively more important in the euro area than in the US inflation. De Santis (2024) finds that supply chain disruption shocks contributed more than a third of the increase in euro area inflation (to September 2022), and retail energy shocks 12 percent. Work in progress by Ascari et al. (2024) suggests an even smaller contribution of demand factors to euro area inflation at its peak in late 2022. The estimates of Bernanke and Blanchard (2024) imply that supply shocks dominated the inflation burst not only in the euro area and the United Kingdom but also in the United States.

Figure 3
Twelve-month inflation rates in euro area member states, 2020–23



Note: For each date, the figure shows the percentage increase in the Harmonized Index of Consumer Prices over the previous 12 months. In Estonia, prices increased by 25.2 percent between August 2021 and August 2022; in France over the same period, the increase was 6.6 percent.
Source: Eurostat.

Much of the differential was attributable to cross-country differences in dependence on energy supplies from Russia. The impact of the price increases for energy sourced from Russia on energy costs also differed. The differences reflected technical imperfections in the cross-country transmission of energy supplies as well as the differential energy intensiveness of different economies, and in particular the differing degree to which preconditions made it difficult to substitute away from natural gas imported from Russia (Coutinho and Licchetta 2023; Coutinho et al. 2023; Müller 2023). Baltic countries were particularly dependent on imported natural gas.[5]

Inflation differentials were also significantly affected by different national approaches to fiscal subsidization of retail energy costs. Fiscal measures designed to cushion households from some of the energy price increases were introduced in most European countries. Some of these measures resulted in subsidized prices, thereby directly lowering the measured inflation, whereas others came in the form of lump sums not affecting measured inflation. Energy subsidies could have indirect effects also, some of them deflationary (by obviating explicit or implicit wage indexation), some inflationary (by increasing aggregate demand).

The amount of funding allocated by national governments in the euro area to shield households and firms from the energy price increases of 2021–22 varied considerably from country to country, with a high of almost 7.0 percent of GDP in Malta down to about 0.5 percent in Finland (Sgaravatti et al. 2023). About two-thirds of the sums involved in measures targeting households were used to reduce prices, with the remainder used for income support measures. Almost

5 In contrast, the wholesale market for electricity is better integrated and an active market established a common marginal wholesale electricity price across the European Union.

four-fifths applied universally, meaning they were not targeted to particular classes of income levels (Sgaravatti et al. 2023). If they expanded aggregate demand, borrowing-financed fiscal energy subsidies could have an indirect expenditure effect on inflation, partly offsetting reductions in consumer prices of energy products. This does not seem to have been a large effect in Europe, partly because most of the subsidies were time limited. Instead, without the subsidies, it has been estimated that peak euro area 12-month inflation would have been almost 3 percentage points higher (Dao, Gourinchas, and Leigh 2023).[6]

How the welfare of households has been impacted by the unexpected surge of inflation has varied not only by country but also by other characteristics, which can be much more important.[7] A detailed recent study (Pallotti et al. 2023) examined this issue for the four largest euro area countries. For example, the study considered the way in which inflation lowers the real value of nominal assets and liabilities in a way that is unlikely to be reversed when inflation returns to target, thereby shifting the distribution of net wealth from lenders in nominal assets (such as bank deposits and government bonds) to borrowers (such as mortgagees—especially younger households—and governments). The interest rate increases that have followed have only partially offset this effect for those on floating interest rates. Real interest rate increases engineered to dampen inflation also tend to lower the market capital value of other assets, but they are less likely to be irreversible. Drawing on household surveys, the analysis of Pallotti et al. revealed a remarkable degree of heterogeneity, especially with regard to age. It confirmed that older households tended to suffer more than younger households; indeed, because of their higher nominal indebtedness, many of the 25–44 age group were net gainers from the inflation. The degree of national fiscal support was an important factor. Still, the authors reckoned that the average welfare loss for households in these four countries was very high, equivalent to a disposable income decline of about 3 percent in France and Spain, 4 percent in Germany, and over 8 percent in Italy. Although lower-income households were more exposed to the direct effect of the energy and food price increases, they tended to be sheltered by the sluggishness of housing rental increases.

As with previous large shocks, such as that generated by the global financial crisis, the heterogeneity of the effects of the inflation surge across countries evidently presents policy and political challenges to the European Union's institutions. In particular, communication of ECB policy in stabilizing euro area average inflation has needed to address multiple audiences affected to different degrees by shifting national inflation rates.

6 Baba et al. (2023) suggest further factors: Transmission of shocks into consumer price inflation operates with different speeds in different European countries, and the slope of the Phillips curve also greatly varies, being steeper in emerging euro area economies.

7 One distributional dimension relates to the share of labor income in GDP (though the importance of nonlabor household income at all levels must be borne in mind). In the euro area, this share jumped during the pandemic largely due to government subsidies to wages. It subsequently fell steadily to the end of 2022, dipping well below the long-term average because wages absorbed the terms of trade effect of energy price increases to a greater extent than capital (there was a small recovery in 2023) (Bodnár and Mohr 2023). Labor share movements in the United Kingdom in recent years have been less pronounced, and the 2022 share was close to its long-run average (see the UK Office of National Statistics, https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/datasets/labourcostsandlabourshare).

THE MONETARY POLICY REACTION

Monetary policy was tightened across Europe in response to rising inflation. Of the world's major central banks, the Bank of England was the first to increase its policy *interest rate* in response to the inflation, doing so in December 2021, thus well before the Federal Reserve.

The ECB waited some months after the Fed before raising its policy rates, reflecting that the rise in price (and wage) inflation in the euro area was also several months behind that in the United States (Lane 2024). The ECB's policy rate increase in 2021–23 was somewhat lower than that of the Fed, and it was slower to wind down its asset purchase program.

The ECB waited until July 2022 to adjust rates, though long-term yields on euro area government securities increased much earlier because markets responded to the official indications that a policy response would not be delayed indefinitely (Evdokimova et al. 2023, 12). (Indeed, the 10-year yield on German *bunds*, which had been negative for over 2.5 years, turned positive in late January 2022, passed 1.0 percent in early May, and exceeded 1.7 percent in June—before any ECB rate increases.[8]) By that time, responding to its higher inflation rates, the Fed had already made three successive increases (figure 4).

ECB and Fed rate increases then kept in step for the remainder of 2022, with the ECB's deposit rate staying more than 2.25 percent below the midpoint of the Fed's funds rate target. By steadily ramping up its rates, the ECB partially reversed the exchange rate depreciation that had occurred during 2021–22. In 2023 both the Fed and the ECB continued to increase rates, but now the ECB was increasing more, thereby narrowing the differential to about 1.25 percent by the end of 2023.

At that point the Bank of England had brought its rate up to 5.25 percent—about the same level as the Fed.

Of two smaller European non-euro area countries, Sweden's Riksbank steered a course roughly midway between the Fed and the ECB, whereas the Swiss National Bank (SNB), enjoying a much lower inflation rate, increased rates on a much more gradual trajectory, reaching only 1.75 percent by end-2023.

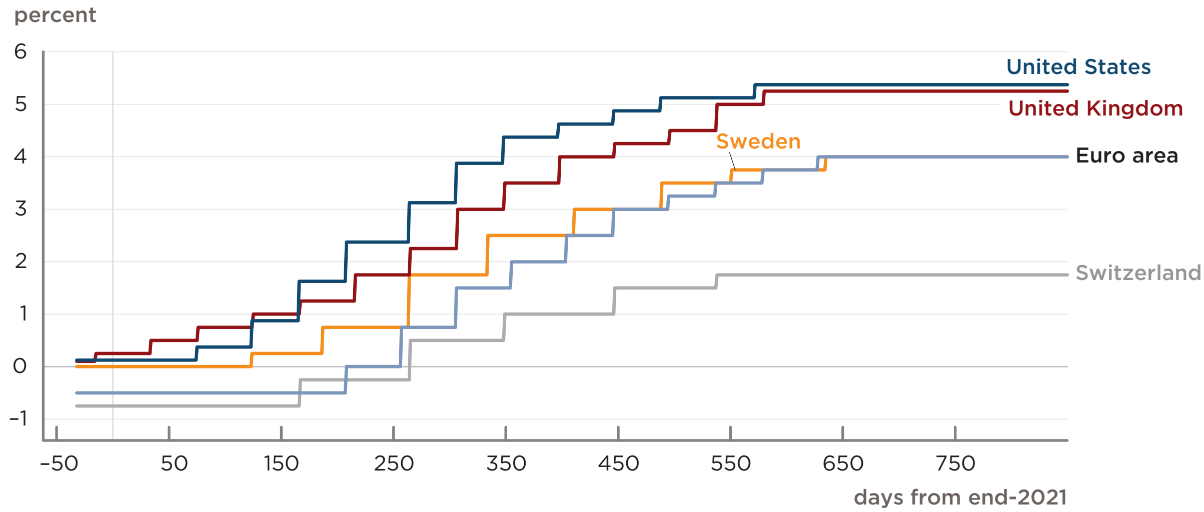
Having reached an effective lower bound of short-term interest rates, the main European central banks had ramped up their *asset purchases* in response to the money market turmoil and decline in economic activity associated with the COVID pandemic in March 2020. All of the central banks slowed or terminated their asset purchase programs during 2021.

The largest asset purchase program—and the last to be terminated—was that of the ECB. It had restarted its program in late 2019 but ramped up purchases dramatically from March 2020 in response to the pandemic in the supplementary so-called pandemic emergency purchase program. Figure 5 shows that monthly net purchases under the two programs combined peaked at €159 billion in June 2020 and were running in excess of €100 billion per month in July 2021; monthly net purchases slowed steadily after this time, becoming negative in July 2022 (thus, about the time of the first interest rate increase). By then, net purchases since end-2019 totaled €2.4 trillion, or about 20 percent of euro area GDP in 2020.

8 Whereas US 10-year yields remained below 2 percent until March 2022, rising over 3 percent in early May, and not reaching 4 percent until October. Indeed, the spread of US over German yields showed no clear trend during 2022.

Figure 4

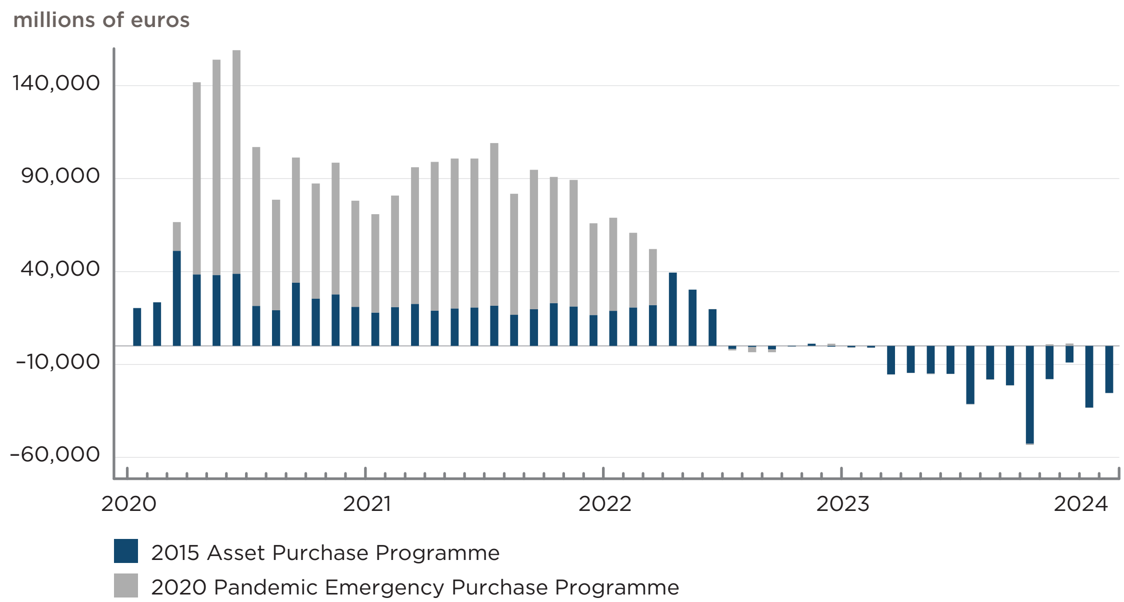
Policy interest rates in selected countries, December 2021–April 2024



Source: Central banks of the economies shown in the figure.

Figure 5

Net monthly asset purchases by the European Central Bank, January 2020–February 2024



Source: European Central Bank.

The United Kingdom and Sweden had both terminated net asset purchases by the end of 2021, and both stopped full reinvestment of maturing assets during 2022.[9] The SNB's purchases of foreign exchange followed a broadly similar pattern, with net sales on average from the start of 2022.

IMPACT OF MONETARY POLICY

How effective was the monetary policy response in Europe to the rise in inflation? Given the importance of one-off supply shocks in driving the surge, is it conceivable that, even without the interest rate increases, medium-term inflation expectations might have remained reasonably anchored? Might inflation have gradually returned close to target without such sizable interest rate increases? After all, global energy price reversals took a lot of the oxygen out of the inflation. Furthermore, the fall in inflation by the end of 2023 occurred before any increase in euro area unemployment rates. And the dynamic through compensatory wage increases has been weaker than during the 1970s.[10] Still, this would be a heterodox view.

More plausible is the conventional view (Amatyakul et al. 2023). According to this viewpoint, the continued anchoring of inflation expectations required the central bankers to demonstrate and confirm their determination to bring inflation back to target. They accomplished this by increasing interest rates, despite this being a generally unpopular step and one that was likely to slow the postpandemic recovery of economic activity. After all, as shown by Acharya et al. (2023), the way in which household expectations of increased inflation from the supply shocks combined with firms' pricing power had the potential to generalize into a broad-based inflation in Europe during 2022. Nevertheless, it is worth noting that median consumer inflation expectations for three years ahead in the euro area moved up from 2 percent to 3 percent only in March 2022 and was still at 3 percent when the ECB raised rates in July. This allows us to conclude that the ECB started to increase rates before consumer inflation expectations had drifted very far from its 2 percent target.

The cost of protection against long-term euro area inflation (for between 5 and 10 years ahead, as indicated by the "5y5y" inflation-linked swap rates in financial markets) did spike from below 2.0 percent to about 2.5 percent immediately after the invasion of Ukraine. An ECB model suggested that most of this spike reflected a risk premium rather than a shift in expectation. As inflation accelerated, swap rates increased again during 2023, occasionally going as high as 2.6 percent.

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9 The Bank of England's announced decision toward the end of 2022 to actively sell some of its holdings was not derailed by the decision to resume net purchases for a couple of weeks following the poorly received government budget of September 2022 (Andrew Hauser, "Thirteen Days in October: How Central Bank Balance Sheets Can Support Monetary and Financial Stability," speech at the European Central Bank's 2022 Conference on Money Markets, Frankfurt, November 4, 2022, available at https://www.bankofengland.co.uk/speech/2022/november/andrew-hauser-keynote-speech-at-the-european-central-bank-conference-on-money-markets).

10 Of these European countries, the one with the earliest and biggest increase in interest rates was the United Kingdom. Despite that tightening of monetary policy, the United Kingdom experienced the highest cumulative inflation. This might also be seen as an indication of the limited and delayed impact of interest rate movements on aggregate inflation.

Should the ECB have raised interest rates sooner—for example, as soon as the invasion of Ukraine sent energy prices much higher? Those with long memories will recall that the ECB had a reputation of tightening too soon. Its previous interest rate increases (in 2008 and 2011) are both criticized as an overreaction to global energy price increases. Both of those increases were quickly reversed and are now generally seen as having been mistakes. During the global financial crisis, the ECB was also widely criticized for being too slow to lower interest rates and too slow in moving to large-scale asset purchases (quantitative easing), though that cannot be said of its reaction to the pandemic.

Clearly, inflation was slower to get under way in Europe than in the United States, and that fact alone can excuse much of the delay in tightening monetary policy. All in all, there is little basis for any assertion that the 2022–23 euro area inflation surge would have been much shorter or had a much lower amplitude if the ECB had moved a few months earlier.[11] Perhaps the main channel of transmission would have been through a stronger exchange rate.

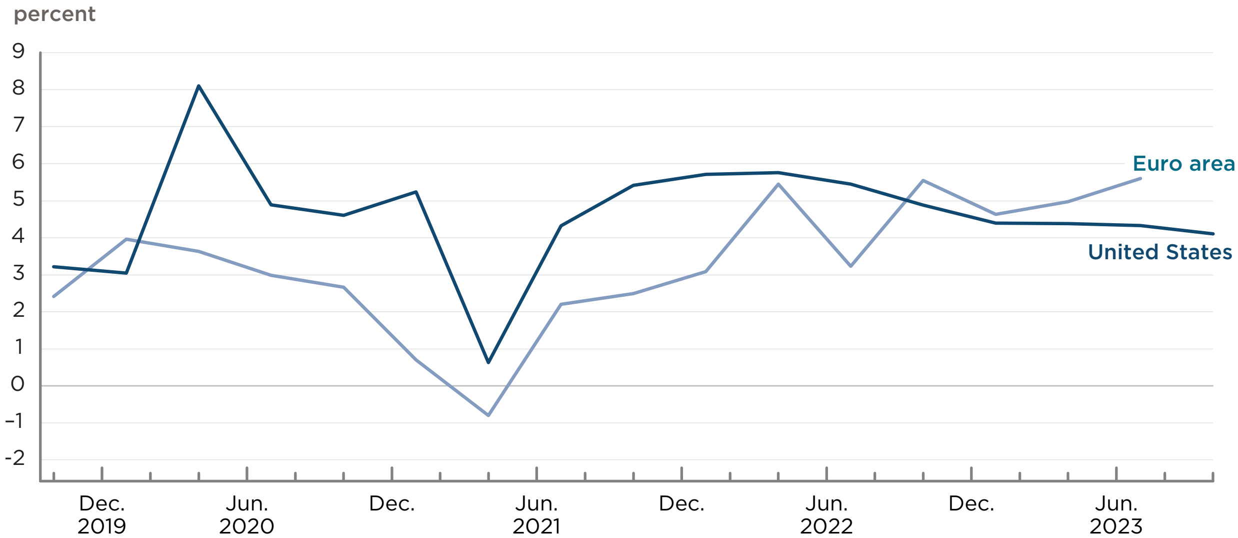
Once it began to move, the ECB continued to raise rates at a brisk pace for over a year. Did it persist in this tightening for too long, bringing interest rates to too high a level? Would inflation have slowed sufficiently, and with less damage to the level of economic activity if the ECB's action had been less aggressive? To the extent that the rate increases were likely important in confirming the ECB's reputation as an inflation fighter, it is possible that this could have been achieved with a smaller overall increase, especially if it had begun earlier. Estimating the likely scale and timing of the adverse effect of euro area interest rate increases on output is an uncertain business, not least because of how low interest rates have been over a long period during which there has been considerable structural change. It is therefore too early to settle this question, given the likely duration of the impact of the rate rises on economic activity. To answer it, we will need the outturn of 2024 and 2025. Certainly, there has been a growth slowdown in much of the euro area, most notably Germany, with zero growth overall during 2023. But a lot of the slowdown can be attributed to the adaptation that was necessary to cope with higher energy costs and with a far smaller flow of natural gas from Russia, as well as weaker demand in China for European exports, rather than just being a consequence of the interest rate increases.

THE FULL UNRAVELLING OF THE PRICE SHOCK

Yet it is also too soon to state categorically that second-round effects of the price increases will be contained, considering the sharp fall in real wages that occurred in 2021–23 and the continued tightness of labor markets. Average unemployment in the euro area fell to its lowest-ever rate of 6.4 percent in late 2023. The tendency for profits to increase at the outset of the inflation means the business sector will be able to absorb some clawback of real wage losses without much of a further increase in prices. Like prices, wage rates were much slower to

11 For instance, the model of Bańbura et al. (2023), mentioned earlier, finds only a small impact of interest rate policy. The approach of Bernanke and Blanchard (2023) does not explicitly examine an interest rate effect, this being implicitly captured through their labor market tightness variable.

Figure 6
Hourly earnings in the United States and euro area, 12-month inflation, 2019–23



Source: Author's calculations based on OECD Main Economic Indicators and US Bureau of Labor Statistics via Federal Reserve Economic Data.

increase in the euro area than in the United States.[12] With nominal wage increases becoming more prevalent during 2023, it remains to be seen how large second-round inflation effects resulting from the attempt of workers to restore former real income levels will result, causing a persistence of inflation. All in all, the medium-term outcome of the contest between labor and capital unleashed by the unexpected surge in prices cannot yet be forecast with certainty (figure 6).

Econometric studies seeking to use data on past experiences to measure the degree to which real wage shocks are likely to pass through to second-round effects on price inflation reach varying conclusions. ECB staff projections as of March 2024 foresee inflation at 2.3 percent in 2024 and averaging below 2 percent in 2025–26.

If the conflict in Ukraine and other geopolitical forces that have increased energy and food prices are resolved soon, the volatile noncore prices could fall back, reversing some of the inflation and thereby easing or even eliminating the pressure on real wages. But that too remains to be seen.

Notably, using a Bayesian approach to estimating a neo-Keynesian model of wage and price determination to see how the euro area economy has reacted to demand and supply shocks in the period up to the middle of 2023, Galstyan (2023) presents projections of the degree to which real wage adjustments might occur in future years if the economy is to return to the initial preshock steady state, clawing back the losses that occurred up to then.[13] The point estimates

12 Wage inflation has varied widely across the euro area and ran well below the consumer price inflation of 2021–23 (Górnicka and Koester 2024).

13 Galstyan's model has generic similarities to that of Blanchard and Bernanke (2023) for the United States but employs a more elaborate dynamic structure as well as the Bayesian approach to parameter estimation.

obtained suggest only a small degree of clawback of about 0.5 percentage points per annum. Bernanke and Blanchard (2024) also find little evidence of catch-up in their 11-economy analysis.

But to the extent that a terms of trade loss is permanent, the new long-term equilibrium will mean that the real wage losses may not be fully reversed (except from such extraneous factors as productivity growth). In that case, the potential of a more persistent inflationary impulse from a struggle between capital and labor for output share cannot be ruled out (Corsetti et al. 2023). But nor can data from the euro's quarter century of history provide much evidence on how large or prolonged this tussle might be.

CONCLUDING REMARKS

After a decade during which the main price stability challenge for the main European central banks was to avoid deflation, the sudden and sharp surge in prices came as a shock. A certain degree of complacency from the years of the "Great Moderation" had led many policymakers as well as independent observers to suppose that the tools of modern central banking would enable any upward pressure on prices to be rapidly suppressed. The independence of the central bank in the use of these tools (notably, and to an unmatched degree, at the ECB) reinforced this view. An expectation that any threat to price stability would come from fiscal indiscipline bolstered this attitude.

Things worked out rather differently. The shocks, at least in Europe, were sudden and came mainly from the supply side; savings and liquidity conditions were so easy that the economy was able to absorb supply-side-driven nominal price increases without much compression of demand. The combined effect was a relatively brief but severe inflation reaching double digits on an annual basis—a rate that had not been seen for half a century in advanced economies.

The sense that the energy price increases associated with Russia's invasion of Ukraine might be short-lived likely stayed the monetary policy reaction by a couple of months, but that is not likely to have greatly affected the scale of the surge. To what extent the monetary tightening will have limited economic activity in Europe when the full effect has worked through remains to be seen; in early 2024, with euro area GDP flat for almost a year, it is not clear that a technical recession will be avoided.

The impact of these shocks has differed both within and across different European countries, even in the euro area, reflecting differing preexisting economic structures as well as differing national fiscal policy responses. In this respect, as in so many others, Europe demonstrates itself to be a more complicated polity than the United States.

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PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

24-21 The Trinity of COVID Era Inflation in G7 Economies

Joseph E. Gagnon and Asher Rose

December 2024

ABSTRACT

COVID era inflation was driven by a unique combination of three shocks: First, a plethora of pandemic-related shifts in demand patterns and disruptions to supply caused prices of consumer durable goods to skyrocket. Second, the Ukraine war caused the largest global commodity price surge in 40 years, which mainly affected prices of nondurable goods such as food and gasoline. Third, strong monetary and fiscal responses to the pandemic recession caused labor markets to tighten, pushing up prices of services. This paper estimates models of the components of consumer prices in each G7 economy in order to document the transmission of these shocks. The first two shocks had run their course by 2023, enabling overall inflation to decline sharply from its 2022 peak. But labor markets remained at least moderately tight in most G7 economies in 2024, and services inflation remained noticeably higher than its pre-pandemic level.

JEL codes: E30, E31

Keywords: durable goods, nondurable goods, services, pandemic inflation

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Introduction

Inflation surged to a 40-year high across the advanced economies and in many emerging and developing economies in 2021-22. Central banks and private forecasters almost universally failed to predict this surge. Economists are now working to understand what caused the COVID era inflation and why it was so hard to foresee.

This paper addresses these questions through separate models of inflation for the three main components of consumption: durable goods, nondurable goods, and services. The focus is on the major advanced, or G-7, economies. The results highlight three important and independent drivers of inflation, hence our "trinity," each element of which is concentrated in a different component of inflation. In temporal order, these are (1) a plethora of pandemic-related demand and supply disruptions that mainly affected durable goods, (2) the global commodity price shock caused by Russia's invasion of Ukraine that mainly affected nondurable goods, and (3) tight labor markets that are a legacy of aggressive monetary and fiscal policy stimulus in the early years of the pandemic and that mainly (though not exclusively) affect services.

We find that the latter two shocks raise inflation through a standard model in which inflation responds to tight labor markets and rising commodity and import prices. We find some evidence for a nonlinear effect of unemployment on inflation, but this nonlinearity is not especially unconventional since it has a pedigree back to the seminal work of A.W. Phillips (1958).

The effects of the first group of pandemic-related shocks are not well explained by a standard model. The pandemic drove a shift in spending from services like restaurants and travel to durable goods like automobiles and furniture, especially in the United States, which gave rise to bottlenecks and exposed the difficulties producers face in responding to very large increases in demand. In addition, factory shutdowns and shipping snafus probably also contributed to high prices of durable goods. Perhaps most importantly, automakers canceled orders for semiconductors at the start of the pandemic, fearing a prolonged recession. In the event, the recession was short and demand for autos bounced back quickly, resulting in a massive supply shortfall in autos that pushed their prices way up.

To a large extent, the COVID era inflation reflects an unusual combination of shocks that is likely to occur very rarely. A conventional macroeconomic model of inflation can explain most of the surge in inflation. But sector-specific demand and supply shocks were large enough to have important aggregate effects that are not well-explained by a standard model. The COVID era inflation has some similarity with the inflation surge during the Korean War in 1950-51, which was also associated with a large increase in demand for durable goods and which receded quickly without any increase in unemployment (Gagnon and Rose 2025).

With commodity prices back in historical ranges, demand for durables waning, and semiconductors in plentiful supply, inflation has fallen dramatically for nondurable and durable goods. However, tight labor markets are keeping services inflation elevated in some economies, most notably the United States.[1]

Previous studies

There has been an explosion of research on causes of the COVID era inflation around the world. Results differ somewhat depending on the years and economies being examined. But the trinity of this paper receives broad support. For evidence on the effects of demand and supply chain disruptions related to COVID-19, see Brooks and Orszag (2023), Comin, Johnson, and Jones (2023), Koch and Noureldin (2023), and Firat and Hao (2023). For evidence on the effects of commodity price shocks, see Hansen, Toscani, and Zhou (2023), Firat and Hao (2023), and Ha et al. (2023). For evidence on the effects of fiscal policy and tight labor markets, see Koch and Noureldin (2023) and Jorda and Nechio (2023).

One interesting outcome is renewed interest in a possible nonlinear relationship between the unemployment rate or other labor market measures and inflation, sometimes referred to as a nonlinear Phillips curve (Benigno and Eggertsson, 2023; Gudmundson, Jackson, and Portillo, 2024). Focusing on the United States, Laurence Ball, Daniel Leigh, and Prachi Mishra (2022) propose replacing the unemployment rate in the Phillips curve with the ratio of job openings (or vacancies) to unemployed persons. By putting the unemployment rate in the denominator, this specification creates a modest nonlinearity in the relationship. The authors go further and include both the square and the cube of the vacancy-unemployment ratio, which they argue helps to explain core inflation by allowing even more curvature in the relationship.

In a subsequent paper, Leigh and Mishra join with Mai Chi Dao and Pierre-Olivier Gourinchas (2024) and model core inflation allowing for the square and cube of the vacancy-unemployment ratio in a broad sample of economies. A unique feature of Ball, Leigh, and Mishra (2022) and Dao et al. (2024) is that these studies split inflation into (1) core inflation defined as the weighted median of the underlying components of inflation and (2) the gap between headline and core inflation. Broadly speaking, the gap between headline and core is mainly driven by commodity price shocks and some of the pandemic-related demand and supply shocks, whereas core inflation mainly reflects labor market conditions with spillover from the gap shocks.

Perhaps the most widely cited work on COVID era inflation is the analysis of US inflation by Ben Bernanke and Olivier Blanchard (2023). In a subsequent paper, Bernanke and Blanchard (2024) summarize the results of a coordinated research project among central banks for 10 other advanced economies. These studies estimate small models of price inflation, wage inflation, short-run inflation expectations, and long-run inflation expectations. They generally find that inflation began with pandemic-related shortages of critical goods and a global commodity price shock caused by the Ukraine war. These shocks have receded and inflation has fallen. But labor markets have tightened or remain tight in

[1] For further analysis of the slow normalization of services inflation across economies, see Amatyakul, Igan, and Lombardi (2024).

most economies, contributing to a moderate continuing excess of inflation above its target in most economies.[2] As in Ball, Leigh, and Mishra, Bernanke and Blanchard and their collaborators use the vacancy-unemployment ratio in their wage Phillips curves but without further nonlinear transformation.

This paper shares the basic conclusions of both the Bernanke and Blanchard multi-country research project and the Ball, Leigh, and Mishra and Dao et al. papers on the main drivers of COVID era inflation. Unlike those studies, however, our breakdown of inflation by type of consumption enables us to trace the demand-shift and supply shocks through durable goods, the commodity price shock mainly through nondurable goods, and the labor market tightness mainly through services. In addition to the Bernanke-Blanchard supply shortage variable, we find that the shift in consumer demand to durable goods during the pandemic also plays a significant role in durable goods inflation in some economies.

Inflation in G-7 economies, 1995-2023[3]

Inflation soared to a 40-year high in 2021-22 in many economies around the world, including the major advanced, or G-7, economies. Inflation dropped noticeably in most G-7 economies during the course of 2023, but it had not reached pre-2021 levels as of early 2024.

The solid black lines in figure 1 display four-quarter rates of change of the price index for personal consumption expenditures (PCE) in each G-7 economy from 1995 through 2023. Many other studies focus on the consumer price index (CPI) or the Harmonized Index of Consumer Prices (HICP). All three measures of inflation rose sharply in 2021-22 and fell in 2023.

The colored bar segments display the contributions to inflation from three categories of spending: durable goods, nondurable goods, and services.[4] When all components contribute positively to inflation, the solid line is at the top of the stacked bars. When inflation is positive but some components are negative, the solid line is below the top of the bars. Three broad patterns are apparent in the data. First, services prices tend to be the largest contributor to inflation on average, except in Japan, as can be seen from the relatively large area shaded in pink. Second, highly volatile nondurables prices are the main drivers of changes in overall inflation, as ups and downs of overall inflation tend to coincide with ups and downs in the green areas. Third, durables prices are the smallest contributor

[2] Japan is somewhat of an outlier with less of a surge in inflation and less impact on inflation from labor market tightness (Nakamura et al. 2024).
[3] The analysis in this section begins in 1995 because all G-7 economies had low explicit or implicit targeted rates of inflation after that point, enabling us to avoid modeling changes in monetary regime. The transition to low inflation happened earliest in Japan and latest in Italy.
[4] Non-US G-7 economies have a fourth category: semi-durable goods. We include semi-durables with durables because they tend to have higher labor and lower commodity inputs than nondurables. According to Statistics Canada, semi-durables include clothing, footwear, tableware, and household utensils. In the United States, clothing and footwear are considered nondurables and tableware and household utensils are considered durables. Thus, it is not possible to have categories that are identical across all G-7 economies.

to inflation on average and often have a negative contribution, reflecting outright declines in the prices of durable goods, shown in the dark blue areas. Nondurables prices were particularly important in the inflation surge of 2021-22. Durables prices also made their largest positive contribution to inflation since 1995 during the years 2021 and 2022.

Table 1 summarizes the inflation surge during and after the COVID-19 pandemic (2020-23) in comparison to the four-year period prior to the pandemic (2016-19). All of these economies undershot their 2 percent inflation targets in the four years prior to 2020. All but Japan overshot their targets in the four years that began in 2020; in some cases, inflation was more than twice its targeted level.

Goods prices (durable and nondurable) contributed between about half (France, United Kingdom) to more than three-quarters (Japan) of the cumulative increase in inflation in the years 2020-23 compared to the years 2016-19. This is particularly notable in light of the fact that half or less of consumer spending in these economies is on goods, whereas half or more is on services (the final three rows of table 1).

Figure 1 displays a common pattern over time in these economies. In 2020, goods inflation was zero or negative and services inflation very low. In 2021 and 2022, goods inflation surged while services inflation moved up steadily. In 2023, goods inflation dropped back sharply while services inflation remained constant or fell slightly. Japan shared in the common pattern, but with a much smaller rise and fall of inflation.

A modest difference across these economies is that inflation peaked earlier in Canada and the United States, by 2022Q2. In the other G-7 economies, inflation peaked at the end of 2022 or beginning of 2023. The next three sub-sections explore each of the elements of the COVID era inflation trinity in turn.

Durables demand and supply chain shocks

Durable goods are the smallest category of consumption and typically have flat or even falling prices because they enjoy the greatest improvements in productivity over time. Thus, their average contribution to inflation over 1995-2019 was negligible in all G-7 economies except Japan, where they made a negative contribution to overall inflation of 0.4 percentage point.

Durables prices surged in 2020-23, making a small but significant positive contribution to inflation for the first time in decades. (See figure 1.) A conventional model of inflation with unemployment and commodity prices is not able to explain the surge in durable goods prices. Two other factors appear to have been important.

First, consumer demand shifted from services to durable goods during the pandemic, as consumers avoided airplanes, restaurants, and hotels and instead spent on furniture, appliances, and vehicles. This shift was most pronounced and prolonged in the United States.

The surge in demand for durable goods pushed some industries to capacity limits and highlighted bottlenecks in production. Limitations in supply caused price increases that were much larger than would be expected from a similar shift in demand starting from a position of excess capacity. In other words, the price adjustment process is nonlinear. (Gagnon and Collins 2019; Forbes, Gagnon, and Collins 2022.)[5]

Figure 2 plots the four-quarter change in real (inflation-adjusted) spending on consumer durables in G-7 economies. All but Germany and Japan display a large increase in 2021. However, in Canada, France, Italy, and the United Kingdom, this large increase was preceded by a large decrease in 2020. Only in the United States is there a large increase that does not mainly reverse a previous large decrease. The level of US real spending on durable goods continued to be above its historical trend into 2023, unlike that in the other G-7 economies.

A second important driver of durable goods prices is COVID-related disruptions to production and transportation in general, which temporarily reduced the capacity to produce and transport durable goods in particular. The price effects of these disruptions were compounded by the historic mistake of nearly all global automakers to cancel orders of semiconductors in 2020 because of fear of a global recession that would sharply reduce demand for automobiles. In the event, the 2020 recession was brief and the reduction in spending was focused on services--not durables--a sharp contrast with the traditional business cycle. The upshot was that automakers found themselves desperately short of a critical component of new cars in 2021 and 2022.

There are several measures of supply chain disruption, such as the Federal Reserve Bank of New York's Global Supply Chain Pressure Index (GSCPI) and the Institute of Supply Management (ISM) Supplier Delivery Time index. A key problem with such measures is that backlogs and delays may reflect either shortfalls in supply or excesses of demand. Phil Levy (2024) shows that delays in ocean shipments in 2021 and 2022 owed more to strong demand than to losses of capacity in shipping or at US ports. The GSCPI attempts to control for demand-side influences by removing movements related to the "new orders" and "quantities purchased" subcomponents of the ISM's purchasing managers' index. However, the resulting series still shows notable declines in supply chain pressures during the recessions of 2001 and 2008-09, suggesting that demand factors have not been fully removed.[6]

Bernanke and Blanchard (2023) propose using the frequency of Google searches on the word "shortage". We choose a narrower search on the term "chip shortage" in English-speaking countries and tried various alternatives in the other G-7 countries. We prefer a

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[5] Moreover, the corresponding reduction in demand for services was not deflationary because the service sector was already on the flat portion of its supply curve. Because of downward nominal wage and price rigidity, high unemployment rates in the service sector did not cause widespread reductions in services prices.

[6] Inserting the GSCPI into the regression for durable goods inflation reduces the coefficients on the growth of real durable goods spending with little change on the chip shortage coefficient or other coefficients and it reduces the sample by three years. It is modestly significant in the United States and not significant in other economies.

somewhat narrower search because strong demand may look like a shortage to buyers. By focusing on the semiconductor shortage, our measure is more limited to a mistake by motor vehicle producers and semiconductor supply conditions generally, though we cannot rule out a demand element.[7] In any case, our results do not change much if we use the Bernanke and Blanchard measure.

Figure 3 displays the frequency of Google searches on "chip shortage" or the best alternative in non-English-speaking countries. These data are from Google Trends, which begins in 2004. In the following regressions, data for earlier years are set equal to zero.

Table 2 presents results of the following regression of durable goods inflation over the period 1995Q1 through 2023Q4.[8] Labor market variables were not significant in most economies and are not included.[9]

$$\Delta PD_t = \alpha + \sum_{i=1}^{4} \rho_i \Delta PD_{t-i} + \sum_{i=0}^{1} (\beta_i \Delta PE_{t-i} + \gamma_i \Delta PF_{t-i} + \delta_i \Delta PIM_{t-i})$$

$$+ \theta\, CHIPSHORT\_US_t + \sum_{i=0}^{3} \sigma_i \Delta CD_{t-i}$$

Δ denotes annualized percent change. Note that these are one-quarter changes, unlike the four-quarter changes displayed in figure 1. *PD* is the price index for durable goods. *PE* is the price index for energy. *PF* is the price index for food. *PIM* is the price index for imports of goods and services. *PE, PF, and PIM* are expressed relative to the GDP deflator. Import price inflation is also scaled by the ratio of nominal imports to nominal GDP. For every country, the US search result for "chip shortage" yields essentially the same coefficient and equation fit as the local search result and this variable is used in table 2. *CD* is real spending on consumer durables.

To save space, table 2 presents the sums of the coefficients for each variable. The sums of the lagged durables inflation coefficients are moderate; a value of 0.4, which is roughly the median across these economies, implies that the large majority of any shock to inflation has dissipated after two or three quarters. The larger value for Japan may reflect poorer fit of the model, especially as the chip shortage and real durables demand terms had the wrong

[7] The coefficient on "chip shortage" is roughly twice as large in a regression of motor vehicle inflation as it is in a regression of durable goods inflation in the United States, supporting the interpretation that it primarily reflects semiconductor shortages.
[8] Sources and definitions of the data are described in the appendix.
[9] We included the unemployment rate and its first difference and one of these terms is statistically significant with the correct sign in Canada and Japan. However, one of these terms is significant with the wrong sign in France and the United States. Because these variables have little explanatory power in all G-7 economies, we do not include them in the final regressions.

sign and were dropped. The negative sum of lag coefficients in France may be caused by large outliers in durable goods inflation in 2020 (shown in figure 4).[10]

The energy and food price coefficients are usually positive but small. Occasional negative coefficients on energy, food, or imports may reflect interactions between the terms, as imports may include substantial amounts of food or energy.

The chip shortage variable is most important in the United States followed by the United Kingdom, Germany, Canada, and France.[11] It is negative and not significant in Italy and Japan, where it is dropped from the final regression.

The growth rate of real spending on consumer durables has a positive effect everywhere except France, Japan, and the United Kingdom, where it is not significant and is dropped from the final regression. In Italy and the United States this variable is nearly statistically significant and it has large but not significant coefficients in Canada and Germany.[12]

The colored bar sections in figure 4 display the estimated effects on durables inflation of (1) initial conditions, (2) food, energy, and import prices, (3) the chip shortage, and (4) growth of real durable goods demand. The calculations begin in 2020Q1 and the effects of the independent variables are based on their values in 2020Q1 and later. The initial conditions are defined as the sample mean of durables inflation plus lagged effects of deviations of the right-hand-side variables from their sample means in the quarters immediately prior to 2020Q1. The effects of the other variables are given by their coefficients times their deviations from their sample means starting in 2020Q1 and then adding in lagged dynamics from these effects starting in 2020Q2. In other words, a one-quarter shock to energy prices will have an effect on durables inflation that lasts more than one quarter to the extent that the lag coefficients on inflation differ from zero.

The solid black line is the annualized quarterly rate of change of prices of durable goods. The dashed black line is the sum of the colored bar contributions, which equals the fitted value of the model estimated in table 2. Figure 4 shows that fitted values of the model capture most of the surges in durable goods prices in these economies, except for Japan and the 2020Q3 outlier in France.[13]

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[10] The 2021 *Economic Survey of France* (OECD 2021) did not indicate any policy action or other special event that might have caused these outliers. Including a dummy variable for the largest outlier in 2020Q3 had only modest effects on the coefficients of interest.

[11] The contemporaneous value of *CHIPSHORT_US* yielded a higher R^2 than the first or second lag in every economy except France.

[12] To test whether US demand for durable goods drove global durables inflation, we replaced each economy's real durables spending growth with US real durables growth. The results fit better in Canada, France, and the United Kingdom and worse in Germany, Italy, and Japan. Effects on other coefficients were minimal.

[13] In Japan, large lag coefficients, including the fourth lag, contribute to an unusual contribution from initial conditions. The large fourth lag may owe to residual seasonality given our simple seasonal adjustment methodology.

The chip shortage variable is particularly important in explaining durables inflation in Canada, Germany, the United Kingdom, and the United States. The growth in real spending on durables is notably helpful in 2020 and 2021 in Canada, Germany, Italy, and the United States. Commodity and import prices were especially important in France, Italy, and Japan.

The global commodity price shock of 2022 and nondurables inflation

Russia's invasion of Ukraine in February 2022 caused the largest global commodity price shock in decades. The four-quarter changes in food and energy prices in each G-7 economy surged in 2022, reaching their highest rates since the early 1980s or late 1970s. (See figure 5.) These inflation rates remained high for about four quarters, whereas in some earlier spikes, such as 2008-09, increases were quickly reversed and thus caused less persistent inflation and economic harm. This subsection shows that these global shocks were the most important drivers of inflation in nondurable goods prices.

The European G-7 economies and Japan subsidized consumer energy spending after the invasion of Ukraine, both through subsidies to suppliers to keep energy prices lower than otherwise and through grants or tax rebates to households. Differences in energy inflation across these economies reflect differences in the approaches to energy subsidies as well as differences in the energy mix used in each economy.[14] The United States and Canada did not take any direct measures to subsidize energy, but their markets for natural gas are largely segmented from global markets, helping to limit the impact of the loss of Russian gas supplies on overall energy prices in North America.

Food price inflation was much lower and less volatile than energy price inflation, but still surged to a significant extent. Germany and the United Kingdom had the largest food price increases, but differences across these economies in food inflation were relatively small.

Labor markets also contribute to nondurable goods inflation. The conventional Phillips curve describes a negative effect of unemployment on inflation as excess workers and economic slack put downward pressure on prices.[15] Concerns about the behavior of the natural, or equilibrium, rate of unemployment in the pandemic (arising from school closures, fear of COVID, and temporary boosts to unemployment insurance) raise challenges in the use of a simple Phillips curve with the unemployment rate to model inflation. The United States and Canada relied more heavily than other countries on the unemployment benefit system for delivering pandemic assistance and the United States had longer school closures than other economies. These factors likely drove up the natural rate of unemployment along with the spike in actual unemployment in 2020, and it may have taken two or three years for the natural rate to return to its pre-pandemic level.

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[14] For example, subsidies to energy suppliers reduce measured energy inflation but subsidies to energy consumers do not reduce measured inflation (Honohan 2024).

[15] It is conventional to express the Phillips curve in terms of the gap between the unemployment rate and its natural rate. The natural rate is not directly observable but is believed to be determined by the demographic composition of the labor force and labor market policies and institutions (Brauer 2007). In some samples, it may be reasonable to treat the natural rate as constant and thus controlled by the equation intercept, as is done in the regressions of this paper that measure labor market tightness with the unemployment rate.

In response to these concerns, a number of researchers have focused on high job openings (vacancy rates) as an indicator of tight labor markets even when the unemployment rate is not especially low. It is possible that an increase in the unobserved natural rate of unemployment led to increases in both the unemployment rate and the vacancy rate. Bernanke and Blanchard (2023), Ball, Leigh, and Mishra (2022), and others have had some success using the ratio of the vacancy rate to the unemployment rate as an indicator of labor market tightness in an otherwise conventional Phillips curve. The vacancy to unemployment ratio has a positive effect on inflation because a higher number indicates a tighter labor market (more vacancies and fewer unemployed persons).

Figure 6 shows that in every G-7 economy except Italy, the unemployment rate is at or close to a 30-year low. In the economies with a long history of vacancy rate data, vacancy rates were at or near 30-year highs in 2022. But vacancy rates fell in 2023 in Canada, Germany, the United Kingdom, and the United States. (We were not able to obtain vacancy rates for more than a few years in France or Italy.) Overall, it appears that labor markets are fairly tight in most G-7 economies, with the vacancy rate pointing to an especially tight US labor market in 2022 that has since eased somewhat while remaining tight relative to the past 30 years.

Nondurable prices in these economies are well explained by food and energy prices with a contribution from labor market variables. Table 3 presents results of the following regression of nondurable goods inflation over the period 1995Q1 through 2023Q4.

$$\Delta PN_t = \alpha + \sum_{i=1}^{4} \rho_i \Delta PN_{t-i} + \sum_{i=0}^{1} \left(\beta_i \Delta PE_{t-i} + \gamma_i \Delta PF_{t-i} + \delta_i \Delta PIM_{t-i}\right)$$

$$+ \mu_0 UN_t + \mu_1 \Delta UN_t + \theta\, UN\_LOW_t$$

PN is the price index for nondurable goods. *UN* is the unemployment rate. *UN_LOW* is zero except for observations in which *UN* is below its economy-specific 25th percentile value, in which case *UN_LOW* is *UN* minus the 25th percentile value. This variable allows for a stronger nonlinear effect of the unemployment rate on inflation when unemployment is particularly low. The other variables are the same as before.

Instead of including the current and lagged levels of unemployment, the regression is specified in terms of the current level and change in unemployment. The coefficient on the level captures the long-lasting effect of unemployment on inflation, whereas the coefficient on the change captures a temporary effect.[16] Note that even temporary effects may be persistent to the extent that the coefficients on lagged inflation (ρ_i) are positive.

[16] The Phillips curve is generally viewed as a long-lasting effect of unemployment on inflation. The temporary effect of a change in unemployment has been referred to as a "speed limit" effect because it captures the notion that fast growth in activity or employment can be inflationary even when the level of activity or employment is not especially high.

The lagged nondurables inflation coefficients in every economy sum to less than 0.2, indicating a rapid return to mean inflation after any shock, consistent with relatively stable expectations of future inflation and a short price adjustment process.

The sums of the energy, food, and import price coefficients are usually positive and often strongly significant. In some cases, a negative coefficient may reflect interactions between the terms, as imports may include substantial amounts of food or energy.

A regression of nondurable goods inflation with the vacancy/unemployment ratio, *V/U*, instead of *UN* had a higher R^2 in Japan and the United States and it is shown in table 3. In these cases, *UN_LOW* is not statistically significant and is dropped. Note that *V/U* already incorporates an element of nonlinearity because low values of unemployment in the denominator have outsized effects on the value of the ratio.

In Canada, Germany, and the United Kingdom, a model with the unemployment rate (including a nonlinear term for extra low unemployment) had a higher R^2 than a regression with *V/U*, and it is displayed in the table.[17] We were unable to find a historical series of the vacancy rate for France and Italy and thus report the results with unemployment rates for these economies.

For Canada, France, Germany, and the United Kingdom, the main effect of unemployment on nondurables inflation arises from the coefficient on the *change* in the unemployment rate, which always has the correct (negative) sign, is large everywhere except Italy, and is statistically significant in Canada. The coefficient on the level of unemployment is small and not significant. An additional nonlinear effect of extra-low rates of unemployment has the correct sign and is large in several economies, but is statistically significant only in Germany.

For the United States and Japan, the coefficient on the level of *V/U* is indeed positive and is strongly significant for the United States. The coefficient on the change in *V/U* is also positive and significant in both economies, implying both a positive long-term effect of the vacancy/unemployment ratio on inflation as well as a strong but temporary "speed limit" effect of changes in the ratio.[18]

The colored bars in figure 7 display the estimated effects of (1) initial conditions, (2) food, energy, and import prices, and (3) labor market conditions on nondurables inflation since 2019. The effect of initial conditions (the dark blue portion of the bars) primarily reflects the historical mean of nondurables inflation with only tiny deviations in the first few quarters from the lagged effects of inflation rates before 2020. The medium green portion of the bars represents the contribution to nondurables inflation from commodity and import prices falling in 2020 and then rising faster than their historical average in 2021 and

[17] Haskel, Martin, and Brandt (2023) find a significant effect of *V/U* on wage inflation in the United Kingdom.
[18] For the United States, the job quits rate is not statistically significant in addition to or in place of the *V/U* ratio.

2022. The pink portion of the bars represents the effects of labor market slack in early 2020 and then tight labor markets in 2022 and 2023. The dashed line is the sum of the three colored bar portions, which equals the model fitted value; it tracks the top of the bars whenever all three contributions are positive.

Figure 7 shows that the commodity and import price effects are the dominant driver of nondurables prices (the solid black line) over this period. The labor market effects are most pronounced in Canada, Japan, and the United States and least apparent in Italy and the United Kingdom.[19] Note the much larger scale in the latter two economies, which had the largest increases in commodity prices and nondurables inflation. Overall, a conventional nonlinear Phillips curve model can explain most of the fall, rise, and subsequent decline of nondurable goods inflation in these economies.

Labor markets and services prices

The contribution of services prices to the 2021-22 surge came later than that of goods prices. It may reflect tight labor markets across all the G-7 economies, with the possible exception of Italy. Labor costs are a much higher share of services prices than of goods prices. Even though services have little or no tangible substance, commodity prices can be important owing to their role as an input in industries such as transportation and restaurants.

Table 4 presents results of the following regression of services inflation over the period 1995Q1 through 2023Q4.[20]

$$\Delta PS_t = \alpha + \sum_{i=1}^{4} \rho_i \Delta PS_{t-i} + \sum_{i=0}^{1} (\beta_i \Delta PE_{t-i} + \gamma_i \Delta PF_{t-i} + \delta_i \Delta PIM_{t-i})$$

$$+ \mu_0 UN_t + \mu_1 \Delta UN_t + \theta\, UN\_LOW_t$$

PS is the price index for services. The other variables are the same as those used in the nondurable goods regression above. The lagged services inflation coefficients are somewhat higher than those for nondurable goods, reflecting greater stickiness in services inflation. Nevertheless, even the Italian cumulative lag coefficient of 0.72 indicates fairly rapid mean reversion of inflation, with a half-life of shocks that is less than three calendar quarters.

[19] The positive labor market contributions in 2020 in Japan are puzzling. Replacing *V/U* with *UN* in the Japan regression eliminates this anomalous result with very little change in the other estimated effects.

[20] A regression of inflation in housing services in the United States yields very similar results to those for overall services inflation. Although labor costs are not viewed as the most important contributor to housing costs, wage income may be important in driving overall housing demand and thus prices, including rental rates.

The energy, food, and import price coefficients are usually positive but generally lower than for both durable and nondurable goods. Again, negative coefficients may reflect interactions between the terms, as imports may include substantial amounts of food or energy.

As in the nondurables inflation regression of table 3, the coefficient on the change in unemployment is negative and larger than the coefficient on the level of unemployment, which is never significantly different from zero. Given the moderately large coefficients on the lagged dependent variable, even a temporary effect of unemployment can persist for a few quarters. There is an additional permanent nonlinear effect of very low rates of unemployment (*UN_LOW*) in Germany and Japan. The *UN_LOW* coefficient was positive but not significant in France, Italy, and the United Kingdom and is dropped in these economies.

The services inflation regressions for Canada and the United States employ the ratio of job vacancies to unemployed persons (*V/U*) because this specification has a higher R^2 than that with *UN* and *UN_LOW* in these economies. The coefficients on both the level and the change of *V/U* are positive and the level effects are strongly significant. These results imply both a positive long-term effect of *V/U* on inflation as well as a temporary "speed limit" effect of changes in *V/U*.[21]

Figure 8 shows that these models explain most of the rise in services inflation. The labor market is dominant in Canada, Germany, Japan, and the United States. Commodity and import prices are relatively more important in France, Italy, and the United Kingdom. However, there are notable unexplained portions of services inflation in all economies except Italy. It is worth noting that the abrupt decline in services inflation in the United States in the last three quarters of 2023 was reversed in the first quarter of 2024 (not shown) when services inflation bounced back to 5.3 percent, consistent with continued pressure from a still-hot, albeit gradually cooling, labor market.

Conclusions

In 2021-22, a trinity of unrelated shocks caused the largest surge of inflation experienced by G-7 economies in roughly 40 years. The trinity consists of (1) a plethora of pandemic-related demand and supply disruptions, (2) the global commodity price shock caused by Russia's invasion of Ukraine, and (3) tight labor markets.

These results are obtained in separate models of inflation in the three main components of consumption: durable goods, nondurable goods, and services. Inflation in durable goods is not well explained by a standard model. Durable goods inflation was driven by the shift in demand to durable goods as well as supply disruptions and bottlenecks, especially in the United States. Durable goods are the smallest contributor to COVID era inflation in these economies.

[21] For the United States, the job quits rate is not statistically significant in addition to or in place of the V/U ratio.

Inflation in nondurable goods and in services is well explained by a standard model with commodity and import prices and labor market conditions, including a nonlinear effect of the unemployment rate in some economies. Cumulating the effects of these underlying driving variables across the three components of inflation from 2020Q1 through 2023Q4, we find that commodity and import prices are the largest contributor to COVID era inflation in France, Germany, Italy, and the United Kingdom—economies that were most severely affected by the loss of Russian gas supplies. Tight labor markets are the largest contributors in Canada, Japan, and the United States.

As of early 2024, labor markets remain relatively tight in G-7 economies, with the possible exception of Italy. Pandemic-induced reductions in labor supply are mostly reversed, so that tight labor markets primarily reflect the legacy of extraordinarily easy monetary and fiscal policies in 2020 and 2021. Easy macroeconomic policies boosted labor demand and enabled the rapid economic recovery in 2021-22. Monetary and fiscal policies began to tighten in 2022, but it seems that policy tightening so far has not led to a significant weakening of labor market conditions.

The pandemic-related demand and supply disruptions in durable goods have largely reversed and commodity prices are back in historical ranges, allowing a large decline of inflation in 2023 that is likely to continue in 2024. Tight labor markets, however, may keep inflation above its pre-pandemic levels for a while longer, especially in the United States. The effects of tight labor markets are least pronounced in France and Italy. In Japan, they are a welcome development after years of falling well below the target for inflation.

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Appendix: Data sources and definitions

Sources

The primary source for US data is the Bureau of Economic Analysis National Accounts database via https://fred.stlouisfed.org/. For other (non-US) G-7 economies, national accounts data were collected from Macrobond using Organization for Economic Cooperation and Development (OECD) data. For other G-7 economies, durable goods and semi-durable goods were combined into a single category. The price index for this combined category was created using chain weighting on the underlying data.

Food and energy inflation data for all countries come from the World Bank Global Database of Inflation at https://www.worldbank.org/en/research/brief/inflation-database.

Unemployment rates are obtained from the Bureau of Labor Statistics (BLS) via https://fred.stlouisfed.org/ for the United States and Macrobond using OECD Labor Force Survey for the other G-7 economies.

The US job vacancy rate was obtained from the BLS Job Openings and Labor Turnover Survey database via https://fred.stlouisfed.org/. The vacancy rate was extrapolated backwards using data from Petrosky-Nadeau and Zhang (2021) available at https://drive.google.com/file/d/1NcuUMRR4_fOwJW6qHb-XxitVSXXONBHW/view. The German vacancy rate is from OECD *Main Economic Indicators* (MEI) via https://fred.stlouisfed.org/. The Japanese vacancy rate was constructed from the total number of vacancies from Statistics of Japan (table 6 at https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00450222&tstat=000001020327&cycle=1&tclass1=000001218240&tclass2val=0) and the labor force size from OECD MEI via https://fred.stlouisfed.org/. The UK vacancy rate is from OECD MEI via https://fred.stlouisfed.org/ and was extended before 2018 using the Bank of England's Millenium of Macroeconomic Data weblink at https://www.bankofengland.co.uk/statistics/research-datasets. The Canadian vacancy rate is provided by Bounajm, Roc, and Zhang (2024) at https://www.bankofcanada.ca/?p=239093. The Canadian vacancy rate was extrapolated for the last two quarters of 2023 using data from Statistics Canada at https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410039801.

Data are available from 1993Q4 through 2023Q4, except for the United Kingdom (1995Q1), Italy (1996Q1), and Japan (1994Q1).

All data are reported in seasonally adjusted terms except for Japanese consumption components. We seasonally adjusted Japanese quarterly consumption inflation rates (used in regressions) by regressing them on three mean-zero quarterly dummies and using the residuals plus the intercept term. Four-quarter inflation rates displayed in figure 1 are based on the original unadjusted data.

Our proxy for supply shortages is constructed using data from Google Trends on frequency of search results. For the United States, United Kingdom, and Canada, the term “chip shortage” is used. Different terms are used in non-English speaking countries: “半導体不足” in Japan, “chipmangel” in Germany, “crisi semiconduttori” in Italy, and “penurie composants” in France. Results are available from 2004 to present at a monthly frequency, with the peak month indexes at 100. We converted the data to a quarterly frequency using averages within each quarter. We extrapolated data before 2004 at 0.

Definitions

PN	price index for consumption of nondurable goods.
PD	price index for consumption of durable and semi-durable goods[22]
PS	price index for consumption of services
PE	energy component of consumer price index, ratio to GDP price index
PF	food component of consumer price index, ratio to GDP price index
PIM	price index for imports of goods and services, ratio to GDP price index (the *PIM* inflation rate is scaled by the ratio of imports to GDP)
UN	unemployment rate, percent of labor force
UN_LOW	zero except for observations in which *UN* is below its economy-specific 25th percentile value, in which case *UN_LOW* is *UN* minus the 25th percentile value
VAC	job vacancy rate, percent of labor force
V/U	ratio of job vacancies to unemployment
CD	real consumption of durable and semi-durable goods
CHIPSHORT	Google Trends search results by economy for the term “chip shortage” or foreign-language equivalent

[22] The United States does not report semi-durable goods. For the United States, *PD* and *CD* refer to durable goods only.

Table 1. Average PCE inflation in 2020-23 was much higher than in 2016-19
(average percent change over four years)

	Canada	France	Germany	Italy	Japan	United Kingdom	United States
Inflation target	2.0	2.0	2.0	2.0	2.0	2.0	2.0
2016-2019 average annual inflation	1.4	1.0	1.4	0.7	0.5	1.5	1.6
2020-2023 average annual inflation	3.4	3.6	4.4	3.8	1.8	4.7	3.9
Change in average inflation (percentage points)	2.0	2.6	3.0	3.1	1.3	3.2	2.3
of which							
Durable goods	0.4	0.3	0.5	0.3	0.3	0.4	0.5
Nondurable goods	0.8	0.9	1.6	1.5	0.7	1.0	0.7
Services	0.8	1.4	0.8	1.3	0.3	1.7	1.1
Shares in nominal consumption (percent, 2016-2023 average)							
Durable goods	20	15	21	17	14	19	11
Nondurable goods	25	30	28	32	29	22	21
Services	55	54	51	51	58	59	67

PCE = personal consumption expenditures
Note: In this table, durable goods include semi-durable goods in countries that report both.
Source: Authors' calculations using data described in the appendix.

Table 2. Durable goods inflation, 1995Q1-2023Q4							
Variable	Canada	France	Germany	Italy	Japan	United Kingdom	United States
Lagged Δ*PD*	0.55** (0.12)	-0.13 (0.30)	0.58** (0.09)	0.29** (0.10)	0.85** (0.11)	0.45** (0.13)	0.27* (0.11)
Δ*PE*	0.01 (0.01)	-0.12 (0.10)	0.03* (0.01)	0.03** (0.01)	0.05 (0.05)	-0.02 (0.02)	-0.02 (0.01)
Δ*PF*	0.07 (0.05)	0.36* (0.15)	0.04 (0.02)	0.16** (0.05)	0.20* (0.09)	0.09 (0.09)	0.03 (0.06)
Δ*PIM*	-0.02 (0.08)	0.87* (0.33)	-0.11 (0.06)	-0.06 (0.06)	0.84 (0.72)	0.26 (0.21)	0.53** (0.20)
CHIPSHORT_US	0.04** (0.01)	0.01 (0.04)	0.05** (0.01)			0.08** (0.02)	0.12** (0.02)
Δ*CD*	0.13 (0.18)		0.16 (0.21)	0.18 (0.11)			0.05 (0.02)
Constant	-0.17 (0.25)	-0.03 (0.61)	-0.12 (0.14)	0.33* (0.15)	-0.04 (0.37)	-0.02 (0.32)	-1.53** (0.24)
Observations	116	116	116	107	115	111	116
R^2	0.47	0.35	0.76	0.57	0.6	0.34	0.80

*p < 0.05, **p < 0.01. Robust standard errors are in parentheses.
Note: Semi-durable goods (where available) have been added to durable goods in these regressions.
Source: Authors' calculations using data described in the appendix.

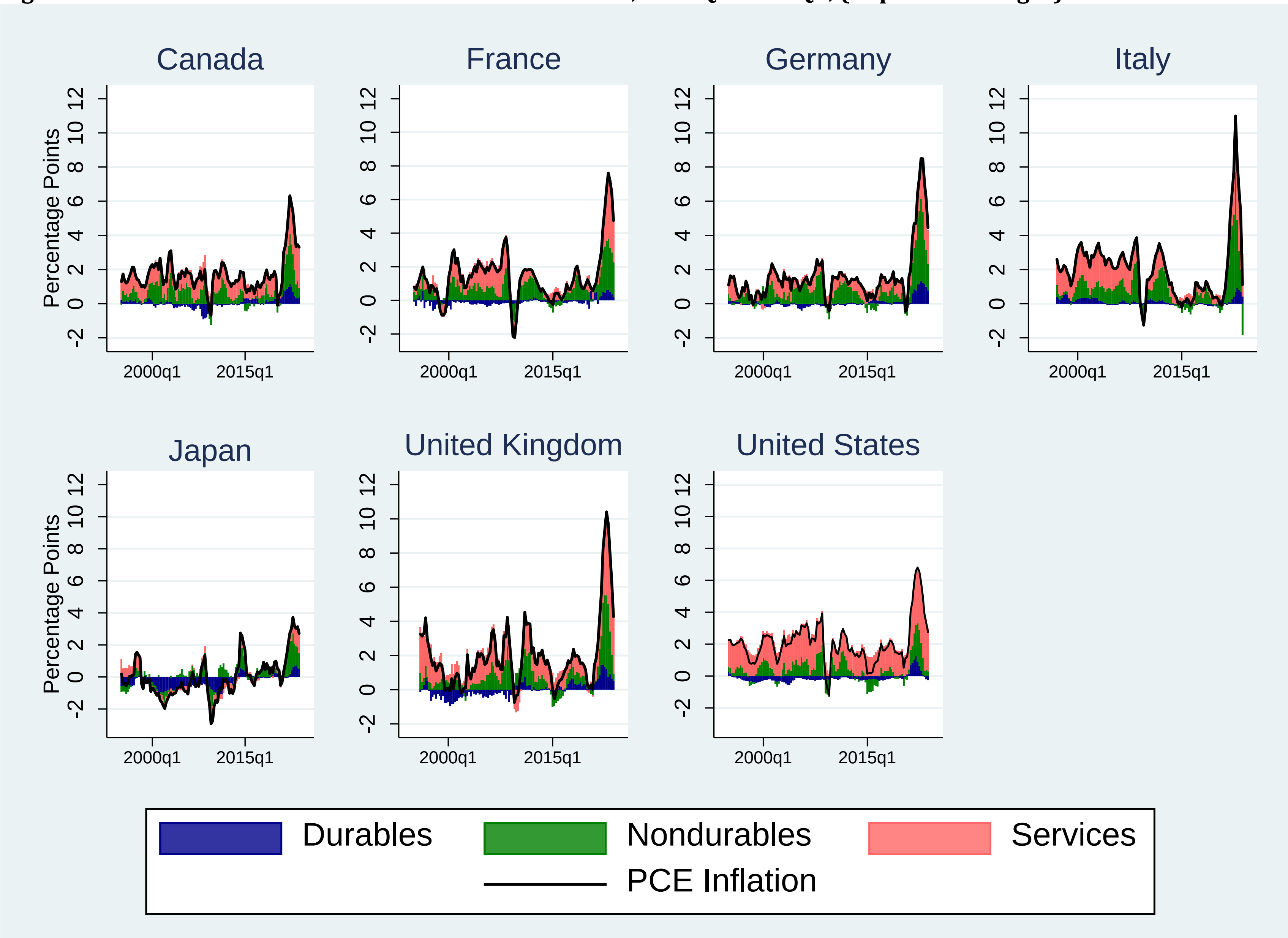
Table 3. Nondurable goods inflation, 1995Q1-2023Q4							
Variable	Canada	France	Germany	Italy	Japan	United Kingdom	United States
Lagged Δ*PN*	0.12 (0.14)	0.12 (0.11)	0.18 (0.13)	-0.06 (0.15)	0.00 (0.15)	-0.04 (0.11)	0.16 (0.13)
Δ*PE*	0.18** (0.03)	0.24** (0.03)	0.17** (0.04)	0.22** (0.05)	0.24** (0.05)	0.29** (0.02)	0.12** (0.02)
Δ*PF*	-0.01 (0.08)	0.37** (0.07)	0.17* (0.08)	0.42** (0.09)	0.46** (0.08)	0.32** (0.09)	0.19 (0.11)
Δ*PIM*	-0.04 (0.16)	0.14 (0.16)	0.63** (0.20)	0.69** (0.16)	1.25 (0.70)	0.63** (0.21)	1.65** (0.56)
V/U					1.16 (0.64)		1.69** (0.49)
Δ*V/U*					8.38** (3.20)		4.80* (2.33)
UN	0.19 (0.24)	-0.21 (0.25)	0.15 (0.17)	-0.13 (0.14)		0.21 (0.29)	
Δ*UN*	-1.64** (0.29)	-0.41 (0.81)	-1.11 (1.05)	-0.01 (0.43)		-1.24 (1.27)	
UN_LOW	-1.80 (0.93)	-1.05 (1.20)	-2.06* (0.98)	-0.21 (0.49)		-1.37 (1.28)	
Constant	-0.16 (2.02)	3.30 (2.39)	0.18 (1.28)	3.05 (1.51)	0.43 (0.60)	0.56 (1.71)	0.12 (0.40)
Observations	116	116	116	103	115	111	116
R^2	0.61	0.78	0.60	0.90	0.67	0.81	0.84

*p < 0.05, **p < 0.01. Robust standard errors are in parentheses.
Source: Authors' calculations using data described in the appendix.

Table 4. Services inflation, 1995Q1-2023Q4							
Variable	Canada	France	Germany	Italy	Japan	United Kingdom	United States
Lagged Δ*PS*	0.23 (0.20)	0.45** (0.13)	0.22 (0.18)	0.72** (0.11)	0.57** (0.17)	0.30 (0.17)	0.67** (0.09)
Δ*PE*	0.00 (0.01)	0.02 (0.03)	0.02 (0.02)	0.01 (0.01)	0.03 (0.02)	0.05** (0.02)	0.00 (0.01)
Δ*PF*	-0.02 (0.03)	0.10 (0.06)	0.05 (0.04)	0.13* (0.05)	0.06 (0.03)	0.15 (0.09)	0.00 (0.03)
Δ*PIM*	-0.09 (0.05)	0.09 (0.17)	-0.09 (0.11)	0.20** (0.07)	0.17 (0.22)	0.03 (0.14)	0.35** (0.10)
V/U	4.06** (0.92)						0.54** (0.17)
ΔV/U	1.77 (2.35)						1.47* (0.60)
UN		-0.19 (0.22)	0.03 (0.07)	0.00 (0.10)	-0.12 (0.12)	-0.19 (0.16)	
Δ*UN*		-1.44* (0.68)	-0.48 (0.59)	-0.71* (0.30)	-1.44* (0.59)	-2.71 (1.50)	
UN_LOW			-0.79 (0.47)		-1.30 (1.50)		
Constant	0.01 (0.29)	2.48 (1.99)	0.69 (0.63)	0.52 (1.19)	0.54 (0.54)	2.25* (1.09)	0.57** (0.21)
Observations	116	116	116	103	115	111	116
R^2	0.45	0.45	0.28	0.60	0.41	0.27	0.73

*p < 0.05, **p < 0.01. Robust standard errors are in parentheses.
Source: Authors' calculations using data described in the appendix.

Figure 1. Contributions to PCE inflation in G-7 economies, 1995Q1-2023Q4, (4-quarter changes)

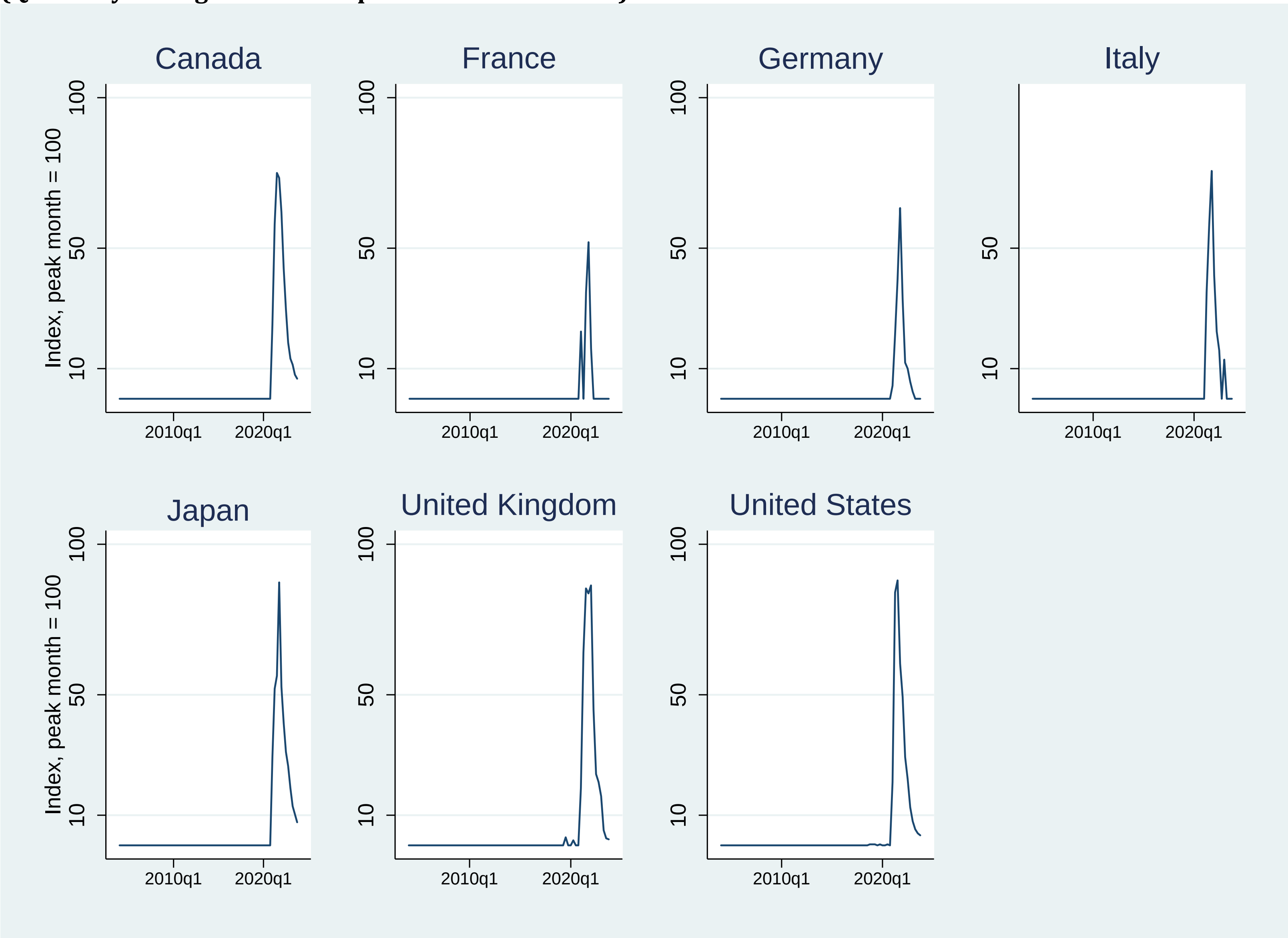


PCE = personal consumption expenditures
Source: Authors' calculations using data described in the appendix.

Figure 2. Real (inflation-adjusted) growth in consumption of durable goods, 1995Q1-2023Q4, (4-quarter changes)

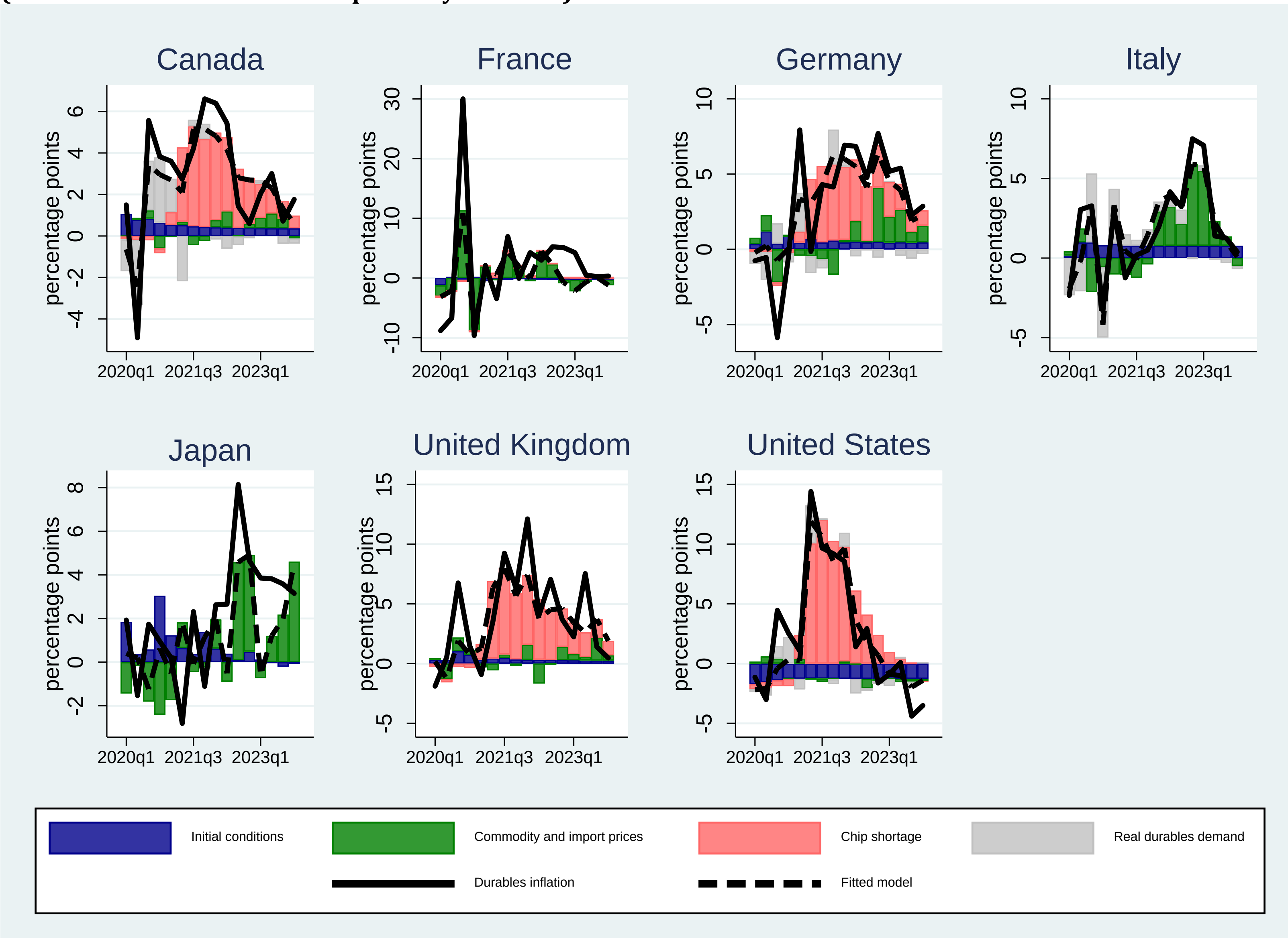
Source: Authors' calculations using data described in the appendix.

Figure 3. Frequency of Google searches for "chip shortage" or similar in G-7 economies, 2004Q1-2023Q4 (Quarterly average index with peak month set at 100)



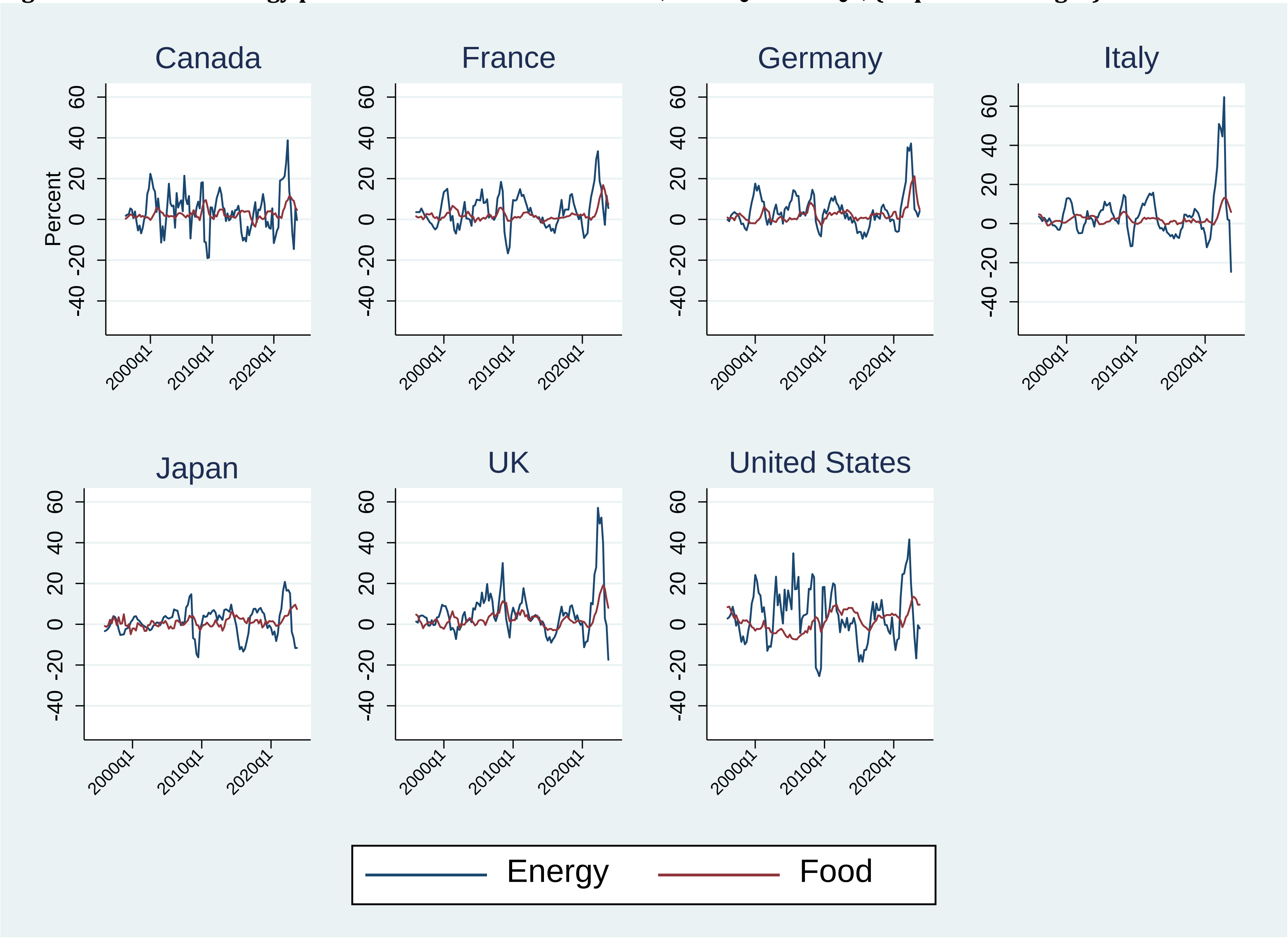
Source: Google Trends.

Figure 4. An augmented model of durable goods prices fits well in many economies, 2020Q1-2023Q4 (contributions to annualized quarterly inflation)



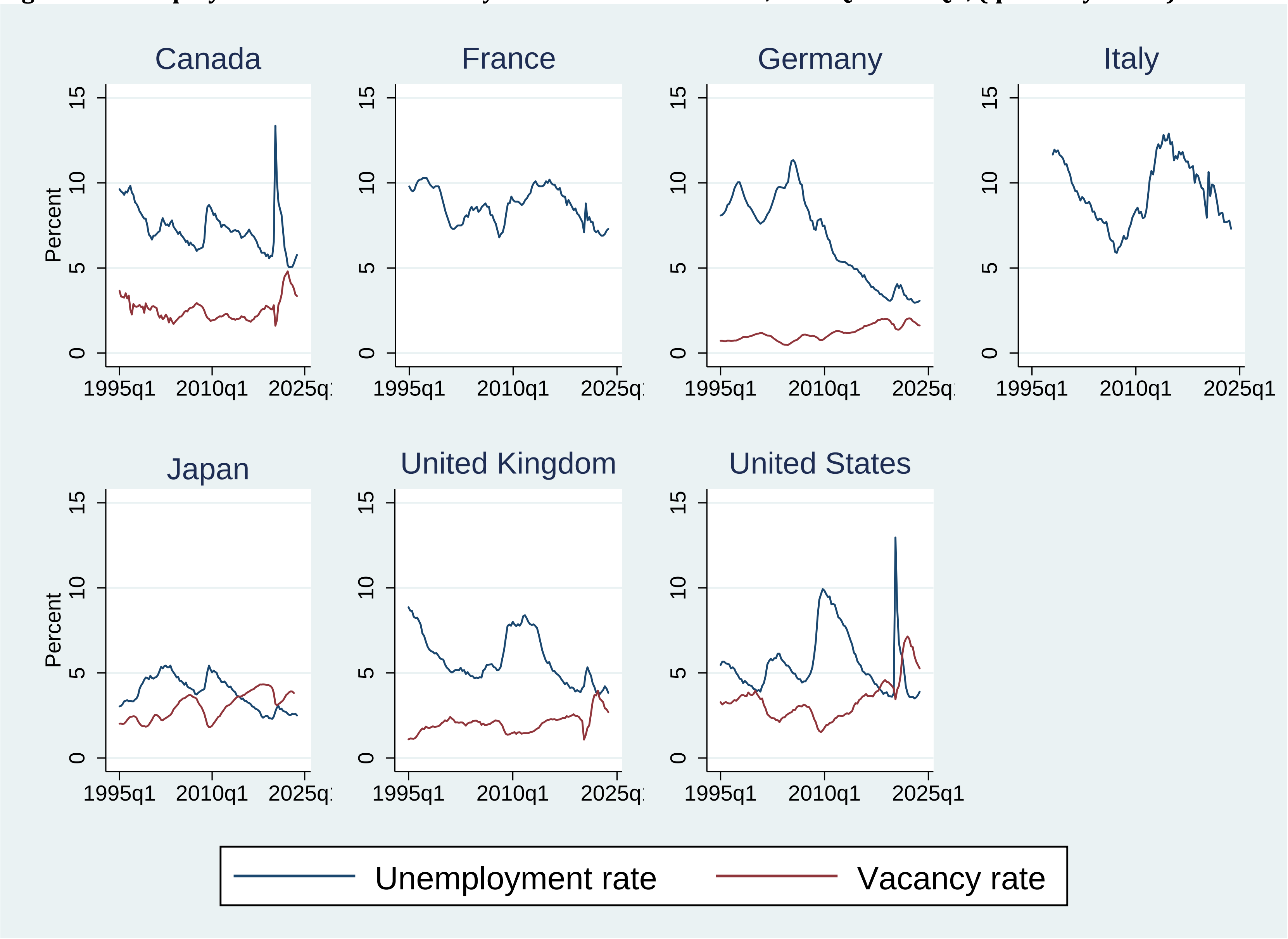
Source: Authors' calculations using data and results from table 2.

Figure 5. Food and energy price inflation in G-7 economies, 1995Q1-2023Q4, (4-quarter changes)



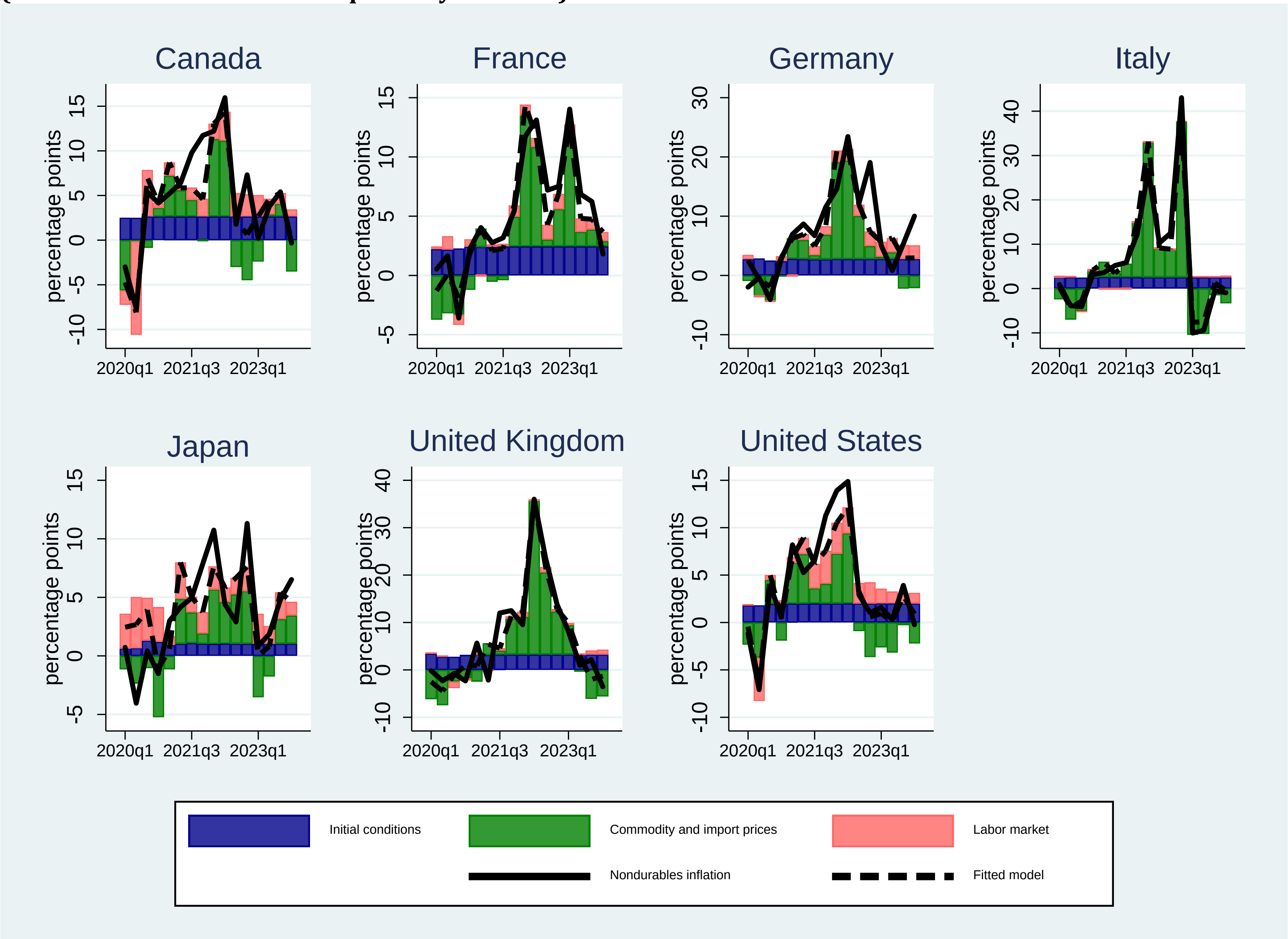
Source: Authors' calculations using data described in the appendix.

Figure 6. Unemployment Rates and Vacancy Rates in G-7 Economies, 1995Q1-2023Q4, (quarterly levels)



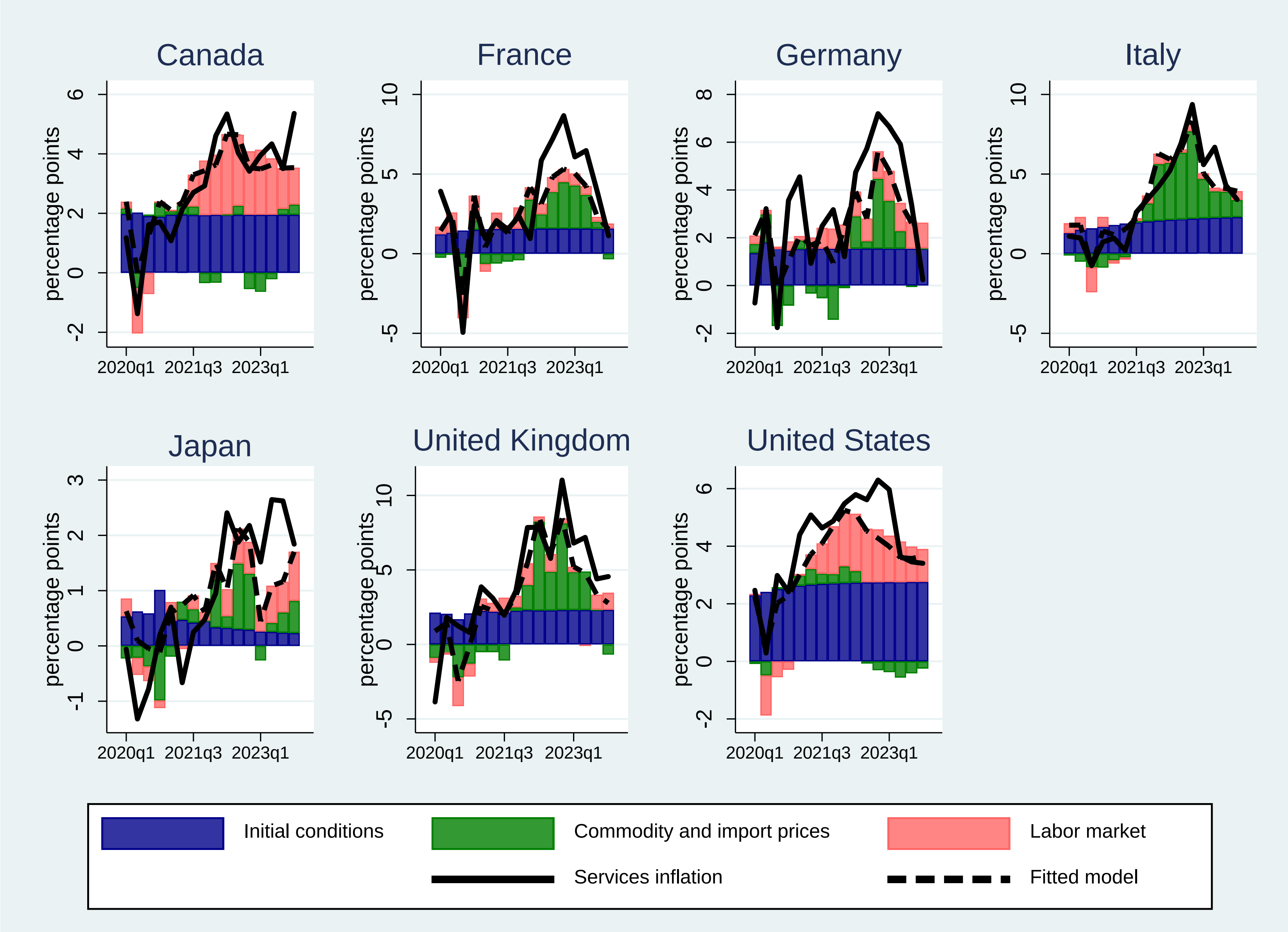
Source: Data described in the appendix.

Figure 7. A nonlinear Phillips curve model of nondurable goods prices fits well, 2020Q1-2023Q4 (contributions to annualized quarterly inflation)



Source: Authors' calculations using data and results from table 3.

Figure 8. A nonlinear Phillips curve model of services prices fits moderately well, 2020Q1-2023Q4, (4-quarter changes)



Source: Authors' calculations using data and results from table 4.

PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

24-22 Fiscal Policy and the Pandemic-Era Surge in US Inflation

Lessons for the Future

Karen Dynan and Douglas Elmendorf

December 2024

ABSTRACT

In the United States, massive fiscal expansion during the pandemic protected households and helped to return output and unemployment nearly to pre-pandemic expectations by the end of 2021—a sharp contrast with the slow recovery from the previous US recession. We document that many policymakers and analysts expected the fiscal-induced increase in demand for goods and services to be accommodated by an increase in supply without much change in inflation. However, those expectations proved incorrect, as fiscal stimulus pushed demand beyond the productive capacity of the economy, stoking temporarily high inflation. We present a collection of evidence implying that the inflation surge was driven largely by supply being fairly inelastic at the level of utilization to which the demand boom pushed the economy, with adverse supply shocks beyond the initial impact of COVID playing a smaller role. We conclude with lessons for future fiscal stabilization policy.

JEL codes: E31, E32, E62, E65
Keywords: Inflation, fiscal stimulus, supply constraints

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The US response to the COVID-19 pandemic included a stunning amount of expansionary fiscal policy. Six bills enacted between March 2020 and March 2021 increased federal spending and reduced federal taxes by an estimated total of nearly $5.1 trillion, or 23 percent of pre-pandemic annual gross domestic product (Swagel, 2021).

This massive fiscal expansion, along with a sharp cut in the federal funds rate and large-scale asset purchases by the Federal Reserve, protected American households from greater economic distress and cushioned the US economy from a deeper and longer slowdown. While the direct effects of the fiscal expansion on households that received new benefits or paid less in taxes were significant (see, for example, the social insurance arguments by Romer and Romer, 2022), our paper focuses on the aggregate economic effects.

By increasing the demand for goods and services, fiscal stimulus in 2020 and 2021 reduced layoffs, hastened the recovery of output, and pushed down the unemployment rate more rapidly than would have occurred otherwise. Indeed, both output and unemployment in the United States returned nearly to pre-pandemic expectations by the end of 2021—a stark contrast to the painfully slow recovery following the Great Recession a dozen years earlier and to slower post-pandemic recoveries in many other advanced economies.

However, booming US aggregate demand significantly exceeded the economy's ability to supply goods and services between mid-2021 and mid-2022. The excess of demand relative to supply caused a surge in US inflation, with consumer prices rising at the fastest pace in four decades. Although inflation began to decline in the second half of 2022, consumer prices in August 2024 were 9 percent above what they would have been if they had increased at the Fed's target rate since the beginning of 2021. Surveys of households suggest substantial and enduring unhappiness about the higher prices.[1]

Through an analysis of different vintages of economic projections from the Congressional Budget Office, the Federal Open Market Committee, and private forecasters, we show that policymakers and analysts generally expected that fiscal stimulus would significantly boost demand and that supply would rise to meet demand with little effect on prices. In terms of the workhorse framework of aggregate demand and supply, many policymakers and analysts thought that fiscal stimulus, combined with monetary support, would shift the aggregate demand curve notably to the right along a nearly flat aggregate supply curve.

[1] For example, see Binetti et al (2024) and Stantcheva (2024).

Why did that desirable outcome not occur? Some analysts have pointed to the role of adverse supply shocks. Although the impact of COVID was diminishing during the inflation surge as vaccines became available and most people returned gradually to their usual activities, reduced availability of key types of semiconductors and fallout from the Russian invasion of Ukraine held down aggregate supply. But the broader backlogs and bottlenecks observed in that period demonstrate only that quantities demanded exceeded quantities supplied; they do not indicate the degree to which those gaps arose from supply shocks or from supply constraints in the face of demand shocks.

To distinguish between those explanations, we present an assemblage of evidence regarding the timing and breadth of the inflation surge and the tightness of the labor market. This evidence implies that the primary cause of higher inflation was the strength of demand rather than shocks to supply—in other words, that the aggregate supply curve turned out to be fairly steep at the level of utilization to which the demand boom pushed the economy.[2]

We emphasize the distinction between adverse supply shocks and fairly inelastic supply (a steep supply curve over the relevant range) to draw lessons for future fiscal stabilization policy. Supply shocks are generally idiosyncratic and unpredictable, while inelastic supply is somewhat foreseeable and can be taken into account by policymakers when calibrating responses to economic downturns. The pandemic experience shows that even when demand falls short of potential supply, spurring demand too strongly may have less effect on output and more on inflation if the economy is already nearing full employment.

In the following sections we review the fiscal stimulus that was enacted, describe the impact expected by analysts and policymakers, examine what the outcomes imply about fiscal stimulus and inflation, and draw lessons for future fiscal stabilization policy.

1. Fiscal Stimulus Enacted in 2020 and 2021

Between March 2020 and March 2021, the US federal government responded to the COVID pandemic with legislation that increased federal spending by $4.6 trillion and cut federal

[2] Other researchers whose analysis yields a similar conclusion include Benigno and Eggertsson (2023 and 2024); Comin, Johnson, and Jones (2023); Demirel and Wilson (2023); Giannone and Primiceri (2024); Jordà and Nechio (2023); and Koch and Noureldin (2023). Inflation surged in Europe as well as in the United States, even though fiscal stimulus was more limited in Europe, and some observers have interpreted that fact as evidence against a significant role for fiscal policy in the pickup of US inflation. However, Europe was significantly more exposed than the United States to inflationary pressures from energy and food price shocks related to the invasion of Ukraine, and inflation in Europe increased later than inflation in the United States, so inferring causes of higher inflation from cross-country comparisons is difficult. For analyses of recent European inflation, see Gagnon and Rose (2024), Honohan (2024), and Schnabel (2024).

revenue by $0.5 trillion, as estimated by the Congressional Budget Office (CBO; see Swagel, 2021). Although those figures include all years in the subsequent decade, reflecting CBO's usual practice, the policy changes were heavily concentrated in 2020 through 2022. Together, these amounts equaled 23 percent of pre-pandemic annual gross domestic product (GDP).[3]

The legislation is listed in Table 1: In March and April of 2020, Congress and the president agreed to almost $2½ trillion of fiscal stimulus distributed among four bills. Eight months later, a broad appropriations bill was enacted of which nearly $1 trillion represented pandemic-related stimulus. Nearly three months after that, in March 2021, about $1¾ trillion of further stimulus was enacted.[4]

For comparison, fiscal stimulus enacted in 2008 and 2009 in response to the Global Financial Crisis and Great Recession was much smaller. Policymakers in that earlier period enacted the Economic Stimulus Act in February 2008, increasing the budget deficit by an estimated $124 billion over a decade (CBO, 2008a). In October 2008, they passed the Emergency Economic Stabilization Act (EESA), for which CBO (2008b) stated that it could not provide a cost estimate because of uncertainty about the implementation of the Troubled Asset Relief Program. The American Recovery and Reinvestment Act (ARRA), enacted in March 2009, increased the budget deficit by an estimated $787 billion over a decade (CBO, 2009). A number of subsequent bills increased the budget deficit by an estimated $706 billion (Council of Economic Advisers, CEA, 2014). The total, roughly $1.6 trillion (excluding the cost of EESA), equaled 10 percent of the country's pre-crisis annual output.

[3] In addition to traditional fiscal policies, many countries used credit policies, such as loan guarantees and direct lending, to mitigate the economic fallout from the pandemic. Hong and Lucas (2023) showed that such support was limited in the United States but quite large in some other countries.
[4] Other significant changes in fiscal policy followed in 2021 and 2022, including the Infrastructure Investment and Jobs Act and the CHIPS Act. However, those policy changes were focused on long-term issues and had limited macroeconomic effects in the short term (CBO, 2022, Box 2-2, and 2023, Box 2-1), so we do not address them in this paper.

Table 1: COVID-Era Fiscal Stimulus

Legislation	Change in Spending	Change in Revenue	Change in Budget Deficit
Coronavirus Preparedness and Response Supplemental Appropriations Act, 2020 *March 6, 2020*	8	0	8
Families First Coronavirus Response Act *March 18, 2020*	97	-94	192
Coronavirus Aid, Relief, and Economic Security (CARES) Act *March 27, 2020*	1314	-408	1721
Paycheck Protection Program and Health Care Enhancement Act *April 24, 2020*	483	0	483
Consolidated Appropriations Act, 2021, Divisions M and N *December 27, 2020*	862	-5	868
American Rescue Plan Act of 2021 *March 11, 2021*	1803	0	1803
Total	4567	-507	5075

Note: Figures are CBO's estimates of billions of dollars over the traditional decade-long budget window (Swagel, 2021). Enactment dates are shown.

The legislation of 2020 and 2021 was expected to boost inflation-adjusted ("real") output and employment substantially relative to what would have occurred in the absence of stimulus. For example, CBO estimated that:

- The legislation enacted in March and April of 2020 would raise real GDP by 4.7 percent in 2020, 3.1 percent in 2021, and 0.3 percent in 2022 (CBO, 2020);

- The legislation enacted in December 2020 would raise real GDP by 1.8 percent in 2021 and 1.1 percent in 2022 (CBO, 2021a); and
- The legislation enacted in March 2021 would raise real GDP by 1.0 percent in 2021, 2.7 percent in 2022, 1.4 percent in 2023, and 0.5 percent in 2024 (CBO, 2021b).

Those figures cannot be summed exactly because the projected levels of GDP used in the calculations changed over time and because CBO's assessment of the effect of the initial bills may have changed by the time the later packages were enacted. But in rough terms, CBO expected that, relative to what would have happened in its absence, the fiscal stimulus enacted in 2020 and 2021 would raise the level of real output by roughly 5 percent in 2020 through 2022 and roughly 4 percent in 2023—very large effects.[5]
Rather than reviewing every step in fiscal policymaking during 2020 and early 2021 as the pandemic and its economic fallout rapidly evolved, our analysis focuses on the final piece of pandemic-oriented fiscal stimulus in early 2021 and the subsequent economic developments. That package—the American Rescue Plan (ARP)—has been at the heart of the debate over the connection between pandemic fiscal support and the surge in inflation.

2. Analyzing Fiscal Policy's Impact on Output and Inflation

We begin by reviewing the framework and methods used by many policymakers and analysts to predict how fiscal stimulus affects economic outcomes.

A basic framework

Our starting point is the textbook graph of aggregate supply and demand, with real output on the horizontal axis and inflation on the vertical axis.[6] While policy analyses often do not present these diagrams explicitly, they typically rely on the underlying logic.[7]

The pre-stimulus economy is captured by the solid lines in Figure 1. The COVID pandemic and public health measures adopted in response to it reduced people's ability and willingness to go to their usual workplaces—in the United States, and in China and other countries that produced items sold to US consumers or used in US production. Those

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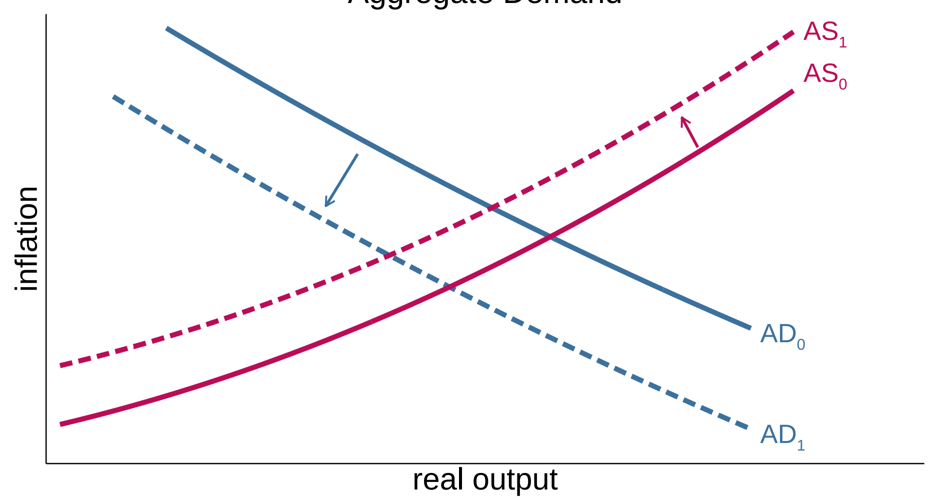
[5] By raising the level of output more in the near term than beyond it, fiscal stimulus reduced the *growth* of output in later years. That effect explains why the estimated contribution of fiscal policy to growth can be negative even during periods of substantial fiscal support; see, for example, the "fiscal impact" measure published by Brookings' Hutchins Center on Fiscal and Monetary Policy.
[6] Mankiw (2019, pages 435-449) showed how to derive this framework from one that has the price level on the vertical axis.
[7] Papers that explicitly include such diagrams include Gagnon (2024) and Benigno and Eggertsson (2024).

developments constituted a large adverse supply shock, shifting the aggregate supply curve to the left. At the same time, aggregate demand declined, as people who lost jobs or work hours received less income and curtailed their consumption, as many people were reluctant to go out in public and lowered their spending, and as businesses facing falling or uncertain sales cut back on their hiring and investment. Those changes shifted the aggregate demand curve significantly to the left.

Monetary policymakers responded by cutting the federal funds rate sharply and purchasing financial assets on a large scale. Fiscal policymakers increased federal spending and reduced federal taxes. Those fiscal actions boosted household income, business cash flow, and the resources available to state and local governments. The actions also may have affected the incentives for people, firms, and governments to spend, invest, work, and hire.

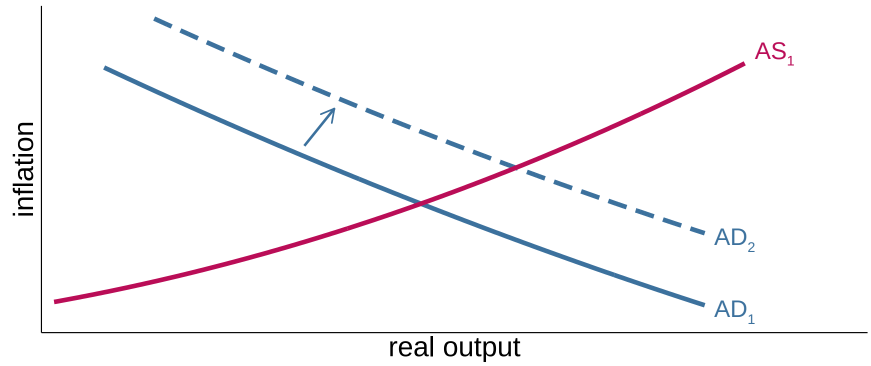
Figure 1
COVID Pandemic Reduces Aggregate Supply and Aggregate Demand



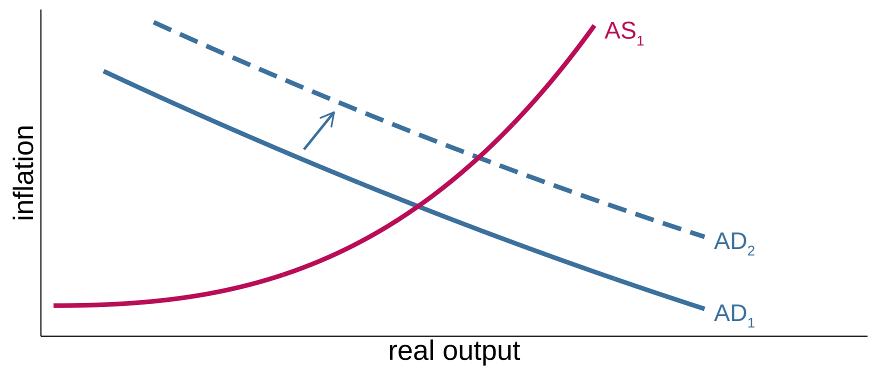
The panels of Figure 2 show the effects of fiscal stimulus on aggregate demand under different assumptions about supply conditions. To highlight the impact of that stimulus, the solid lines in Figure 2 include the initial effects of the pandemic shown in Figure 1, and Figure 2 omits the effect of monetary policy on aggregate demand and the effects of fiscal stimulus on aggregate supply.

Figure 2
Aggregate Supply and Demand Analysis
of Fiscal Policy Response

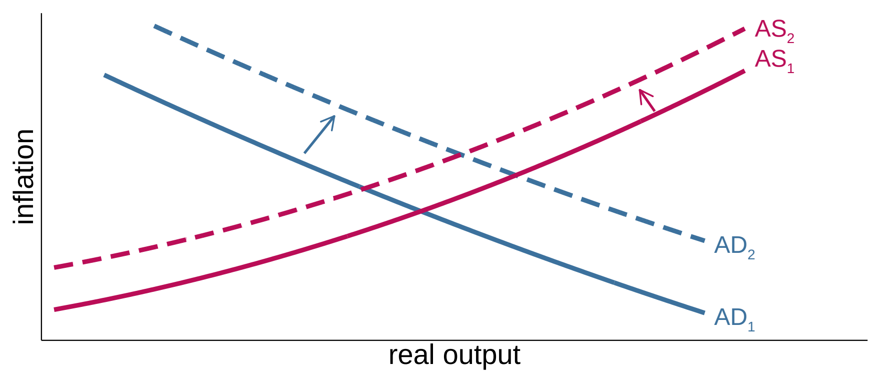
(a) Fiscal Policy Response



(b) Fiscal Policy Response
When Economy is on Steeper Part of Aggregate Supply Curve



(c) Fiscal Policy Response
With Further Aggregate Supply Shocks



Notes: The solid lines in the figures include the initial effects of the pandemic. The analysis omits the effects of monetary policy on aggregate demand and the effects of fiscal stimulus on aggregate supply.

On net, the effects of fiscal policy described above are captured by a rightward shift of the aggregate demand curve, leading to increases in both output and inflation. The magnitudes of those increases depend on two factors:

- How much households, businesses, and state and local governments spend rather than save out of the federal tax and spending changes; and
- How much producers of goods and services raise production and raise prices in response to the higher demand—that is, how flat or steep is the aggregate supply curve in the range over which aggregate demand increases.

Comparing Figures 2a and 2b shows that when the relevant part of the supply curve is steeper, a given stimulus has a smaller effect on real output and a larger effect on inflation.

Applying this framework

In practice, many analysts estimating the short-run impact of fiscal policy on real output and inflation essentially apply the foregoing framework: They quantify changes in demand for goods and services and then incorporate changes in supply.

A change in policy with a budgetary effect of x dollars directly changes demand by amounts ranging from ***x*** dollars (for changes in federal purchases) to something much smaller than ***x*** dollars (say, for changes in the timing of tax payments by businesses whose investments are not cash-constrained). That direct effect ripples through the economy, creating indirect effects that may be reinforcing (such as firms with higher sales deciding to increase investment) or opposing (such as greater demand raising interest rates, which reduces investment); in addition, changes in incentives can have indirect effects by altering the supply of goods and services. Taken together, the direct and indirect effects produce an overall effect.

For example, CBO (2020b) and Seliski et al (2020) explain how the agency estimated the impact of the legislation enacted in March and April of 2020. In CBO's terminology, the "output multiplier" is the change in GDP per dollar of budgetary change in fiscal policy, which equals the product of a policy's direct effect on purchases of goods and services and a "demand multiplier" that captures indirect effects. The agency "used delayed and reduced estimates of the output multiplier to reflect the effects of social distancing" (Seliski at al, 2020, Abstract) and predicted that the stimulus would raise GDP cumulatively by 58 cents per dollar change in the budget deficit (CBO, 2020b). CBO (2021b, Appendix B) reported later that the stimulus legislation enacted in March 2021 would raise GDP cumulatively by 73 cents per dollar change in the budget deficit.

Multipliers are uncertain, of course. Different studies have reached different conclusions about average multipliers, and multipliers are known to differ across types of government spending and taxes, so analysts need to make a host of specific judgments. For example, CBO applied multipliers to different aspects of fiscal stimulus legislation that differed by a factor of more than two.[8] Moreover, multipliers vary over time based on economic circumstances—including, during the pandemic, social distancing reducing people's willingness to engage with others in consumption or work.[9] To capture this uncertainty, CBO (2020b) provided a two-thirds confidence region for the effect of the early stimulus packages on real GDP that stretched from 2 percent to 15 percent in the third quarter of 2020, and that range did not even account for uncertainty about "the impact of social distancing and the trajectory of the pandemic on the effectiveness of fiscal policy" (pages 11-12).

CBO's approach is in no way idiosyncratic. The CEA (2014) conducted a similar analysis for the Great Recession period. In section 4, we show that the outcomes expected during 2021 and 2022 by Federal Reserve policymakers and by private forecasters surveyed by *The Wall Street Journal* aligned very closely with the expectations of CBO.

Supply shocks versus a steep aggregate supply curve

In 2021 and 2022, the initial adverse pandemic supply shock continued to unwind—a positive development for supply. But the economy was hit by further adverse supply shocks that have received significant attention in the discussion around the post-pandemic surge in inflation.

We discuss these adverse supply shocks in more detail later in the paper, but they include reduced availability of key types of semiconductors and fallout from the Russian invasion of Ukraine. Such developments would be expected to shift the aggregate supply curve to the left as shown in Figure 2c (which omits for clarity the waning of the initial pandemic shock). Those reductions in the aggregate quantity of goods and services supplied at the pre-existing inflation rate tended to decrease output and increase inflation.

Together, Figures 2b and 2c show that when a limited increase in real output and a sharp rise in inflation follow an increase in aggregate demand, the cause might be either a steep aggregate supply curve as in Figure 2b or adverse supply shocks as in Figure 2c.

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[8] See CEA (2014) for a survey of research at the time, Ramey (2019) for a later review of the evidence, and CBO (2020b) and Seliski et al (2020) for many relevant citations.

[9] The pandemic period saw a wave of research on consumer and business responses to fiscal support, but the unique conditions and data limitations have hindered firm conclusions about lessons for the future. See Gelman and Stephens (2022) for an overview of estimated propensities to consume out of Economic Impact Payments, Edelberg and Sheiner (2021) for a discussion of uncertainty related to the unusual circumstances of the pandemic, and Auerbach et al (2022) for estimates of fiscal multipliers during the pandemic.

Yet, this distinction is important. Shifts of supply curves—that is, shifts of the relationship between price and quantity supplied—are appropriately termed "supply shocks." Movements along supply curves—that is, changes in prices and quantities caused by shifts of demand curves—can appropriately be described as reflecting "supply constraints," but they are not "supply shocks." Unfortunately, many analyses of supply issues during and after the pandemic have conflated these concepts. "Supply chain disruptions" seem to represent supply shocks. But the terms "shortages," "bottlenecks," "backlogs," "pressures," and "delivery times" do not necessarily involve supply shocks; instead, those terms apply to gaps between quantities supplied and demanded, without addressing whether the gaps arise from supply shocks or from supply constraints in the face of demand shocks.[10]

Distinguishing between a steep supply curve and adverse supply shocks in the COVID-era experience is important to drawing lessons for the designers of future stabilization policy. Supply shocks such as those seen over the past few year are generally idiosyncratic and not particularly likely to recur in future economic downturns. But if the aggregate supply curve was steep as the economy neared full employment during the COVID era, that characteristic may persist in future downturns, implying that policymakers should be concerned about providing too much stimulus as well as too little stimulus.

Moreover, the optimal policy response to higher inflation may be different when inflation is driven by the economy being on a steep portion of the supply curve rather than by adverse supply shocks. In the former case, inflation can be reduced by constraining demand enough to pull the economy back from the steep part of the supply curve. In the latter case, a large reduction in demand might be needed to offset the impact of the supply shocks, but if policymakers view those shocks as transitory, they may choose to take no action and wait for the shocks to ease (an approach sometimes described, as in Powell, 2023, as "looking through" the shocks).

[10] For example, a *New York Times* article about supply issues in January 2022 (Swanson, 2022) explained that China "has confined millions of its residents in recent weeks to try to keep the Omicron variant at bay"—a supply shock—and that US Secretary of Transportation Pete Buttigieg "said the record volumes of goods moving through American ports were straining systems"—a supply constraint facing strong demand. As another example, the Federal Reserve Bank of New York publishes a Global Supply Chain Pressure Index that incorporates various useful measures of supply pressures, but the cost-based components do not disentangle shifts in supply curves from movements along supply curves generated by changes in demand.

3. Considerations Shaping the American Rescue Plan of March 2021

When the ARP was being developed in early 2021, debate arose about whether the amount of additional stimulus under consideration was appropriate to address the ongoing fallout from the pandemic or was unnecessary and risked overheating the economy.

Economic outlook before enactment of the ARP

A starting point for assessing the impact of additional fiscal stimulus in early 2021 is to appraise the economic outlook in the absence of such stimulus. We do so by comparing economic forecasts just prior to the ARP with forecasts before the pandemic.

One source of forecasts we explore is CBO's "baseline projections," which are typically issued twice per year. Those projections show CBO's expectations for economic and budgetary outcomes conditional on the laws regarding federal spending and revenue in place when the projections are prepared. We also analyze projections from participants in meetings of the Federal Open Market Committee (FOMC)—the Federal Reserve's governors and the presidents of the Federal Reserve Banks. Their "Summary of Economic Projections" (SEP) documents are released four times per year and include median projections for year-end values of key economic variables. Finally, we look at median projections from private forecasters, as collected by the *Wall Street Journal* (*WSJ*) Economic Forecasting Survey. This survey was published monthly through March 2021 and quarterly thereafter.[11] For all series, we link projections to the real-time history of variables so they reflect information about the economy at the time the projections were made.

The Appendix presents figures showing selected vintages of projections from all three sources for four variables: inflation-adjusted GDP, the unemployment rate, inflation (as measured by the price index for personal consumption expenditures (PCE) excluding food and energy for CBO and the FOMC and by the consumer price index (CPI) for the *WSJ* forecasts), and the federal funds rate. In the text in this section and the following one, we present simpler figures that highlight the key points.

In February 2021, CBO projected that, conditional on the law of the time (and thus not taking account of the ARP), real GDP in the fourth quarters of 2021 and 2022 would be 2.3 percent and 1.6 percent below the January 2020 baseline projections for those quarters, as shown in the left panel of Figure 3.

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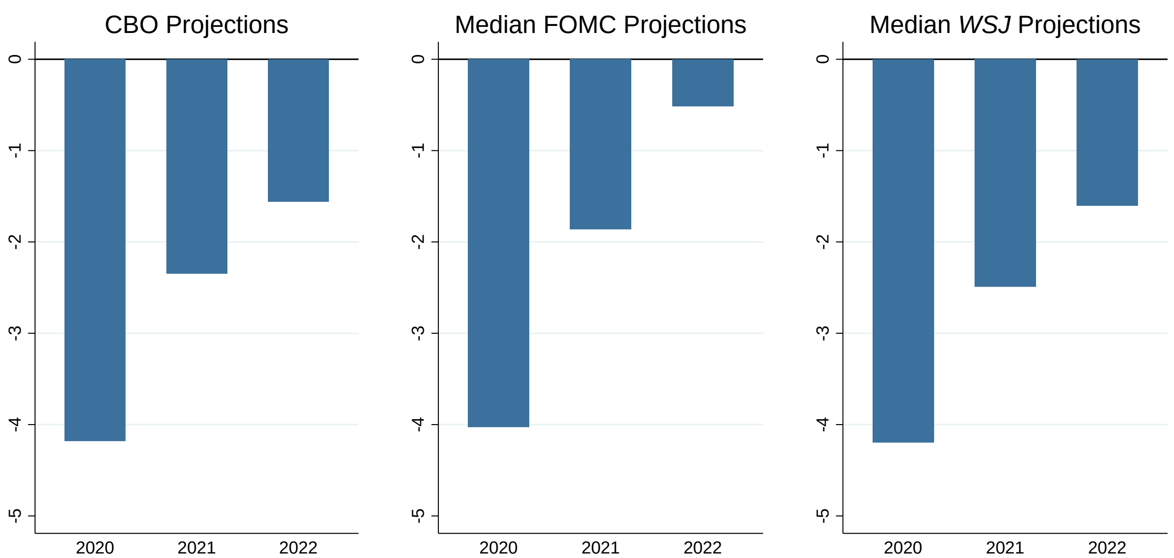
[11] For both the SEP and *WSJ* projections, we converted projected fourth-quarter-over-fourth-quarter growth rates into projected levels of real GDP.

Also relevant for assessing the potential for the ARP to overheat the economy is CBO's estimate of the difference between output and potential output. CBO (2021, page 13) explained that its estimates of potential output are based on its "projections of trends in underlying factors, such as the size of the labor force, the average number of labor hours per worker, capital investment, and productivity—taking into account the effects of federal tax and spending policies embodied in current law." During the pandemic, CBO revised its estimates of potential output based on expected changes in investment and other factors, but it did *not* adjust its estimates to reflect the social distancing the agency expected in the short run (CBO, 2020a). In February 2021, CBO projected quarterly gaps between actual and potential output for the second quarter of 2021 through the fourth quarter of 2022 of -2.1, -1.7, -1.3, -1.0, -1.0, -0.9, and -0.8 percent of potential output, for a total of -2.2 percent of annual potential output. Because social distancing reduced available labor input and productivity, the projected shortfall of output relative to *a short-run concept of potential* would have been notably smaller than CBO's published gap.

Figure 3
Shortfall in Projected Real GDP Relative to Pre-Pandemic Expectations as of Early 2021
(percent, calculated from fourth-quarter levels)



Pre-pandemic projection published in January 2020.
Pre-ARP projection published in February 2021.

Pre-pandemic projection published in December 2019.
Pre-ARP projection published in December 2020.

Pre-pandemic projection published in December 2019.
Pre-ARP projection published in December 2020.

Decisionmakers in the Federal Reserve System had similar views before the ARP was enacted about real output returning to its pre-pandemic path. The most recent SEP at that time had been released in December 2020, and for comparison, we use the pre-pandemic SEP from December 2019. As shown in the middle panel of Figure 3, the median FOMC member expected real GDP to end 2021 1.9 percent below the December 2019 projection and to end 2022 just 0.5 percent below that benchmark.

Likewise, the median expectation among private forecasters surveyed by *The Wall Street Journal* at the end of 2020 was for a moderate and gradually closing shortfall in real GDP relative to its pre-pandemic trend.[12] As shown in the right panel of Figure 3, the median projection in the *WSJ*'s December 2020 survey showed GDP in the fourth quarters of 2021 and 2022 at 2.5 percent and 1.6 percent below the December 2019 survey.

Policymaker and forecasters appeared more concerned about the pace of labor market recovery compared with real output, but pre-ARP expectations were still for ongoing improvement. In February 2021, the unemployment rate was 6.2 percent, well above most analysts' estimates of the sustainable rate, and the labor force participation rate was 61.4 percent, roughly 2 percentage points below the pre-pandemic mark. CBO projected that the unemployment rate would fall to 4.9 percent by the fourth quarter of 2022, still nearly a full percentage point above its pre-pandemic projection for that quarter. The FOMC was more optimistic, expecting that the unemployment rate would fall to 4.2 percent by the fourth quarter of 2022—but that would still have been a half-percentage point above its pre-pandemic projection. The forecasters surveyed by the *WSJ* aligned closely with CBO, expecting that the unemployment rate would fall to 4.8 percent by the fourth quarter of 2022, roughly a percentage point above their pre-pandemic projection.

In sum, before enactment of the ARP, analysts and policymakers at key federal agencies, along with leading private-sector forecasters, expected that real output and unemployment would move significantly back toward their pre-pandemic trends during 2021 and 2022, though not fully reach those benchmarks within that timeframe. Still, this anticipated recovery represented a substantial rebound, considering that the pre-pandemic benchmarks were quite strong: The US economy had just experienced the longest expansion on record, the unemployment rate had been below four percent for most of the preceding year and a half, and labor force participation among people ages 25 and 54 had risen to its highest mark in more than a decade.[13]

Considerations regarding potential further fiscal stimulus in early 2021

The fiscal stimulus enacted in March, April, and December of 2020 was an important driver of the economic rebound that occurred in 2020 and the pre-ARP projections for continued

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[12] The *WSJ* survey was published monthly (as noted earlier), but we chose not to use early 2021 vintages of the survey because they likely embodied mounting expectations of additional fiscal stimulus.

[13] The FOMC had cut the funds rate three times in 2019 amid concerns about international trade disputes and weaker global economic prospects, but, by the end of the year, the median projection by FOMC members for GDP growth during 2020 was about equal to the longer-run trend.

recovery. The question facing fiscal policymakers in early 2021 was how much additional stimulus, if any, was appropriate.

The projections described above are the basis for one argument against enacting much additional stimulus. As noted, CBO projected that, from the second quarter of 2021 through the end of 2022, real output would be below long-run potential by a cumulative 2.2 percent; further, if one incorporated a significant reduction in labor supply and productivity due to social distancing—and adjustment CBO did not make—the shortfall would be considerably smaller. As also noted, projections from Federal Reserve policymakers and leading private forecasters suggested moderate and closing output gaps as well. If those expectations were accurate, another roughly $500 billion of well-designed spending increases and tax cuts—a small amount of additional stimulus relative to the 2020 bills or the ARP as ultimately enacted—could have absorbed all the available resources.

Relatedly, providing stimulus beyond what was needed to close the remaining output gap risked pushing aggregate demand for goods and services beyond the economy's ability to supply output, in turn putting upward pressure on inflation. This concern was raised forcefully in early 2021 by Summers (2021a and 2021b), as well as by Blanchard (2021), Mankiw (2021), Posen (2021), Strain (2021), and others.

A further argument against additional substantial stimulus was that federal debt imposes long-term economic costs, including by crowding out capital investment. If one doubted that additional federal borrowing in 2021 and 2022 would be offset by reduced borrowing in a foreseeable future year, then the advantages of using resources more fully in the short term would need to be compared with the disadvantages of having less resources in the long term. Such a comparison would imply that the optimal amount of further stimulus was less than $500 billion.

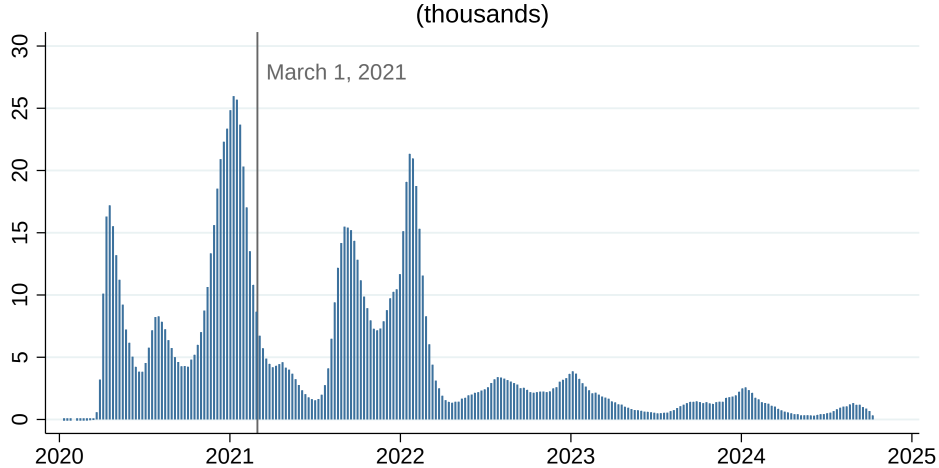
Why, then, did policymakers decide to enact a very large amount of additional fiscal stimulus—about $1¾ trillion, or roughly 8 percent of GDP? Multiple factors seem to have played a role.

First, policymakers were skeptical about economic forecasts given considerable uncertainty about the course of the pandemic and the potency of fiscal policy:

- COVID-related deaths in the United States surged in late 2020, exceeding more than 20,000 per week between mid-December and the end of January, as shown in Figure 4. That pace was above the worst seen earlier. Although vaccinations against COVID began in mid-December and deaths declined rapidly through the winter, there was uncertainty about how many people would be vaccinated, the vaccination timetable, and the vaccines' effectiveness. In addition, many people were chafing about social distancing and mask-wearing, so future behavioral patterns were difficult to predict.

- As discussed above, the effectiveness of fiscal policy in spurring demand for goods and services was uncertain, especially given the unprecedented nature of the pandemic. For example, if social distancing had caused households to defer some spending enabled by the initial rounds of fiscal stimulus, more stimulus remained in the pipeline and less new stimulus might be needed—but if social distancing continued, additional spending from further stimulus might be deferred as well.[14]

Figure 4
Weekly COVID-19 Deaths in the United States
(thousands)



Data source: Centers for Disease Control and Prevention. Last data point: October 12, 2024.

Second, many policymakers and analysts saw significantly greater danger in enacting too little stimulus than in enacting too much stimulus:

- Many observers thought that the government had provided too little fiscal stimulus in response to the Global Financial Crisis and Great Recession—and that the economic and social costs of that mistake were substantial.

[14] Aladangady et al (2022) pointed to significant "excess saving" in the early pandemic period. CBO (2021a, page 72) said that "because households, in aggregate, have accumulated considerable private savings over the past several quarters, they will tend to spend the additional resources provided by the recently enacted legislation at a slower pace than they spent the resources provided in legislation enacted last year." But CBO (2021b, page 48) noted that CBO had subsequently "raised its estimate of spending out of the additional savings accumulated during the pandemic."

In that period, significant amounts of unused resources persisted for many years. CEA (2014, Table 3-4) noted that the final pieces of recovery legislation were enacted in 2012 when the unemployment rate was still around 8 percent. As the economic expansion finally brought the unemployment rate down below 5 percent in 2016, labor force participation among workers ages 25 to 54 picked up notably, implying that the earlier worker demand shortfalls not only kept unemployment high but also deterred would-be workers from entering the labor force. Even when unemployment reached historic lows, inflation stayed below the Federal Reserve's target—consistent with the view that inadequate stimulus had led to years of unnecessarily high joblessness.

A substantial body of research documents the high costs of joblessness. Job displacement is associated with persistent negative effects on earnings (for example, see Couch and Placzek, 2010, and Shiro and Butcher, 2022), and displacement during the Great Recession had lasting negative effects on employment rates (Yagan, 2019). Moreover, "the impacts of the Great Recession [were] felt most strongly for men, black and Hispanic workers, youth, and low-education workers" (Hoynes et al, 2012). Dynan and Elmendorf (2023) showed that "families whose heads experienced long-term unemployment during or immediately after the Great Recession lost wealth between 2007 and 2019, on balance, while families that experienced no unemployment gained wealth."

Weak labor markets can also impose costs beyond the earnings and labor market prospects of those who lose jobs. Rothstein (2023) showed that college graduates entering the labor market around the time of the Great Recession had permanently lower employment probabilities than their counterparts who entered in better times. Nikolova and Nikolaev (2018) found persistent deleterious effects of parental job loss on the mental health of children.

More generally, the unevenness of the pandemic's impact—across economic sectors, geographic areas, and income levels—posed a heightened risk that some populations and parts of the economy would be "left behind" if overall stimulus were insufficient. Indeed, Guerrieri et al (2021) presented a model of structural reallocation in which asymmetric shocks lead monetary policy to aim for higher inflation in order to support all sectors of the economy.

- Many observers did not see much chance of notably higher inflation.

Core inflation as measured by the four-quarter change in the core PCE price index had not exceeded 2½ percent for two quarters in a row since 1993. In addition, that measure had been below the Federal Reserve's target of 2 percent almost continuously since the Great Recession—even as the unemployment fell below many analysts' estimates of its natural rate in the late 2010s. Indeed, many estimates of the Phillips curve implied that inflation would increase significantly only with very large declines in unemployment; we return to this issue later.[15]

Moreover, a modest increase in inflation was not viewed as unwelcome. The Fed had adopted a policy framework in August 2020 stating that: "following periods when inflation has been running persistently below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time" (FOMC, 2020a).[16] In addition, some analysts had urged the Fed to raise its inflation target so that the nominal funds rate would tend to be higher and the effective lower bound would be less binding.

Finally, the Fed's ability to raise interest rates if fiscal stimulus overheated the economy was reassuring to some. In contrast, with the federal funds rate close to zero, the Fed could not cut interest rates further if too little fiscal stimulus were provided to return the economy to full employment.

Third, some supporters of significant further fiscal stimulus may have thought the time was right for Democrats to put their own stamp on policy. The recent elections had brought in a new Democratic president and a (bare) Democratic majority in the Senate, while retaining the Democratic majority in the House of Representatives. Those outcomes were credited in part to unhappiness about the government's handling of the pandemic. In particular, the Democratic Senate candidates from Georgia had emphasized in their successful runoff campaigns their support for further pandemic relief. And legislation to address the pandemic provided an opportunity to expand programs that many Democrats already backed, such as the child tax credit.

[15] Those estimates correspondingly implied that *reducing* inflation if it overshot the target would require very large *increases* in unemployment, which should have increased inflation aversion by policymakers.
[16] See the discussion in Blinder (2024).

4. Following Enactment of the American Rescue Plan

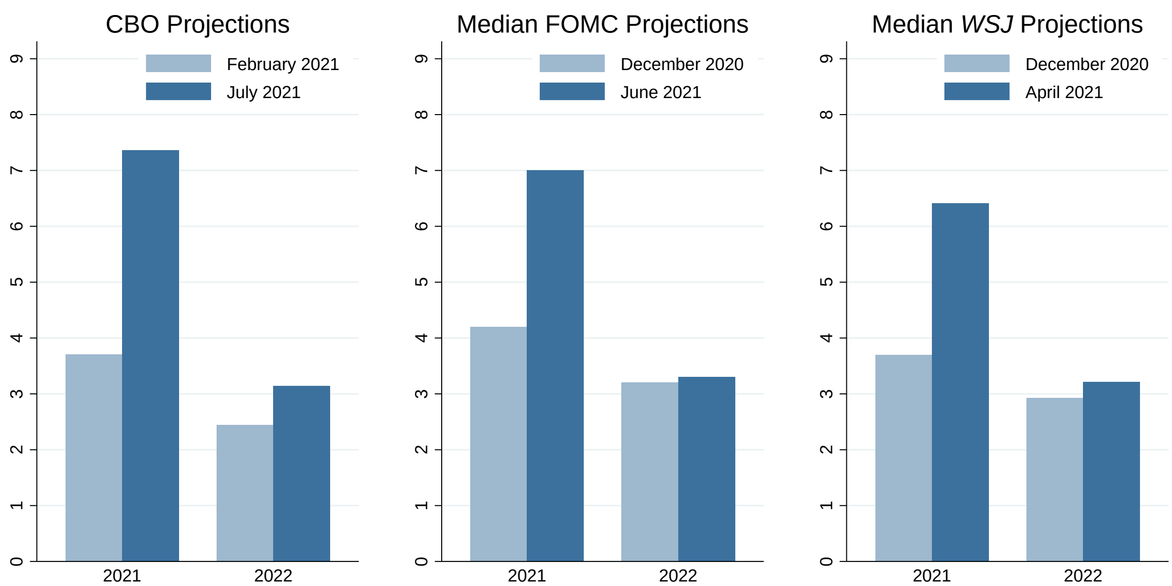
Following enactment of the ARP, forecasts for the US economy changed notably. However, economic outcomes differed from those forecasts in significant ways that can inform future stabilization policy.

Post-ARP updates to the economic outlook

Projections published after enactment of the ARP showed much better outcomes for real GDP and unemployment than previous projections, but only small upward revisions for inflation and little change in monetary policy.

In its July 2021 baseline—the first update after passage of the ARP—CBO projected real output growth of 7.4 percent over the four quarters of 2021 and 3.1 percent over 2022, as shown in the left panel of Figure 5. The resulting path for the level of real GDP (shown in Appendix Figure 12a) lay well above CBO's pre-ARP projection and even above its pre-pandemic projection, with a peak difference relative to the latter of 2.4 percent in the fourth quarter of 2022.

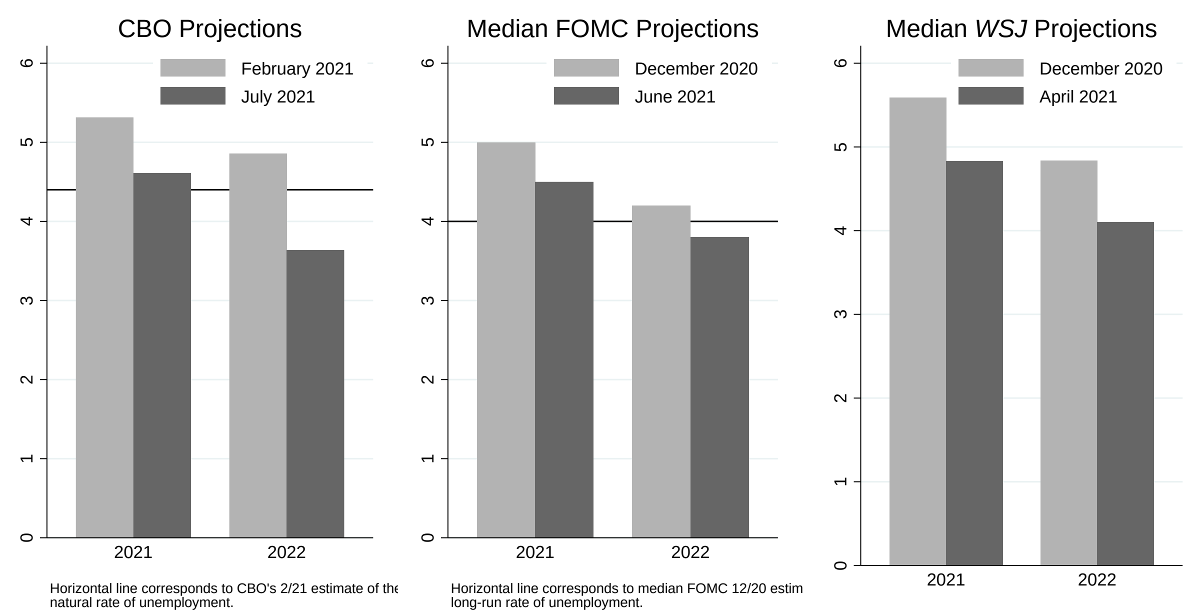
Figure 5
Projections of Q4/Q4 Real GDP Growth
(percent)



CBO's July 2021 projection of the output gap (not shown), which incorporated revisions to potential output as well as output, is noteworthy: From an estimated shortfall of output relative to potential of 1.1 percent in the second quarter of 2021, CBO projected that output would *exceed* potential by 0.5 percent in the third quarter, 1.4 percent in the fourth quarter, nearly 2.4 percent during 2022, still 1.5 percent in the fourth quarter of 2023, and gradually declining amounts through 2025. The cumulative excess from the third quarter of 2021 through the end of 2025 was projected to be 5.9 percent of annual potential output—slightly below the estimated cumulative excess during the late 1990s boom but above the estimated cumulative excess in every other expansion since the late 1960s. In addition, as noted earlier, the CBO's estimates of potential output made no adjustment for social distancing; incorporating such effects would have made the excess even more striking.

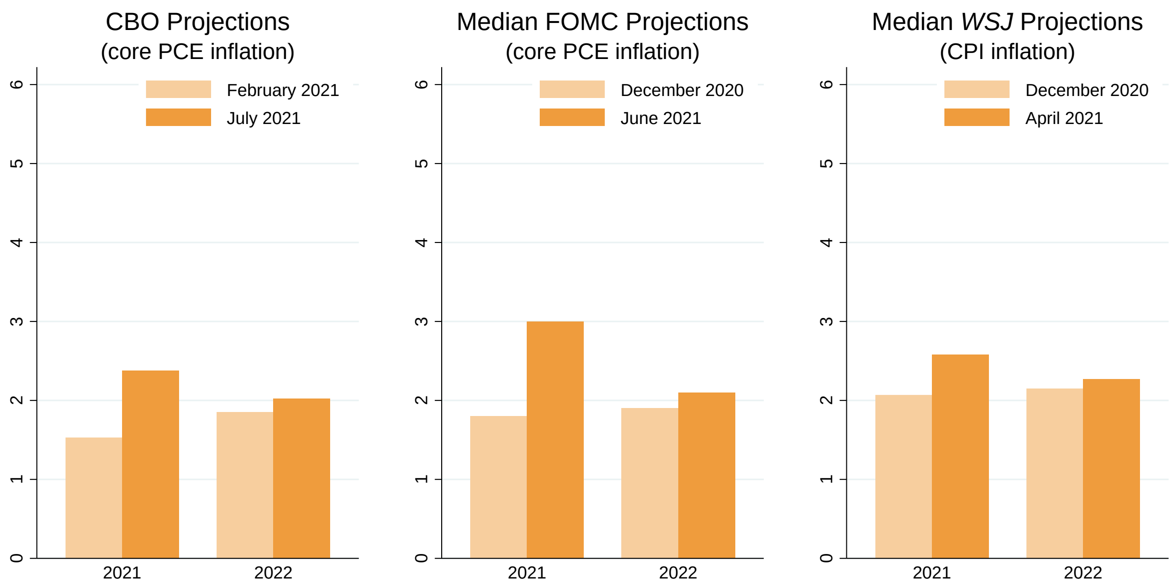
As can be seen in the left panel of Figure 6, CBO projected that the unemployment rate would fall much more sharply than it anticipated before enactment of the ARP, reaching 4.6 percent in the fourth quarter of 2021 rather than the 5.3 percent projected earlier. Before the pandemic, CBO projected the unemployment rate to be 3.6 percent in that quarter. The agency also expected that the demand for workers would be strong enough to draw more people into the labor force, pushing the participation rate well above its pre-pandemic trend in late 2022 and beyond; we return to this point later.

Figure 6
Projections of Q4 Unemployment Rate
(percent)



Despite anticipating strong demand for goods and services and a significant tightening of the labor market, CBO only nudged up its projection of core inflation. In July 2021, CBO estimated that core PCE prices had risen at an annual rate of 3.2 percent in the second quarter of the year but would increase at an annual rate at or below 2.2 percent in every quarter going forward—just slightly above the pre-pandemic projection of increases between 2.0 and 2.1 percent. The resulting changes in core PCE inflation over the four quarters of 2021 and 2022 are shown in the left panel of Figure 7. Moreover, CBO continued to project that the federal funds rate would remain near zero until 2023.

Figure 7
Projections of Inflation
(percent change, year-end to year-end)



Federal Reserve policymakers revised their outlook similarly. The FOMC published an SEP in March 2021, just after the passage of the ARP, but the assumptions about the fiscal package embodied in those projections are unclear; therefore, we examine the FOMC's June 2021 projections compared with its December 2020 projections.

As can be seen in the middle panel of Figure 5, the median projection in the June 2021 SEP was for real GDP growth of 7.0 percent over the four quarters of 2021 and 3.3 percent over 2022. The resulting path for the level of real GDP lay above those policymakers' pre-ARP projection and even above their pre-pandemic projection, with a peak difference relative to the pre-pandemic projection of 2.3 percent in the fourth quarter of 2022 (see Appendix Figure 12b).

Like CBO, Federal Reserve policymakers expected that the unemployment rate would drop more sharply than they anticipated prior to enactment of the ARP, as shown in the middle panel of Figure 6. The median expectation was 4.5 percent for the fourth quarter of 2021—

0.5 percentage point below the pre-ARP expectation, though still above the expectation before the pandemic.

As with CBO, Federal Reserve policymakers' better expected post-ARP outcomes for GDP and unemployment were associated with a moderate but short-lived upward adjustment to expected inflation. As can be seen in the middle panel of Figure 7, the projected increase in core PCE prices was 3.0 percent over the four quarters of 2021, followed by a reversion to around a 2 percent rise in 2022. Additional information in the December 2020, March 2021, and June 2021 SEPs shows that, over the first half of 2021, FOMC members became slightly more uncertain about the inflation outlook and viewed the risks as increasingly skewed to the upside. Nonetheless, the median respondent expected that the federal funds rate would remain near zero until 2023.

The first *WSJ* survey of forecasters following enactment of the ARP took place in April 2021. The forecasters marked up their expectations for real GDP growth and marked down their expectations for the unemployment rate, as shown in the right panels of Figures 5 and 6, but not by as much as CBO or the FOMC did in their projections in the summer.

For both the FOMC and the private forecasters, the expectation that the level of real output would exceed their pre-pandemic projections in 2022 was accompanied by an expectation that the unemployment rate would *not* fall below their pre-pandemic projections in 2022. This divergence may reflect lags in the Okun's law relationship between output and unemployment gaps. But the slower expected return of low unemployment may have been important to the FOMC, which stated in September 2020 its intention to keep the federal funds rate very low "until labor market conditions have reached levels consistent with the Committee's assessments of maximum employment" (FOMC, 2020b).

As with the government agencies, the median private forecast of inflation showed only a small upward revision following enactment of the ARP, as can be seen in the right panel of Figure 7.[17] The 90th percentile of the distribution of projected twelve-month changes in the CPI for December 2021 was just 3.1 percent, only about a half percentage point higher than in the December 2020 survey. And, as with CBO and the FOMC, the median response to the *WSJ* survey looked for the federal funds rate to stay fairly close to zero until 2023.

To summarize: Following enactment of the American Rescue Plan, analysts and policymakers at key federal agencies and leading forecasters in the private sector

[17] This panel is not fully comparable to the other panels of the figure because, at the time, the *WSJ* survey asked forecasters for their predictions of the CPI but not the core CPI or any version of the PCE price index. Forecasts for PCE inflation and core inflation became available with the April 2022 *WSJ* survey.

generally expected that real output would rise above its pre-pandemic trend by late 2021 and stay above the trend for multiple years, that the unemployment rate would drop to about 4 percent by the end of 2021, and that inflation would rise a little but remain quiescent—and with those outcomes involving no adjustment to monetary policy.

Economic outcomes in 2021 and 2022

Those forecasts proved much too optimistic. US real output grew at a solid pace in 2021 and 2022 but not as rapidly as had been anticipated, and unemployment fell a little faster than projected, inflation surged, and the Federal Reserve responded by raising the federal funds rate very sharply.

According to current estimates, real GDP increased 5.7 percent over the four quarters of 2021 and 1.3 percent over 2022. This rebound marked a full recovery from the pandemic downturn, with the levels of GDP in the fourth quarters of 2021 and 2022 nearly matching the pre-pandemic projections of CBO, the FOMC, and private forecasters (as can be seen in Appendix Figure 12). Even so, this performance fell materially short of the post-ARP projections, as shown in Table 2 for all three sources and depicted in the top left panel of Figure 8 for CBO. (To limit the number of figures, we do not include corresponding figures for the FOMC or the *WSJ* survey, but the results are qualitatively similar.)

Unemployment dropped further in 2021 than many analysts and policymakers expected in the spring and summer, as shown in Table 2 and (for CBO) the top right panel of Figure 8. By early 2022, the unemployment rate had fallen to roughly the levels projected before the pandemic (as can be seen in Appendix Figure 13).

Inflation far outran the projections of most analysts and policymakers, as the core PCE price index jumped 4.9 percent over the four quarters of 2021 and 5.2 percent over 2022. The wide difference between expectations and outcomes is summarized in Table 2 and (for CBO) the bottom left panel of Figure 8. That runup in inflation reduced the inflation-adjusted federal funds rate, which provided a further boost to demand.

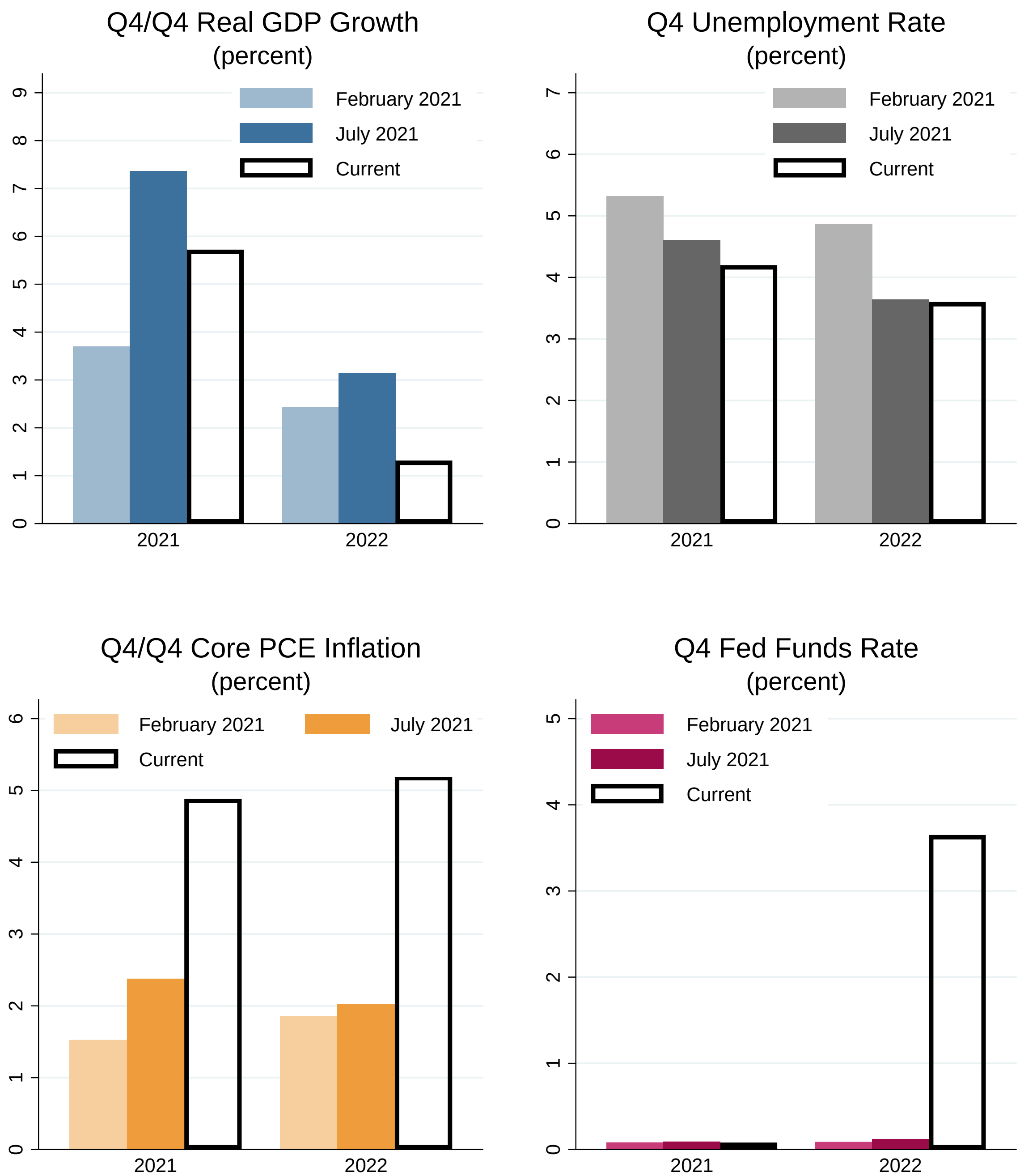
As the inflation surge persisted into 2022, the Federal Reserve became increasingly worried that demand for goods and services would continue to exceed available supply, and it embarked on a remarkably rapid pace of increases in the federal funds rate. The surprise relative to many analysts' and policymakers' expectations for the funds rate can be seen in Table 2 and (for CBO) the bottom right panel of Figure 8.

Table 2: Economic Projections in Mid-2021 and Subsequent Outcomes

Economic Measure	CBO	FOMC Median Response	*WSJ* Survey Median Response	Actual (Current Estimate)
Real GDP growth				
2021	7.4%	7.0%	6.4%	5.7%
2022	3.1%	3.3%	3.2%	1.3%
Unemployment rate (Q4)				
2021	4.6%	4.5%	4.8%	4.2%
2022	3.6%	3.8%	4.1%	3.6%
Core PCE inflation rate (Q4/Q4)				
2021	2.4%	3.0%		4.9%
2022	2.0%	2.1%		5.2%
CPI inflation rate (Dec./Dec.)				
2021			2.6%	6.8%
2022			2.3%	7.1%
Federal funds rate (Q4)				
2021	0.1%	0.1%	0.2%	0.1%
2022	0.1%	0.1%	0.3%	3.7%

Notes: The CBO forecast was published on July 1, 2021; the FOMC forecast on June 16, 2021; and the *WSJ* survey results on April 11, 2021. Actual values are the estimates reported by government statistical agencies in Fall 2024. Values for the unemployment rate correspond to the Q4 average for CBO, the FOMC, and the actual, and to the December value for the *WSJ* survey. Values for the federal funds rate correspond to the Q4 average for CBO and the actual, to the year-end value for the FOMC, and to the December value for the *WSJ* survey.

Figure 8
CBO Projections and Actual Realizations



5. Demand Boom, Inelastic Supply, and Supply Shocks

The US economic outcomes discussed in the previous section have a straightforward interpretation: Expansionary fiscal policy, expansionary monetary policy, and the natural rebound of the economy due to the waning of the pandemic generated a boom in demand for goods and services in 2021 and 2022. In mid-2021, many analysts and policymakers expected that the demand boom would push output in 2022 well above the path they had projected before the pandemic and bring unemployment in 2022 down to the pre-pandemic path—but that core inflation in 2022 would be close to the pre-pandemic projection. In other words, they expected that the economy could supply the additional output demanded by a boom without any significant upward pressure on inflation. However, output grew significantly less than they anticipated, and inflation surged to its highest mark in more than 40 years.

Why the supply of goods and services did not rise to meet demand without higher inflation is the topic of this section. Using the aggregate supply and demand framework from Section 2, the explanation is a combination of inelastic supply—with the demand boom pushing the economy onto a steep part of the aggregate supply curve—and further adverse supply shocks beyond the pandemic itself. Understanding the relative importance of these factors is useful in drawing lessons for future stabilization policy, as we discuss later.

We do not offer sharp empirical tests of the magnitudes of these factors. Rather, we present a collection of evidence that helps to distinguish between them—identifiable supply shocks, the timing and breadth of the inflation surge, the tightness of the labor market, the slope of the Phillips curve, and the disinflation of the past two years.

We find that inelastic supply was the dominant factor behind the inflation surge, with the aggregate supply curve being fairly steep at the level of output to which the demand boom pushed the US economy. Adverse supply shocks played a smaller role in raising inflation.

Identifiable supply shocks

The initial adverse supply shock from the pandemic continued to unwind during 2021 and 2022. A significant portion of this shock reversed relatively quickly, with many businesses reopening and a sharp partial rebound in labor force participation within a few months of the pandemic's onset. This process continued gradually thereafter. Notably, labor force participation among Americans ages 25 to 54 climbed fairly steadily in 2021 and 2022, as people received vaccinations or abandoned social distancing without being vaccinated. In contrast, labor force participation for Americans aged 55 and older showed little rebound—likely due to continuing fear of COVID, increased wealth from rising equity and house prices, and aging within the group. On balance, though, the adverse labor-force shock of the pandemic diminished in 2021 and 2022, with the US labor force returning to its pre-pandemic high by late 2022.

However, additional adverse supply shocks hit the US economy during these years. To start, a global shortage of semiconductors emerged. Shocks that held back semiconductor production included COVID, severe weather, and earlier decisions by US automakers to cut back their semiconductor orders on (ultimately inaccurate) expectations of a prolonged drop in motor vehicle demand. As Levy (2024) argues, though, the shortage likely reflected the combination of these supply shocks and strong demand for goods produced with semiconductors, so it would be incorrect to attribute the inflation associated with the shortage solely to the supply shocks.

Another adverse supply shock was the Russian invasion of Ukraine in February 2022. The invasion disrupted global grain supplies, reduced natural gas shipments (especially to Europe), pushed up oil prices, and limited the availability of certain other raw materials. These shocks occurred after the initial surge of inflation but presumably played a role in keeping inflation high.

The United States also experienced a significant *favorable* shock to supply when immigration jumped upward in 2022. CBO (2024, page 30) estimated that net immigration apart from temporary foreign workers and lawful permanent residents "swelled from a historical rate of about 200,000 people per year to 1.9 million in 2022 and 2.4 million in 2023." CBO noted that immigrants who receive work authorization typically do so with a lag, so the jump in immigration may have had a limited effect on aggregate supply in 2022. Moreover, the increase in immigration boosted aggregate demand as well, making the net effect on the imbalance between demand and supply unclear.[18]

All else equal, the shocks that reduced semiconductor production and the supply disruptions from the Russian invasion of Ukraine raised inflation in 2021 and 2022, with the effects concentrated among items that were most exposed to those shocks. Gauging whether the aggregate supply curve was on net higher than expected when the ARP was being developed requires factoring in favorable supply shocks as well. Our informal sense is that the diminishment of social distancing may have gone roughly as expected, while the cutback in supply of semiconductors and the war in Ukraine probably obstructed supply

[18] See Duzhak (2023) for evidence that the post-pandemic immigration surge relieved US worker shortages on net.

more than the immigration surge increased supply relative to demand (at least through 2022).

Timing and breadth of the inflation surge

Examining the timing and breadth of the inflation surge sheds additional light on the importance of the adverse supply shocks just discussed relative to the broader stimulus-fueled demand shock.

Consumer prices began to accelerate in the spring of 2021. For core PCE prices, the annualized six-month change—which smooths through monthly volatility while responding more quickly to shifts than the often-used twelve-month change—reached 2.9 percent in March 2021, 5.1 percent in June 2021, and 5.6 percent in August 2021. This pickup is plotted in the solid line in Figure 9a. The annualized six-month change in overall PCE prices (not shown) also stepped up sharply over this period, reaching 6.2 percent in the summer of 2021. Both core PCE inflation and overall PCE inflation stayed high in 2022.

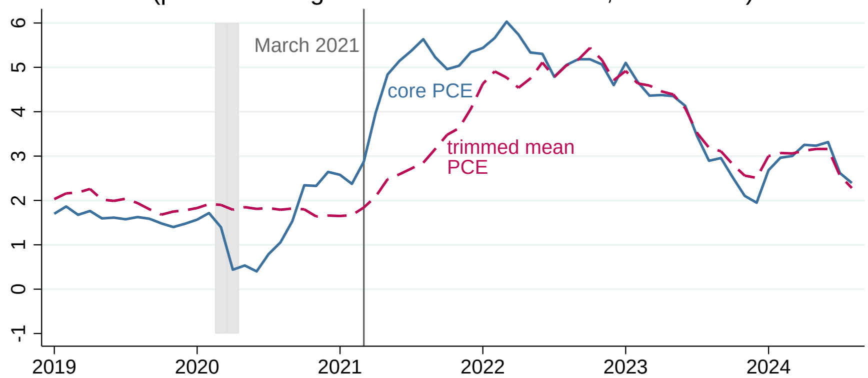
The acceleration in prices was concentrated initially in a fairly narrow set of goods and services but soon became visible across consumer items. The Federal Reserve Bank of Dallas publishes a “trimmed mean” measure of PCE inflation that excludes roughly the lowest and highest quarters of price changes each month.[19] Trimmed mean inflation on an annualized six-month basis reached 2.6 percent in June 2021, 3.2 percent in September 2021 and 4.9 percent in February 2022 (shown by the dashed line in Figure 9a). This series had only been materially above 2.0 percent once over the preceding decade.

Other measures of the breadth of consumer price increases, published by the Federal Reserve Bank of San Francisco, also show sharp rises in the spring and summer of 2021. For example, the share of items in the CPI basket with twelve-month price changes that are two standard deviations above their average twelve-month price change over the preceding five years—known as the “t-diffusion” index—rose from roughly 12 percent at the start of 2021 to nearly 40 percent by May 2021, as shown by the solid line in Figure 9b. The share of consumer *expenditures* with such price increases jumped at about the same time and even more dramatically, shown by the dashed line.[20]

[19] See Dolmas and Koenig (2019).
[20] More information about these measures of price dispersion can be found on the Federal Reserve Bank of San Francisco’s PCE Inflation Dispersion webpage.

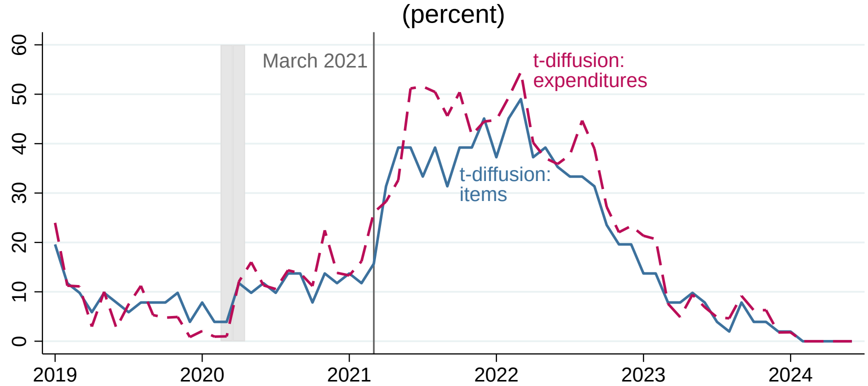
Figure 9
Inflation Realizations

(a) PCE Inflation Measures
(percent change from six months earlier, annualized)



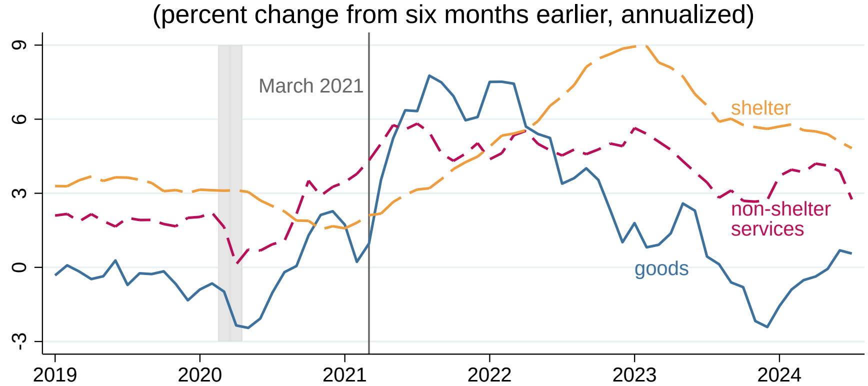
Shaded area corresponds to recession. Data sources: Bureau of Economic Analysis and Dallas Fed (via FRED).

(b) Measures of PCE Inflation Dispersion
(percent)



t-diffusion indexes represent percent of items/expenditures with 12-month increases 2 standard deviations above average of 12-month changes for the past 5 years. Shaded area corresponds to recession.
Data source: Federal Reserve Bank of San Francisco.

(c) PCE Core Inflation Components
(percent change from six months earlier, annualized)



Shaded area corresponds to recession. Data sources: Bureau of Economic Analysis and author's calculations.

One final perspective on the breadth of price acceleration in 2021 comes from the PCE price indexes for broad categories of consumption. The six-month changes in core goods prices and core prices for services excluding shelter both increased markedly in the first half of 2021, as shown on an annualized basis by the solid and red dashed lines in Figure 9c. In 2022, inflation in core goods retreated significantly, while inflation in core services excluding shelter stayed high. The six-month change in shelter prices, the gold dashed line, rose more gradually than the other categories, primarily because it takes time for the contracts of existing renters to turn over.[21] By the end of 2022, shelter inflation had roughly tripled.

Both the timing and early breadth of the inflation surge imply an important role for inelastic supply in the face of a broad demand boom. During 2021, the supply shock of social distancing eased, and the invasion of Ukraine had not yet occurred, while stimulus from fiscal and monetary policy was very strong. In the first half of 2022, policy stimulus remained strong, even though the Federal Reserve began to raise the funds rate in the spring. Moreover, the broad-based price acceleration points to economy-wide factors rather than idiosyncratic shocks as key drivers of inflation.

Tightness of the labor market

The available evidence suggests that labor supply constraints were an important underpinning of the steepness of the aggregate supply curve at the point where fiscal stimulus and other factors had pushed aggregate demand.

The unemployment rate fell rapidly during 2021, and by early 2022 it was nearly back to its pre-pandemic low. A further decline during 2022 brought the unemployment rate down to about 3½ percent. At the same time, job openings surged by more than 50 percent during 2021, reaching a level far above anything seen previously in the twenty-year history of the series. Job openings then held roughly steady at the higher level throughout 2022. As discussed by Furman and Powell (2021), Ball et al (2022), and other analysts, the rise in job openings meant the labor market was significantly tighter in 2021 and 2022 than the unemployment rate alone would suggest.

Strong demand for labor pushed up compensation growth in 2021 as measured by both average hourly earnings of private employees and the Employment Cost Index for wages and salaries of private industry workers. Over the course of 2021, the annualized six-month changes in both series climbed fairly steadily to levels notably above their pre-pandemic averages, as shown in Figure 10.

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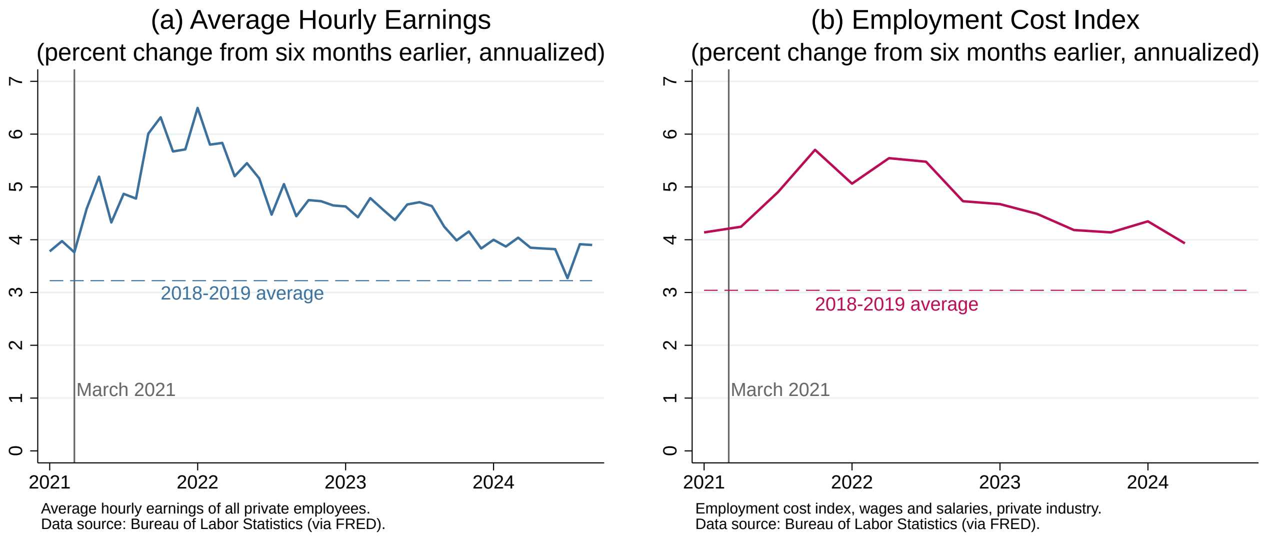
[21] For example, see McKay and Mehrotra (2024).

Figure 10
Compensation Growth Realizations

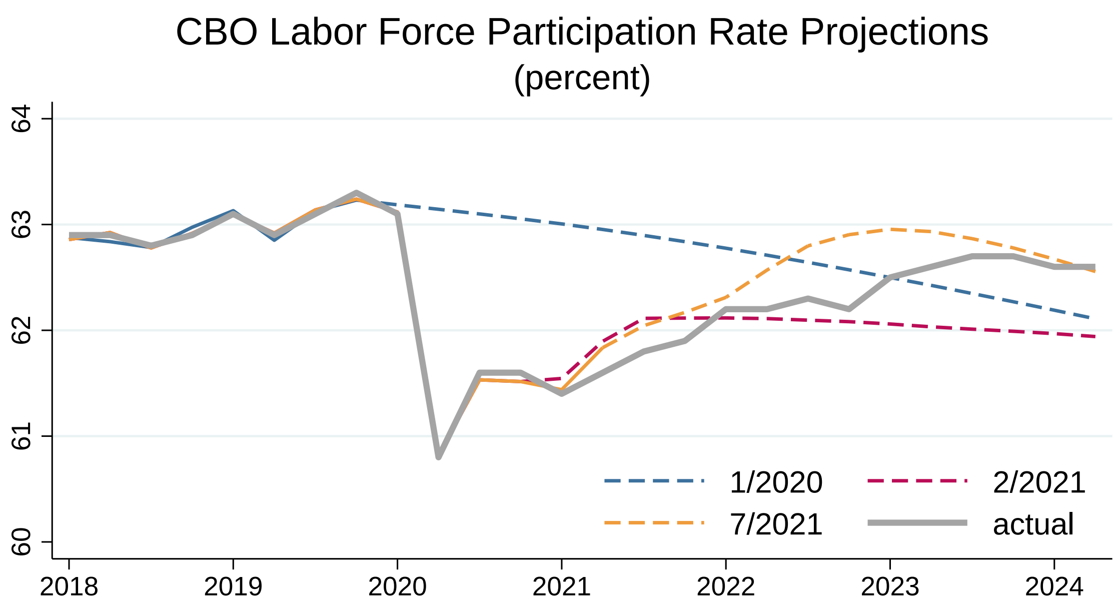


Following enactment of the ARP, CBO projected that the labor force participation rate would rise significantly and exceed the agency's pre-pandemic projection during the second half of 2022 and beyond, as shown in Figure 11. (Neither the FOMC's SEP nor the *WSJ*'s survey of private forecasters report projections of labor force participation.) The expectation that strong demand would induce a large increase in labor supply probably played a role in CBO's projection that inflation would not rise very much. However, the supply of labor turned out to be less elastic in 2021 and 2022 than CBO expected.

The acceleration in compensation and lack of a sharp increase in labor force participation, even as the adverse shock from social distancing was easing, imply that the demand for labor had been pushed up to a point at which the supply of labor was fairly inelastic.

Our interpretation of labor-market outcomes as a demand boom running into a supply constraint beginning in 2021 may seem at odds with Bernanke and Blanchard (2023). They argued that the inflation surge in 2021 did *not* stem from excess demand overheating the labor market because, according to their estimated model, prices rose faster than predicted given labor costs while labor costs did not rise faster than predicted given prices. However, pressures from an overheated economy can affect price-setting directly, not just through higher wages pushing up prices. Indeed, textbook presentations of the Phillips curve link it to the aggregate supply curve by using Okun's law to connect the labor and product markets; for example, see Mankiw (2019, pages 413-415). Moreover, Leduc et al. (2024) and others they cite find little change in the markups of prices over wages during the inflation surge, which suggests that Bernanke and Blanchard's estimates may not be robust in this regard.

Figure 11



Data source: Congressional Budget Office and Bureau of Labor Statistics (via FRED). Dashed segments start with quarter of projection publication. Solid lines correspond to available history at time of projection.

Slope of the Phillips curve

Much of the literature focused on inflation dynamics in the decades preceding the pandemic concluded that the Phillips curve is quite flat, so inflation will increase by a noticeable amount only in response to very large drops in unemployment. Examples of this research include Del Negro et al (2020) and Hazell et al (2022). The post-ARP revisions to the economic projections of CBO, the FOMC, and the *WSJ* survey suggest that forecasters at the time embraced this finding. On that evidence, our narrative that a demand boom in 2021 and 2022 ran into a steep aggregate supply curve is not very persuasive, and an alternative narrative that a demand boom was undone by further adverse supply shocks is more compelling.

However, a good deal of other evidence regarding the Phillips curve—particularly analysis incorporating more recent data—is consistent with the narrative that a demand boom in 2021 and 2022 ran into a steep aggregate supply curve:

- Some research has found that the Phillips curve becomes steeper as the labor market tightens, so inflation becomes more responsive to unemployment at lower unemployment rates. Many of these papers incorporate data from the recent inflation surge, including Ball et al (2022), Demirel and Wilson (2023), Smith et al (2023), and Benigno and Eggertsson (2023 and 2024); see also the recent review by Furlanetto and Lepetit (2024). Notable exceptions based solely on earlier data include Gagnon and Collins (2019), Hooper et al (2019), and Forbes, Gagnon, and Collins (2021),[22]

- Some recent papers have included the job openings rate along with the unemployment rate in measuring labor-market tightness and have observed that the sharp climb of this measure in 2021 and 2022 helps to explain the runup in inflation. Examples of these papers include Furman and Powell (2021), Ball et al (2022), and Benigno and Eggertsson (2023 and 2024).

- Some analysts have attributed the inflation surge in part to a marked shift—or "rotation"—in consumer demand from services to goods combined with constraints on the supply of goods.[23] Indeed, real PCE goods moved above their pre-pandemic trend in mid-2020 and then surged around the time that the ARP was passed, staying well above trend for more than a year thereafter.[24] This pattern aligns well with the surge in core goods inflation shown in figure 9c and supports the view that at least some supply schedules are curved. Bernanke and Blanchard (2023, page 16) explained: "If we think for example of firms facing a flat marginal cost up to some physical constraint where supply becomes vertical, then relative demand increases, if large enough, will move prices along the vertical supply curve, but the corresponding relative demand decreases will move prices along the horizontal part of the supply curve. The increase in prices in some sectors will not be offset by a decrease in prices in the others." While aggregate supply is more elastic than sectoral supply, as some resources can be shifted across sectors, the logic that supply constraints are more likely to bind as resource utilization climbs applies to the overall economy as well.

- The strength of the demand boom implies that the aggregate demand curve was pushed quite far to the right relative to the aggregate supply curve. As discussed in section 4, following enactment of the ARP, CBO projected that actual output would

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[22] Reifschneider (2024) described the Phillips curve used in his baseline simulation as "essentially linear" (page 17) but acknowledges the possibility of nonlinearities by including results from an alternative specification based on the Gagnon and Collins (2019) model.

[23] For example, see Bernanke and Blanchard (2023), Konczal (2023), and Gagnon and Rose (2024).

[24] The trend was estimated in logs using data from 2010 to 2019.

exceed potential output by an average of 1 percent in the second half of 2021 and nearly 2½ percent in 2022. That latter represented a striking overage by historical standards, even leaving aside the effects of social distancing (which were not incorporated into CBO's estimates).

On balance, then, evidence regarding the Phillips curve is consistent with the view that the aggregate supply curve was fairly steep in the relevant range during 2021 and 2022.

Disinflation in 2023 and 2024

US inflation began to ease gradually in the spring of 2022 and then fell sharply in 2023. Core inflation as measured by the annualized six-month change in core PCE prices dropped from close to 5 percent at the beginning of 2023 to an average of just under 3 percent over the first eight months of 2024, as shown by the solid line in Figure 9a.

Just as the surge in inflation can be attributed to a combination of adverse supply shocks and a demand boom colliding with fairly inelastic aggregate supply, so the rapid disinflation can be attributed to a combination of favorable supply shocks and demand restraint in the face of fairly inelastic aggregate supply.

Favorable supply shocks in late 2022 and 2023 included a marked gain in labor force participation, continued increases in semiconductor production, and the spike in immigration noted earlier. The labor force participation rate of individuals 55 and older has continued to drift down, but the rate for ages 25 to 54 has steadily increased, bringing the overall labor force participation rate up by about ½ percentage point since late 2022. As a result, the overall participation rate now stands only ¼ percentage point below its average in the late 2010s. These supply shocks helped to reduce inflation.

But the evidence we provided to show the dominant role of strong demand in pushing up inflation also shows that restraint of aggregate demand was probably the biggest factor bringing down inflation. If the aggregate supply curve is fairly steep only when product and labor markets are very tight, then significant disinflation does not require a massive drop in demand but only a drop sufficient to move the economy back to a flatter part of the supply curve. And, the restraint in demand that occurred was significant: The stimulus from the ARP and earlier rounds of expansionary fiscal policy was diminishing in late 2022 and beyond, and the Fed had implemented a decisive pivot in monetary policy earlier that year. Moreover, a broad easing of the demand-supply imbalance can be seen in a wide array of data—an increase in the unemployment rate, a striking drop in job openings to roughly their pre-pandemic mark, declines in core inflation and trimmed mean inflation shown in Figure 9a, a notable drop in the t-diffusion indexes for price changes shown in Figure 9b, and a slowing in compensation growth shown in Figure 10.

6. Lessons for Fiscal Stabilization Policy

Drawing on our analysis and other economic research, we see three principal lessons from the COVID experience for future fiscal stabilization policy in the United States.[25]

First, fiscal stimulus is a powerful tool for boosting demand for output and thereby reducing the human and economic costs of recessions, and it can be especially useful if monetary policy is constrained by the effective lower bound on interest rates.

The COVID-19 pandemic brought physical suffering and loss of life to the United States and countries around the world. The pandemic also caused a precipitous drop in economic activity and a spike in unemployment as many people adopted social distancing to reduce transmission of the disease. Policymakers responded by adopting a range of measures to protect public health and to support output and income. In the United States, sharply expansionary monetary and fiscal policy, along with an easing of pandemic fears, produced a boom in demand for goods and services in 2021.

By early 2022, US output and unemployment were back nearly to pre-pandemic expectations—a striking performance when compared with the slow recovery of many other advanced economies from the pandemic and the very slow US recovery from the Global Financial Crisis and Great Recession (during which the unemployment rate stayed above six percent for nearly seven years after the recession began). Indeed, the labor force participation rate rose above CBO's pre-pandemic projection in 2023 and 2024, as shown in Figure 11, implying that the strength of labor demand ultimately drew people into jobs as policymakers had sought, albeit more slowly than needed to contain wage pressures. More generally, abundant economic research shows that well-designed fiscal policies spur demand for output and workers *and* that supporting people's incomes during downturns and minimizing the depth and duration of labor-market weakness reduce the damaging consequences of downturns in the short and long runs.

Second, an increase in demand induced by fiscal stimulus may hit supply constraints that push up inflation, so weighing the risk and cost of higher inflation is important in calibrating fiscal stimulus.

Calibrating fiscal stimulus is very difficult. For example, the pandemic affected labor supply in ways that evolved over time—involving the pace of vaccinations, growing

[25] Our focus is on lessons for fiscal policymakers, but the COVID experience offers lessons for monetary policymakers as well. In particular, the strong effect of fiscal policy on aggregate demand and the inelastic nature of aggregate supply at high levels of resource utilization are directly relevant for the FOMC's decisions.

capabilities for remote work, and changing social mores—and that analysts had essentially no basis for estimating. As another example, the production problems with semiconductors were not anticipated—and might not recur in the same ways in the future, although those problems suggest that just-in-time global supply chains are intrinsically not very robust. And the spike in immigration, driven at least in part from the rapid US economic rebound, was not widely expected by economic forecasters but was large enough to significantly affect labor supply (and likely aggregate demand).

As policymakers balance the risks of providing too much or too little stimulus, they assess the social costs of inflation as well as the social costs of unemployment discussed earlier. Many economic models imply that inflation is not very costly, because increases in prices that are matched by increases in nominal incomes leave people with the same purchasing power. Indeed, for US workers, average real hourly compensation in the nonfarm business sector in the second quarter of 2024 was about 2¼ percent higher than in the fourth quarter of 2019. But survey evidence shows that many people view the inflation of recent years quite differently, perhaps due to variation in experiences across individuals depending on their income sources, consumption bundles, and balance sheets, or perhaps due to alternative perceptions of how nominal compensation is determined. And although inflation has fallen sharply, many households remain very unhappy about the higher price level.[26] Even if most people's views of inflation do not align with economists' views, the fact that inflation reduces many people's sense of well-being may be relevant for policymakers.

Third, because calibrating fiscal stimulus in an uncertain and evolving economy is so difficult, automatic triggers for providing and withdrawing additional stimulus could be valuable.

Aspects of law regarding taxes and government benefit programs lead to lower taxes and higher benefit payments when output and income decline. These "automatic stabilizers" play an important role in protecting people and supporting economic activity during downturns. However, the magnitude of this stabilization stems from policy decisions that focused on desired structural aspects of taxes and benefit programs rather than the desired amount of cyclical stabilization, and experience suggests that greater stabilization would be appropriate. Therefore, a number of analysts have proposed ways to augment the existing automatic stabilizers, and the COVID experience may encourage greater attention to those possibilities.[27]

[26] See Stantcheva (2024) and Binetti et al (2024).
[27] For example, see Boushey et al (2019) and Dynan and Elmendorf (2020).

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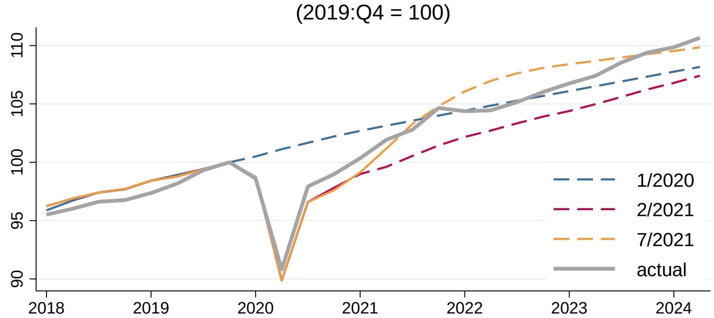
Appendix

This appendix presents selected vintages of projections from CBO, the FOMC, and the *WSJ* survey of private forecasters for four variables: inflation-adjusted GDP (Figure 12), the unemployment rate (Figure 13), inflation (Figure 14, as measured by the core PCE price index for CBO and the FOMC and by the CPI for the *WSJ* forecasts), and the federal funds rate (Figure 15).

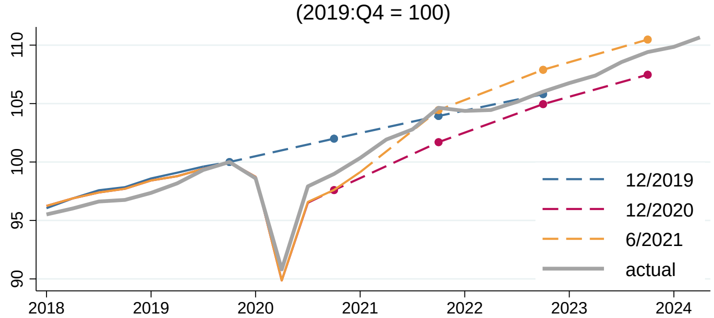
Figure 12
Selected Vintages of Real GDP Projections

(a) CBO Real GDP Projections
(2019:Q4 = 100)



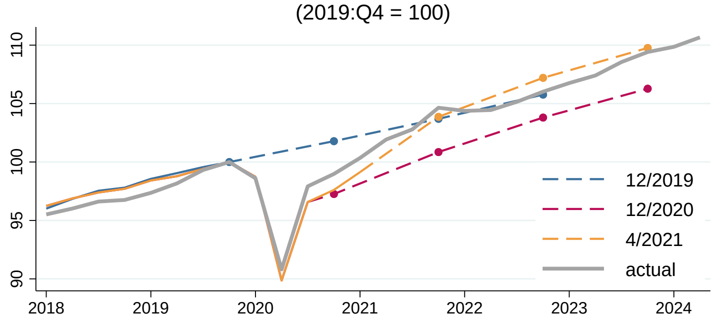
Quarterly average unemployment rate. Data source: Congressional Budget Office and Bureau of Economic Analysis (via FRED). Solid lines correspond to available history at time of projection; dashed lines start with quarter of projection publication.

(b) FOMC Median Real GDP Projections
(2019:Q4 = 100)



Data source: Bureau of Economic Analysis (via FRED and ALFRED), Federal Reserve Summary of Economic Projections, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the fourth quarter of each year.

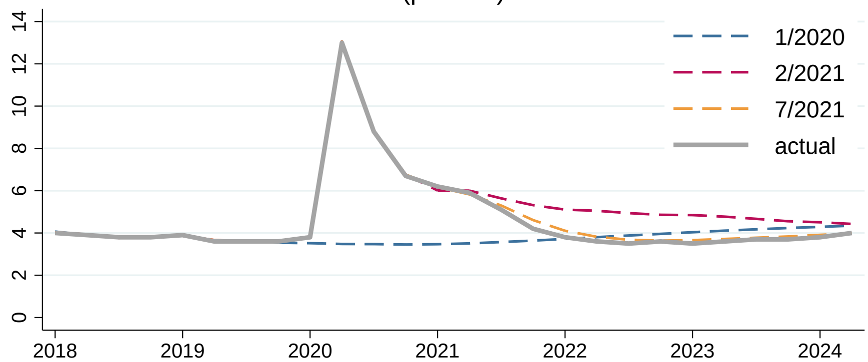
(c) WSJ Survey Median Real GDP Projections
(2019:Q4 = 100)



Data source: Bureau of Economic Analysis (via FRED and ALFRED), Wall Street Journal Economic Forecaster Survey, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the fourth quarter of each year.

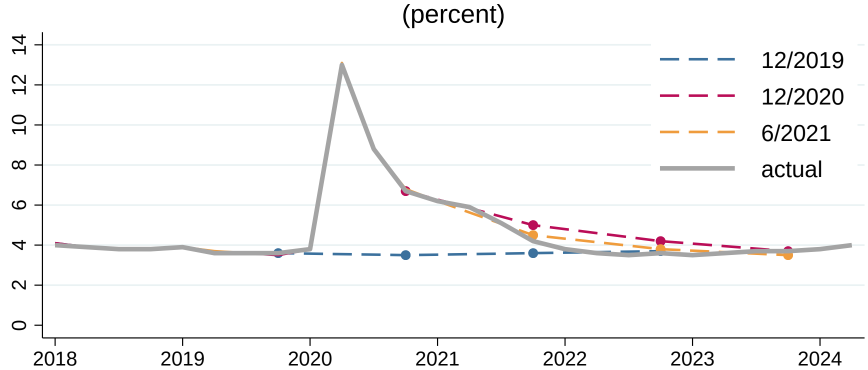
Figure 13
Selected Vintages of Unemployment Rate Projections

(a) CBO Unemployment Rate Projections
(percent)



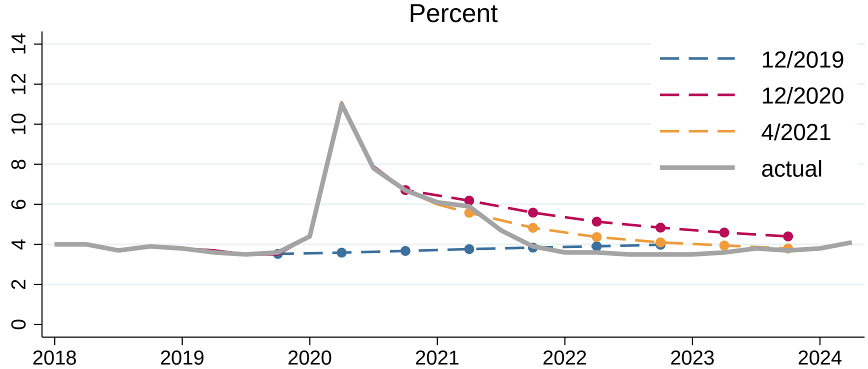
Quarterly average unemployment rate. Data source: Congressional Budget Office and Bureau of Labor Statistics (via FRED). Solid lines correspond to available history at time of projection. Dashed lines start with quarter of projection publication.

(b) FOMC Median Unemployment Rate Projections
(percent)



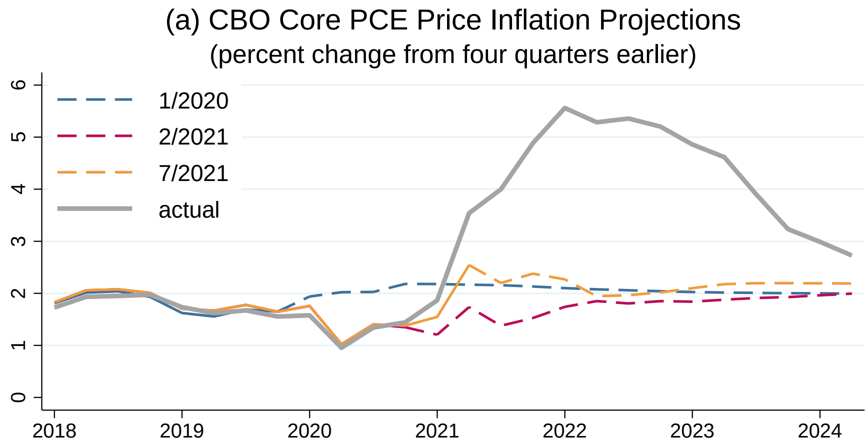
Quarterly average unemployment rate. Data source: Bureau of Economic Analysis (via FRED and ALFRED), Federal Reserve Summary of Economic Projections, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the fourth quarter of each year.

(c) WSJ Survey Median Unemployment Rate Projections
Percent

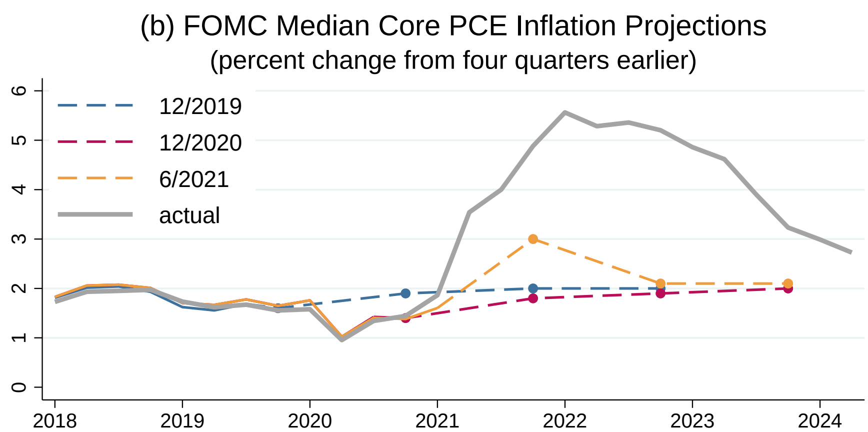


Unemployment rate for last month of quarter. Data source: Bureau of Labor Statistics (via FRED and ALFRED), Wall Street Journal Forecaster Survey, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the second and fourth quarters of each year.

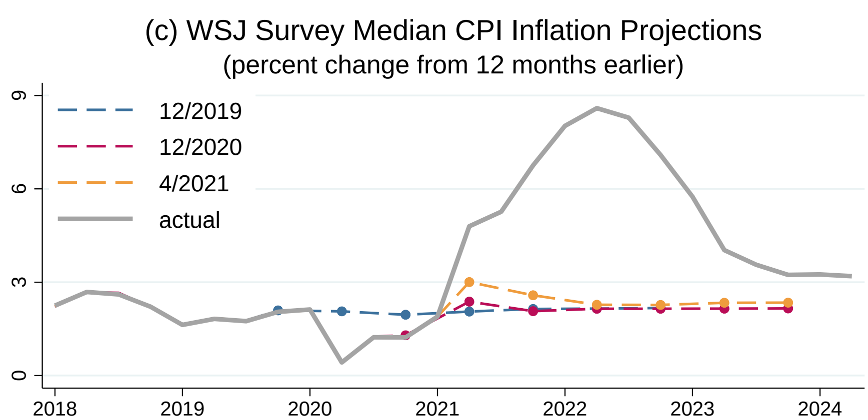
Figure 14
Selected Vintages of Inflation Projections



Data source: Congressional Budget Office and Bureau of Economic Analysis (via FRED). Solid lines correspond to available history at time of projection. Dashed lines start with quarter of projection publication.



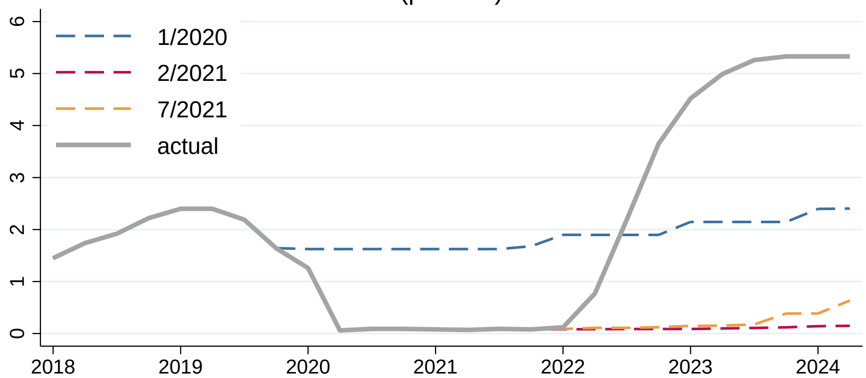
Data source: Bureau of Economic Analysis (via FRED and ALFRED), Federal Reserve Summary of Economic Projections, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the fourth quarter of each year.



Quarterly data corresponding to final month of quarter. Data source: Bureau of Labor Statistics (via (FRED and ALFRED), Wall Street Journal Forecaster Survey, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the fourth quarter of each year.

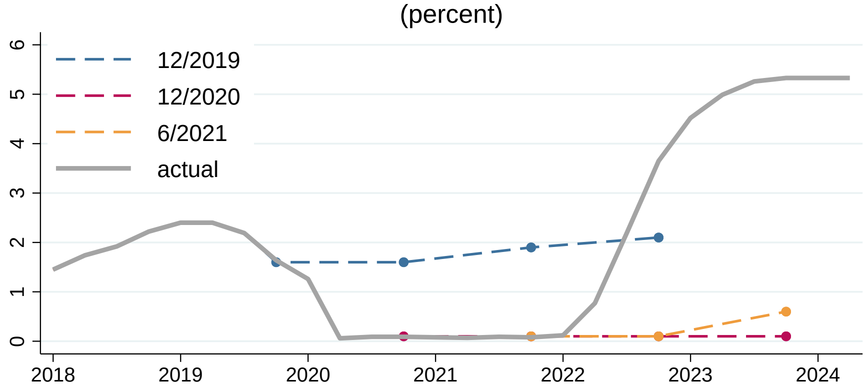
Figure 15
Selected Vintages of Federal Funds Rate Projections

(a) CBO Federal Funds Rate Projections
(percent)



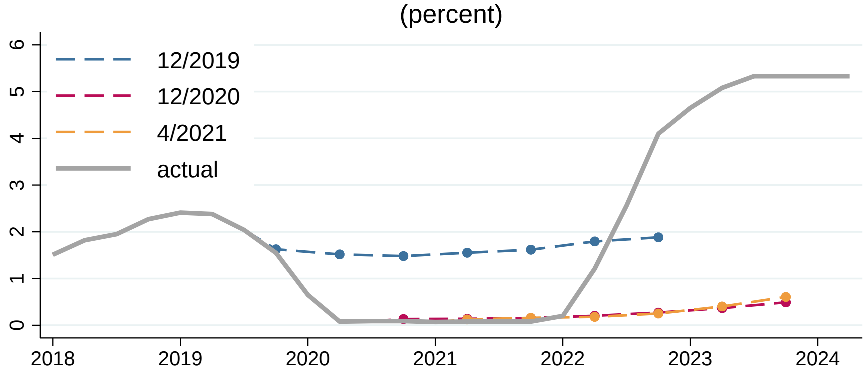
Data source: Congressional Budget Office and Federal Reserve Board (via FRED). Solid lines correspond to available history at time of projection; Dashed lines start with quarter of projection publication.

(b) FOMC Median Federal Funds Rate Projections
(percent)



Data source: Federal Reserve (via FRED and ALFRED), Federal Reserve Summary of Economic Projections, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the fourth quarter of each year.

(c) WSJ Survey Median Federal Funds Rate Projections
(percent)



Quarterly data corresponding to final month of quarter. Data source: Federal Reserve (via FRED and ALFRED), Wall Street Journal Forecaster Survey, and authors' calculations. Solid lines correspond to available history at time of projection; dashed lines connect the last point of history with the dots for the second and fourth quarters of each year.

PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

POLICY BRIEF

24-10 Did Supply Chains Deliver Pandemic-Era Inflation?

Phil Levy

October 2024

Note: The views expressed in this paper are the author's own and do not necessarily represent those of the World Bank or its Board of Directors. This Policy Brief is part of a series titled *Understanding COVID Era Inflation*. PIIE gratefully acknowledges financial support from the Smith Richardson Foundation for the research presented in this Policy Brief. The research was conducted independently; funders are never given the right to review a publication before its release.

INTRODUCTION

The question of whether supply chain breakdowns were a significant cause of pandemic-era inflation has drawn attention, both in terms of supply chain resilience and macroeconomic policy. In the former case, if supply chain breakdowns drove inflation, that might strengthen the argument for capacity expansion, reshoring, or other remediation. In the latter case, if supply chains were not the cause, then one must look more vigorously at other potential explanations, such as monetary or fiscal policy.

This Policy Brief argues that supply chain breakdowns were *not* a principal cause of the inflation of recent years. The allegation that they were is a compound claim that goes as follows: (1) supply chains did not perform as they ought to; and (2) that failure was an important cause of inflation. The claim helped spur serious efforts through legislation, regulation, and executive branch action to push for "resilient" supply chains, where resilience presumably means the ability to handle a similar shock with significantly less disruption.

I largely focus on US trade in containerized goods and shows that, within months of the pandemic's onset, the *quantities* of goods delivered increased significantly. These real increases were seen in broad categories such as overall imports of goods, flow of goods through ocean ports, and in personal consumption expenditures on durable and nondurable goods. They were also mirrored in more disaggregated categories. There were increases relative to both prepandemic levels and trend lines. Both shipping and consumption of goods were well above levels that might reasonably have been anticipated from prepandemic data.

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None of this is to deny the sharp increases in inflation, the price of shipping, and the accompanying delays and empty shelves. Average times for moving container cargo from Asia to North America went from roughly 1.5 months prepandemic to almost 4 months in early 2022. Shipping prices also rose dramatically. But in the presence of significantly increased quantities delivered, those are suggestive of a large positive demand shock. Real personal consumption of durable goods, as an extreme example, rose 32.1 percent from February 2020 to March 2021. Goods consumption levels remained elevated into 2023 and beyond, even as shipping delays and price hikes dissipated.

The Policy Brief concludes with a brief discussion of supply chain resilience. For most businesses there are limits to how quickly they can expand in the short run. Maintaining excess capacity to cover extraordinary shocks is prohibitively expensive. While it may be worthwhile to introduce efficiencies into supply chains and aim for some increased elasticity of supply, the more likely conclusion is that the goal of avoiding inflation and shortages is better met through improved demand management.

DEFINING TERMS

To bring data to bear on the question, we need precision on several key terms: inflation, supply chain, and demand. Despite very frequent usage, each is subject to multiple interpretations.

Inflation

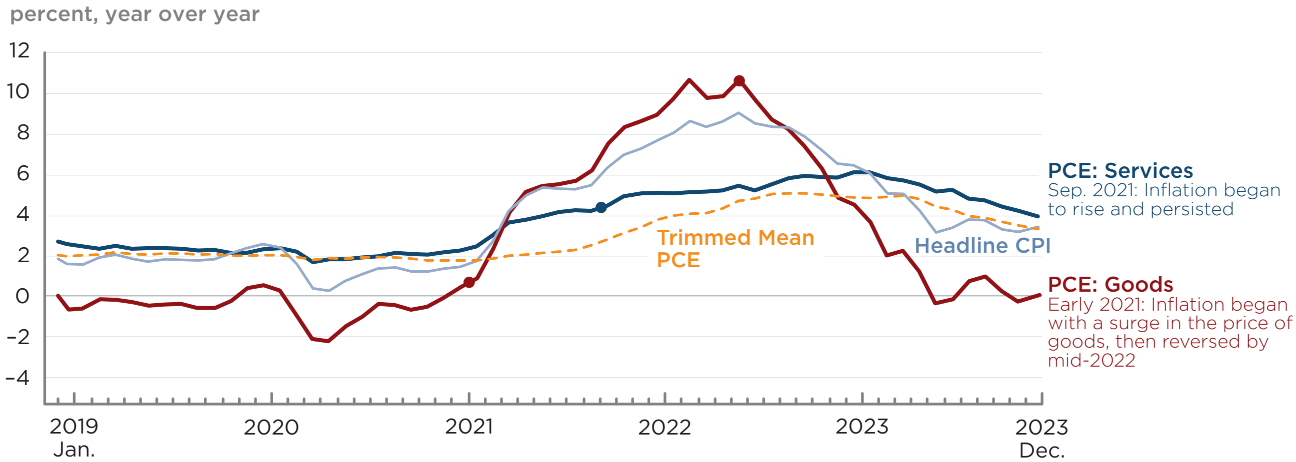
While there is little argument over whether the US economy experienced unusually high inflation in recent years, there is substantial room for debate over how high, the nature of that inflation, and how rapidly it has receded.

Figure 1 shows two broad measures of inflation and two partial ones, all expressed on a 12-month basis.

The broad measures are the full Consumer Price Index (Headline CPI, in light blue) and the Trimmed Mean Personal Consumption Expenditure (TM PCE, dotted yellow) put out by the Federal Reserve Bank of Dallas. While not the only broad measures, these two illustrate some of the choices to be made in measuring inflation. First, CPI and PCE use the prices of different bundles of goods. Second, CPI as shown is a full measure, including volatile components such as food and energy. TM PCE, in contrast, attempts to remove the most volatile parts and come up with a steadier depiction of underlying inflation trends. As seen in the graph, they tell different stories about the inflation experience. The CPI line soars higher but drops faster. As it plunges toward the central bank's 2 percent target, it gives the impression that the battle against inflation is nearly won. TM PCE was slower to rise, didn't hit the same heights, but has also been slower to subside.

The other two lines divide the world of personal consumption expenditures into goods (red) and services (dark blue). The key point here is that the onset of serious inflation in 2021 began with a surge in the price of goods, while services inflation remained docile until roughly September of that year. More recently, though, roles have reversed and goods prices have once again verged on deflation (their persistent state prepandemic) while services inflation has been

Figure 1
US inflation measures, December 2018 to December 2023



CPI = consumer price index; PCE = personal consumption expenditures
Sources: Bureau of Labor Statistics, Bureau of Economic Analysis, and Federal Reserve Bank of Dallas, via Federal Reserve Economic Data.

more persistent. In whatever version we choose, these are the developments we are trying to explain.

Supply Chains

The general idea underpinning the modern supply chain is that goods go through multiple stages of production. With such a broad approach, potentially relevant influences could encompass anything from the effect of domestic labor availability on factory output to the ability to move commodities across oceans and through ports. In this paper, we will largely retain this broad definition, with extra attention paid to international sourcing, which is frequently the subject of policy concern.

Even when focusing on international supply chains, there are at least three systems that are mostly independent from one another in operation but can be referred to as "supply chains": containerized goods; energy; and agriculture and commodities. The independence of operation comes from the different equipment used for transport and handling: a large container ship vs. an oil tanker vs. bulk carriers. This paper will focus on trade in containerized goods.[1]

Demand

In part because of the policy- and data-driven focus on the role of containerized goods supply chains, "demand" will generally mean demand for those goods being moved through containers. This is of course a distinct subset of economic activity. According to World Bank estimates, services as a share of global

1 The narrowing here can be important. While this paper focuses predominantly on inflation in the United States, a study of Europe's experience would almost certainly give more weight to the energy supply interruptions that accompanied the conflict in Ukraine starting in February 2022.

value added ranged from 65.3 percent to 61.7 percent of GDP over the period 1995–2022.[2] It is interesting to note that the high and low values for the series occurred in 2020 and 2022, respectively. The fall in the share of services during the pandemic period helps point to the importance of goods as the complement. Thus, unless otherwise specified, *demand* refers to goods demand, with subcategories described below.

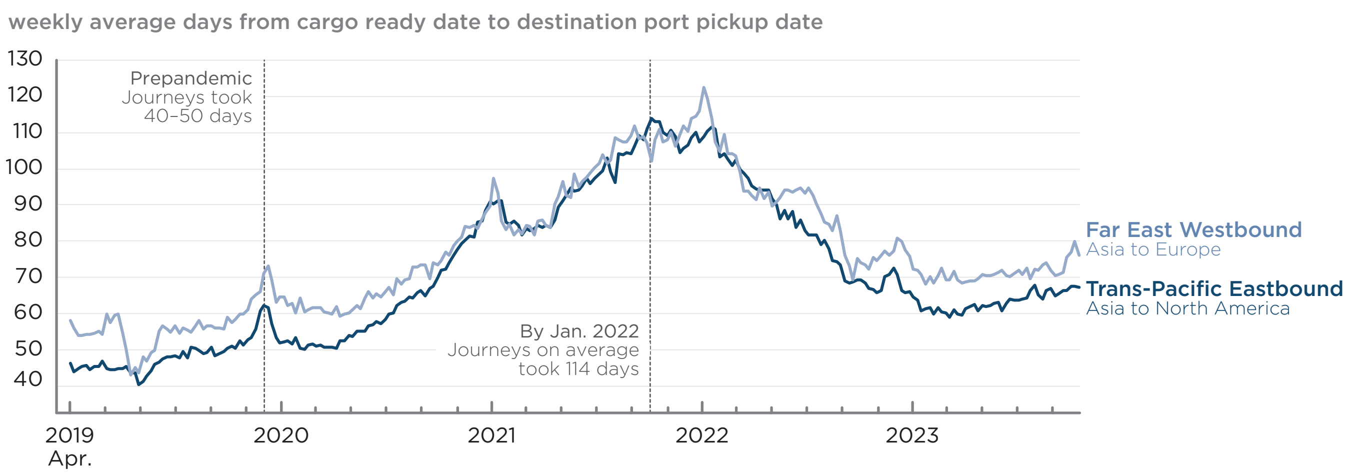
WHY ARE SUPPLY CHAINS A LEADING SUSPECT FOR INFLATION?

There are more direct reasons for analysts to look at supply chains. If the role of supply chains is to deliver the goods people and businesses want in timely fashion and at a reasonable price, that did not happen over this period.

Figure 2 shows Flexport's Ocean Timeliness Indicator, which measures the average amount of time it took to move containers from their cargo-ready date to their pickup from the destination port, after traversing two of the world's major trade lanes. The Trans-Pacific Eastbound (TPEB, in dark blue) series measures the time required to carry goods from Asia to North America, while the Far East Westbound (FEWB, in light blue) does the same for the Asia to Europe route. The chart shows that prepandemic journeys across the Pacific were roughly of 40–50 days' duration. At the worst of the crunch—the week ending January 9, 2022—the average journey was 114 days.

Figure 2

Flexport Ocean Timeliness Indicator, April 2019 to January 2024



Note: Flexport has subsequently changed the calculation of this indicator. This is the version that was current as of January 2024.
Source: Flexport.

The delays in moving goods from factories to domestic distribution centers was highly problematic for businesses that had come to rely on "just in time" inventory practices. It meant increasingly bare shelves. How could retailers see their dwindling stock without thinking about raising prices?

2 World Bank, "Services, Value Added (% of GDP)" (accessed February 23, 2024).

Then there was the unforgettable difficulty of getting key conveniences of modern life, such as toilet paper. That seemed further evidence of supply chain failure—hadn't the paper product shelves always been full before?

Then there were the images of over 100 container ships queueing outside the largest port in the United States—Los Angeles and Long Beach. A *Wall Street Journal* story described this backup as being "at the heart of U.S. supply chain congestion during the COVID-19 pandemic."[3] Not only did this seem a stark shift from prepandemic practice, but surely the inability to process these containers in a timely fashion constituted a failure.

If one combines visible delays with goods shortages and then the onset of inflation concentrated in the goods sector (roughly one-third of the US economy), there seemed to be a strong prima facie case that supply chain breakdowns had led to inflation. This conviction likely strengthened when the shortages, backups, and delays subsided at the same time that goods inflation seemed to drop away.

SUPPLY OR DEMAND?

In any market, if we observe a spike in prices, basic analysis will tell us that it could result from a contraction of supply, an expansion of demand, or some combination of the two. If there is some such shock and prices do not rise quickly enough to clear markets, we are likely to see shortages. Simply knowing that prices increased or shortages appeared, however, cannot help us determine which was the cause.

Fortunately, this same basic analysis offers a ready means of distinguishing. A supply contraction will result in decreased quantities, while a demand expansion will result in increased quantities.[4] Thus, we turn our attention to quantities. This section explores the experience of quantity during the pandemic era. It works through multiple measures. First, we look at the quantity of goods consumed, paying attention to both subcategories and celebrated cases that seemed to show important supply chain failure—semiconductors and automobiles. Then we will turn to quantities of goods imported, both through all modes and then with a look at port volumes.

Goods Consumption

Figure 3a shows inflation-adjusted (real) US personal consumption expenditures (PCE) on goods from January 2007 to November 2023.[5] The solid red line depicts monthly expenditures through December 2019, the eve of the COVID shock.

A first point to note is that consumption sagged at the beginning of the graph with the onset of the global financial crisis. After reaching a local peak in

3 Paul Berger, "Southern California's Notorious Container Ship Backup Ends," *Wall Street Journal*, October 21, 2022.

4 Of course, these are not mutually exclusive. One could have simultaneous shocks to demand and supply. The quantity measure will then tell us which dominated. The central thrust of this paper will be to determine which of these shocks had the dominant effect on inflation.

5 This section draws on the author's written testimony before the Senate Budget Committee on January 24, 2022. The time span covered by figure 3 was the length of the available data series for this variable.

Figure 3a
US real personal consumption expenditures (goods), January 2007 to November 2023

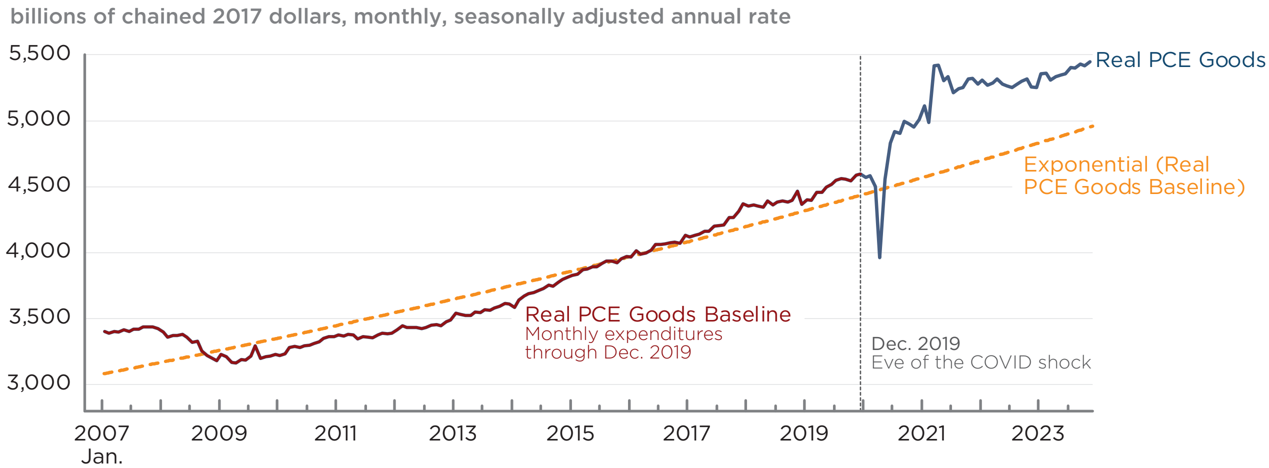
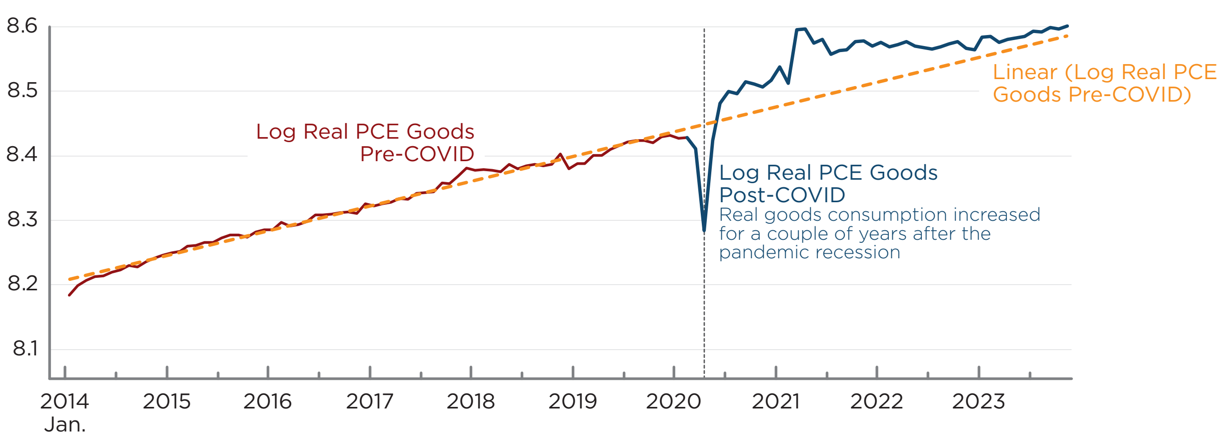


Figure 3b
Log real PCE goods



PCE = personal consumption expenditure
Sources: Bureau of Economic Analysis via Federal Reserve Economic Data and author's calculations.

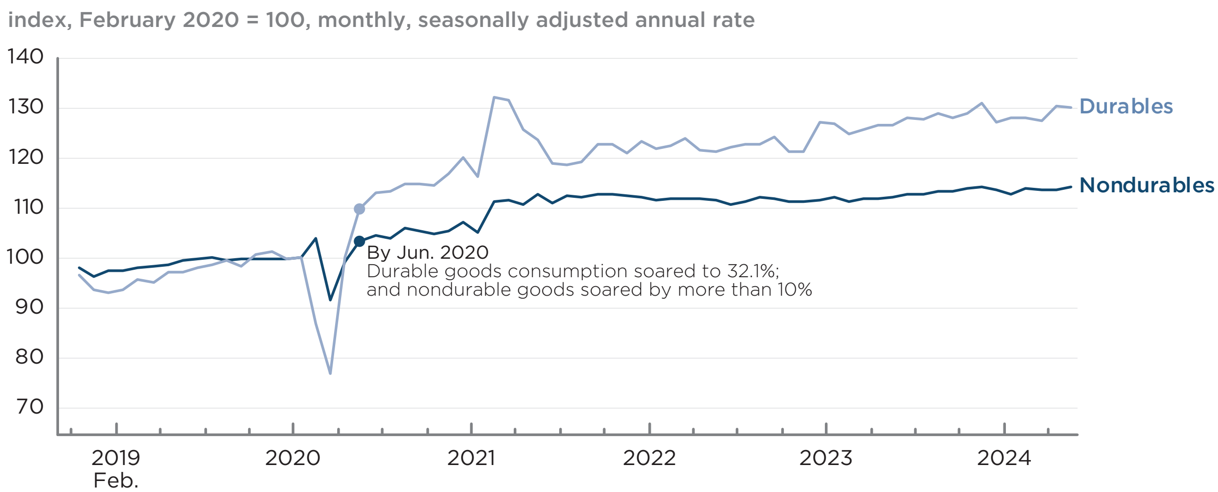
September 2007, goods consumption fell to a trough in April 2009. It did not regain its September 2007 level until February 2012, over four years later.

The aftermath of the global financial crisis is relevant when we think about the expectations that went into setting supply chain capacity at the beginning of 2020. One approach would have been to look at the preceding 13 years, take the average growth rate, and assume it would apply going forward. That's what the dotted line does. An alternative approach would have been to suppose, with an oncoming recession that started with an even larger and more sudden plunge in economic activity, that it might take four years to recover prerecession consumption levels. In this case, the expectation would be to regain February 2020 levels by February 2024. This second, more cautious, approach might have seemed even more appropriate as we moved into the spring of 2020 and goods consumption plunged.

Figure 3b shows that the quantity of goods consumed increased substantially above prepandemic levels and above trend. The jump was even more dramatic off the low of the short-lived pandemic recession. Whether or not PCE *is currently* above trend can vary with the way one specifies the trend line. The robust result, however, is that there was a measurable increase in real goods consumption for a couple of years after the pandemic recession.

Figure 4 offers a decomposition of this goods demand into durables and nondurables, where the former are products that are expected to last three years or more.

Figure 4
US personal consumption expenditures on goods, November 2018 to June 2024



Sources: Bureau of Economic Analysis via Federal Reserve Economic Data and author's calculations.

Beyond the decomposition, figure 4 indexes consumption to February 2020 levels, allowing easy inspection of the magnitude of the swings. During the 2010s, variation in these series was minimal, consistent with the flat section in the prepandemic portion of the chart. We can also note the extreme magnitude of the initial COVID shock: nondurables consumption fell by 8.5 percent to April 2020; durables fell by 23.3 percent.

Nonetheless, any assumption of a slow recovery would prove to have been far off. Instead of taking four years to regain pre-shock levels, both categories were there by May or June of 2020! They then soared to the point where by March 2021, durable goods consumption was up 32.1 percent above its February 2020 level. The gain in nondurable goods consumption of more than 10 percent would look impressive if not sitting next to the durables line.

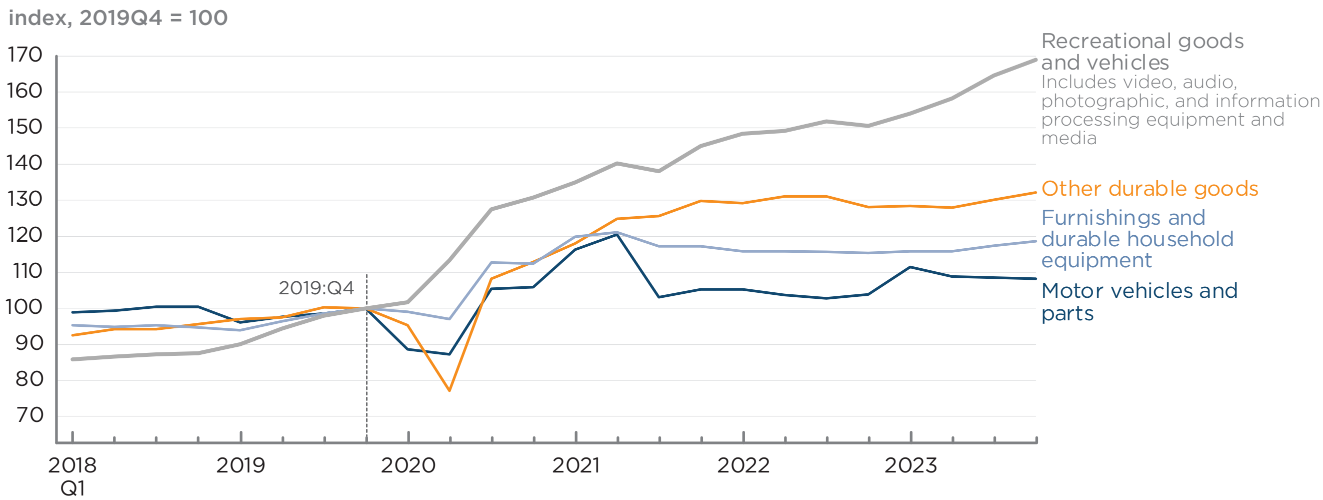
Thus, figures 3 and 4 show that, rather than contracting, the level of goods consumption dramatically expanded during the period that supply chains were in crisis (figure 2) and inflation was emerging (figure 1). All of these goods had to be supplied either out of inventory or through supply chains.

Durable Goods Detail

Figure 4 points to durable goods as the more extreme example of a surge in goods quantity consumed. Figure 5 breaks down quarterly durable goods consumption into its constituent subcategories, with levels benchmarked to 100 in 2019:Q4.

Figure 5

Real personal consumption expenditures: Durable goods categories, 2018Q1 to 2023Q4



Sources: Bureau of Economic Analysis and author's calculations

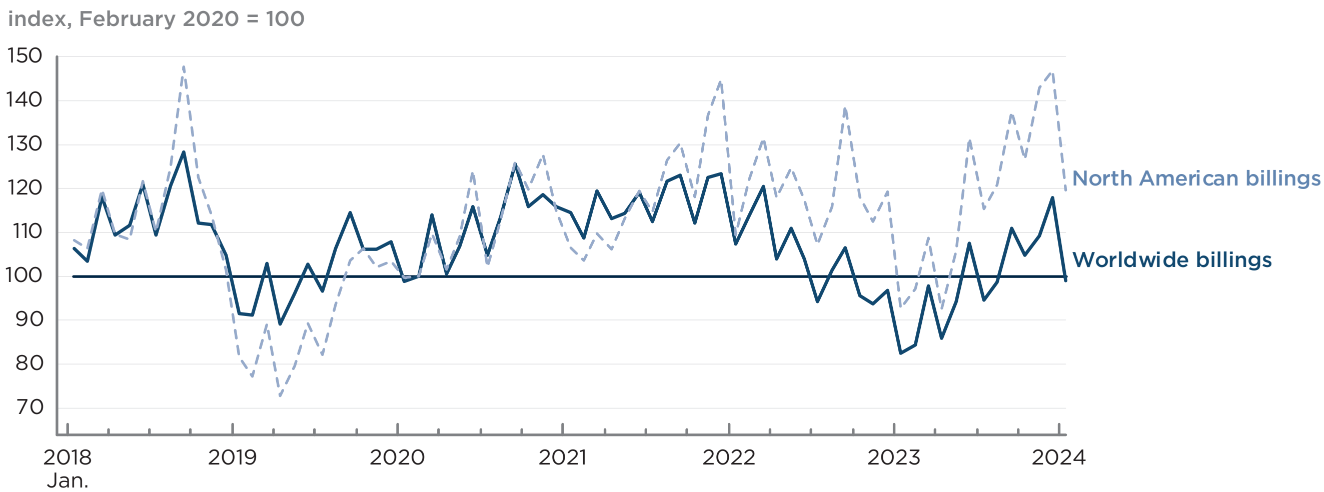
While each subcategory increased, there were stark differences. *Recreational goods and vehicles*, which includes "video, audio, photographic, and information processing equipment and media" along with sporting equipment and recreational vehicles, has grown at an astonishing pace. That pace can overshadow impressive and persistent growth in *Furnishings and durable household equipment* and *Other durable goods*.

The only candidate for laggard would be *Motor vehicles and parts*, though after 2020:Q2, its low point was 2022:Q3, when consumption was up "only" 2.8 percent above the 2019:Q4 level. Though that number still shows increased quantities throughout, it provides an opportunity to focus on two linked sectors that generated substantial concern about supply chain performance through the pandemic period: autos and semiconductors.

One can calculate that real PCE for *New motor vehicles* was up 13.7 percent from the 2018–19 average to the average for 2020:Q3–2022:Q2. One thing not shown in this graph is that there were significant shifts in composition, with new cars down and new trucks up. That introduces difficult questions about composition effects, which could be due either to shifting consumer tastes or to production difficulties. At the aggregate, however, there was no notable decline in real consumption of motor vehicles.

The linkage between autos and semiconductors comes because both seemed to be in short supply and because the auto sector supply difficulties were, in significant part, linked to the inability to obtain the requisite semiconductor chips

Figure 6
Real semiconductor billings, January 2018 to January 2024



Sources: World Semiconductor Trade Statistics Blue Book Data, and author's calculations.

for production. Both modern gas-powered autos and especially electric vehicles are increasingly reliant on semiconductors.

Before concluding that auto supply chain failure was derived from semiconductor supply chain failure, figure 6 depicts both worldwide and North American billings for semiconductors. In the absence of a more precise alternative, the nominal series are deflated by the component of the US producer price index that covers "Intermediate Demand by Commodity Type: Processed Goods for Intermediate Demand."

The solid line, worldwide billing, does not show a notable decline for the era of supply chain difficulties and accelerating goods inflation. This is suggestive, rather than dispositive, as these are not homogeneous goods and there is evidence of shifts in product mix.

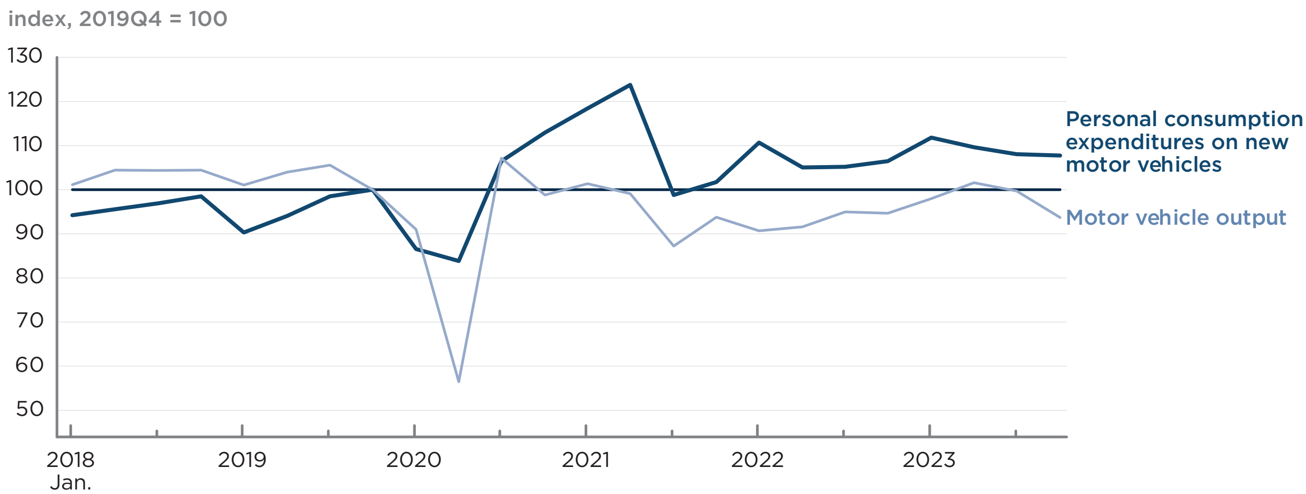
So what impeded the auto industry from meeting its semiconductor needs? The story is worth delving into because it illustrates some of the difficulties with the broad interpretation of supply chain resilience that will be addressed in the next section.[6] Automakers need to order semiconductors in advance. As the pandemic recession began, they saw a fall in auto demand (see figure 7) and anticipated, informed by their experience in the last recession, that it would take an extended period for sales to recover. They thus cut their orders for semiconductors.

When auto sales recovered quickly and inventories began to shrink, the automakers returned to the chip makers and asked to reinstate or expand their orders. However, semiconductor order books had already been filled. One facet of the increased use of devices and electronics as people worked and entertained themselves from home was a surge in demand for the chips that ran the devices. Thus, we simultaneously had a significant expansion of semiconductor production and a shortage of the variety of chips required by automakers.

6 This draws on William Boston et al., "How Car Makers Collided with a Global Chip Shortage," *Wall Street Journal*, February 12, 2021.

Figure 7

Real quarterly US new motor vehicle production and consumption, January 2018 to October 2023



Source: Bureau of Economic Analysis, Table 7.2.6B, Real Motor Vehicle Output, Chained Dollars.

While automakers had faced a very difficult forecasting task in early 2020, there is an important distinction to be drawn between a forecasting failure that resulted in supply being unable to meet strong demand and a supply chain breakdown.

Imports

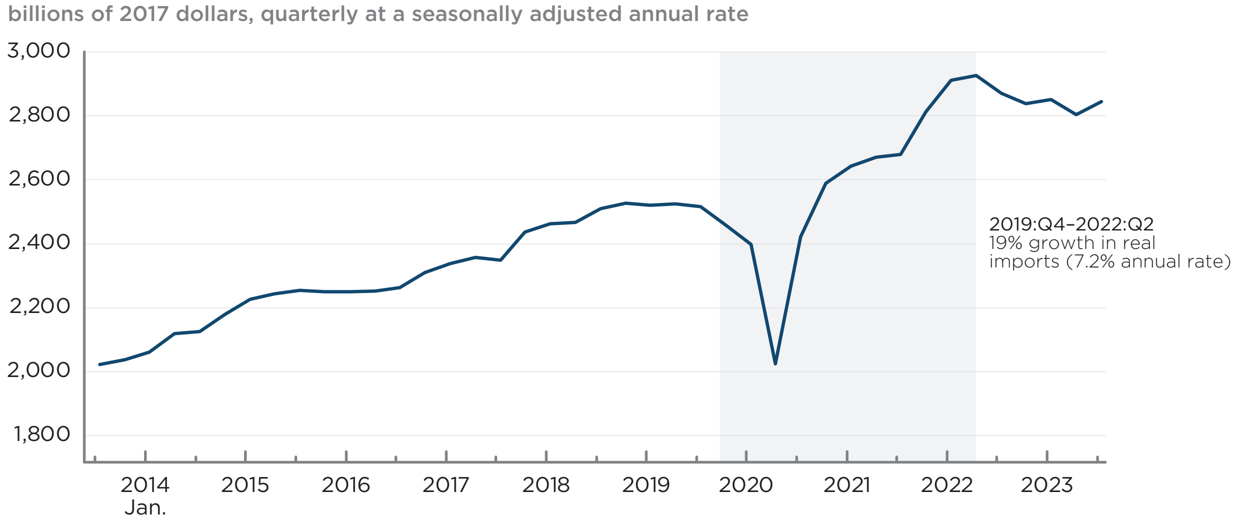
To this point, the discussion has focused on levels of US consumption without regard to whether sourcing was domestic or international. Yet the distinction has proven important in policy discussions. Policies such as a push for *nearshoring* explicitly question the reliability of geographically dispersed supply chains. In this section, we take the same approach of looking for quantity increases or decreases and apply it to trade data.

Figure 8 looks at the volume of goods entering the United States. Note that in the fourth quarter of 2019, real goods imports were below the levels of the first quarter of 2018. Thus, over that two-year period, an observer might have concluded that real import growth had tapered off entirely. Yet from 2019:Q4 to the peak in 2022:Q2, real imports grew 19 percent, or at a 7.2 percent annual rate. That dramatic growth ignores the collapse in imports in the first two quarters of 2020.

While there were indisputably instances in which factories or port terminals or other links in supply chains were disrupted by disease or disease-prevention measures, the net effect was a very substantial expansion of supply. We can see another version of this through container volumes passing through the top US ports, shown in figure 9.

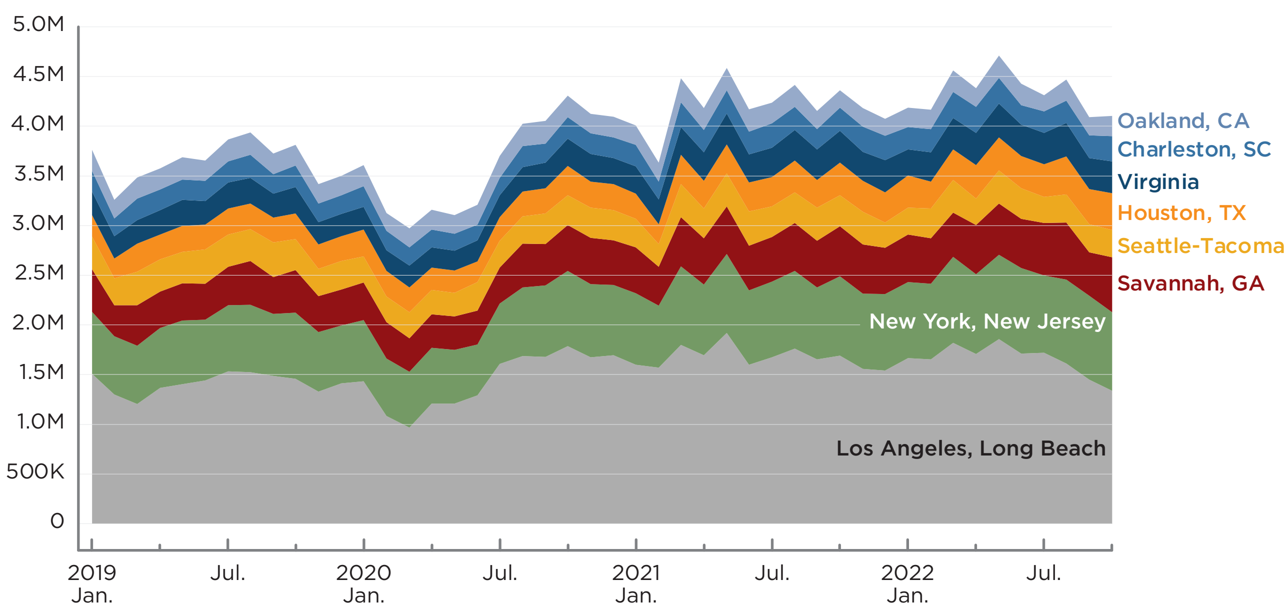
The unit of measurement is twenty-foot equivalent units (TEUs), a standard measure of freight volume. The port volumes are stacked from largest average volume (Los Angeles-Long Beach) to smallest among this group (Oakland). The data are monthly and not seasonally adjusted and ocean freight is a cyclical business. Nonetheless, if we compare the total throughput of these ports after

Figure 8
Real US imports of goods, July 2013 to July 2023



Source: Bureau of Economic Analysis via Federal Reserve Economic Data.

Figure 9
Major US port monthly TEUs handled, January 2019 to October 2022



TEUs = twenty-foot equivalent units
Source: Bureau of Transportation Statistics.

July 2020, there is only a single month in which volume dips below the *maximum* of the period from January 2019 to July 2020 (max = 3.94m). That local minimum was in February 2021, when volume dipped to 3.63m. But February volumes are frequently low given holidays in Asia. Thus, a rough version of a seasonal adjustment shows that February 2021 volume was up 11.5 percent over February 2019.[7]

Aside from that lone month, *every single month* from August 2020 showed more port throughput than the maximum of the preceding 19 months. This lack of cyclical slowdown was itself a problem, as port operators would complain of a never-ending "peak season." The norm had been to have a seasonal crunch followed by a quieter time when ports could recover. They consistently delivered higher quantities throughout.

As a final note on figure 9, which runs only through October 2022 with the latest available data, one can see freight volumes begin to subside in the final months of the graph. This is worth keeping in mind, lest one be tempted by solutions that feature permanently increased capacity.

Thus, the evidence from both goods consumption and import performance indicates that quantities increased significantly and demand expansion effects thus dominated supply contraction. That leaves the question: How do we reconcile these expanded quantities with the delays, high prices, and queued ships described above?

This reflects a supply chain overwhelmed by demand. Supply chains managed to supply over 30 percent more durables in a short time period, but that wasn't easy. The system had not been built for that capacity. Containers were in short supply. Ocean terminals were overwhelmed with unloaded containers stacked deep; they could not be moved quickly enough to truck or rail connections.

In fact, the elevated consumption numbers underplay the extent of the crunch. Because businesses initially observed a downturn and had been working with lean inventories—as in the autos example—they were not in a steady state. They needed to not only replenish depleted inventories but also adjust inventory levels upward both for increased consumption (maintaining an inventory-sales ratio) and even further if businesses decided to forsake leaner inventory approaches, as discussed above. And all of this had to be done in a short time period. Supply chains were able to significantly ramp up their throughput, but strains showed.

SUPPLY CHAIN RESILIENCE

The question of supply chain resilience is linked to the question of culpability for inflation. If the supply of goods was more elastic, could we not diminish the effects of too much money chasing too few goods? More goods would mean fewer shortages and less upward pressure on prices.

Of course, this is generically true for economies. With sufficiently elastic supply, stoking demand would just lead to increased production and consumption without inflation (or not much of it, anyway). But capacity constraints generally preclude that sort of ability to ramp up production quickly and costlessly.

What do those constraints look like in logistics? The supply chains start with factories, which take time to build, equip, staff, and supply. Trucks, rail cars, and containers are required to move the goods to air and ocean ports. Terminals and cranes are required to load and unload ships, which need crews. At either end, warehouses are typically needed to hold the containers. Once the containers

7 We skip over February 2020 to avoid questions about pandemic onset effects.

have arrived in their destination country, they need to move on with truck or rail, each available in limited supply. Then there will be storage and processing at the retail end.

Each of the elements in this chain can be expanded, but not quickly. Take the container ships that carry the vast majority of goods around the world. Why did carriers not order more when the shortage became apparent?

They did. It just takes years to produce a container ship. From January 2021 to January 2024, vessel capacity increased by 4.8 million TEUs—roughly 20 percent. An additional 3 million TEUs of capacity are expected in 2024.[8]

Not only did most of this capacity arrive too late to meet the surging goods demand of 2021 and 2022, but it resulted in a capacity glut in 2023 when prices plummeted back to prepandemic levels. In the face of increased costs, this threatened the profitability and thus the viability of some carriers.

There was a similar story with semiconductors. While they appeared to be in short supply during the pandemic—a shortage that helped prompt a roughly $50 billion program to expand capacity—real billings were falling by 2023 (see figure 6) and the industry was facing a price slump.[9]

This demonstrates why supply chains cannot carry unlimited excess capacity—it's costly. Companies that have to pay for large amounts of unused equipment and facilities will only be viable if there are occasional enormous returns in periods of stress that offset the losses in more standard times. But those enormous returns to the logistics industry—spiking prices—were exactly what proponents of resilient supply chains hoped to avoid.

Thus, we cannot hope to achieve supply chains that are infinitely elastic in supply. Instead, we could define supply chain resilience as the ability to deliver goods in the face of reasonable shocks without unexpected price increases or delays.

This begs the question of what a reasonable shock might be. As noted above, past precedent might have suggested that it would take an extended period for goods demand to recover from a recession. If we set that consideration aside and look at the experience over roughly the preceding decade, the average quarterly percentage change in real US imports from the second half of 2013 through the end of 2019 was 0.8 percent (not at an annual rate). We then exclude the initial COVID shock and rebound and pick up again in the fourth quarter of 2020. From then through the first half of 2022, the average quarterly percentage change was 2.8 percent. If we pushed back the front end of this period to include the COVID rebound (Q3 of 2020), the average is 4.9 percent.[10] Thus, the increases we witnessed during the early years of the pandemic were *not* what one would consider to be a "reasonable" shock.

A final consideration for this section was the global nature of the COVID shock. The sort of behavioral changes that helped drive the goods consumption binge—the impaired ability to go out and enjoy services in the midst of a health crisis—applied worldwide. This prevented one standard approach to resilience, in

8 See Anders Schulze, "Global Ocean Carriers Halt Red Sea Transits—What to Expect," Flexport, January 22, 2024.

9 See Tim Bradshaw, "Chip Industry Slowdown Will Last Longer than Expected, Manufacturers Warn," Financial Times, April 22, 2023.

10 The standard deviation of the prepandemic period was 1.2 percent.

which a slack part of the system can provide resources to a taut part. We do see this sort of adjustment with more localized shocks—as with the current conflict in the Red Sea, which serves to elongate ocean routes to Europe significantly. Carriers have reallocated ships to diminish the impact. That was more difficult in the face of a global shock.[11]

In sum, global supply chains *were* resilient. They delivered remarkable quantities of goods in the face of an extraordinary demand shock. Although supply chain performance can certainly be improved through efficiency measures, it would not be economically viable to maintain sufficient excess capacity to handle the surges we saw without showing serious strain.

IF NOT SUPPLY CHAINS, THEN WHAT?

The previous section showed how the surge in delivery and consumption of goods pointed to a demand shock rather than a supply chain failure as the predominant impetus behind price increases. This begs the question of where the demand shock came from. The answer is pertinent to questions of supply chain resilience because it gets to the question of what sort of demand fluctuations suppliers should reasonably prepare for.

While an analysis of root causes is beyond the scope of this paper, there are two relevant determinants of goods consumption that may be suggestive and should factor into any such analysis.

First, as shown in figure 10, personal income never dropped back to its March 2020 level in real terms—atypical for a recession. This goes to the budget constraint.

Second, as noted above, there was a shift in consumption preferences away from services and toward goods. One can argue that it was a preferences shift as the quantity of goods consumed relative to services increased even while the relative price of goods was increasing (differential inflation rates). This shift in consumption patterns was a sharp break from previous norms and while the tilt has receded somewhat, it has yet to return to prepandemic norms, particularly for durable goods.[12]

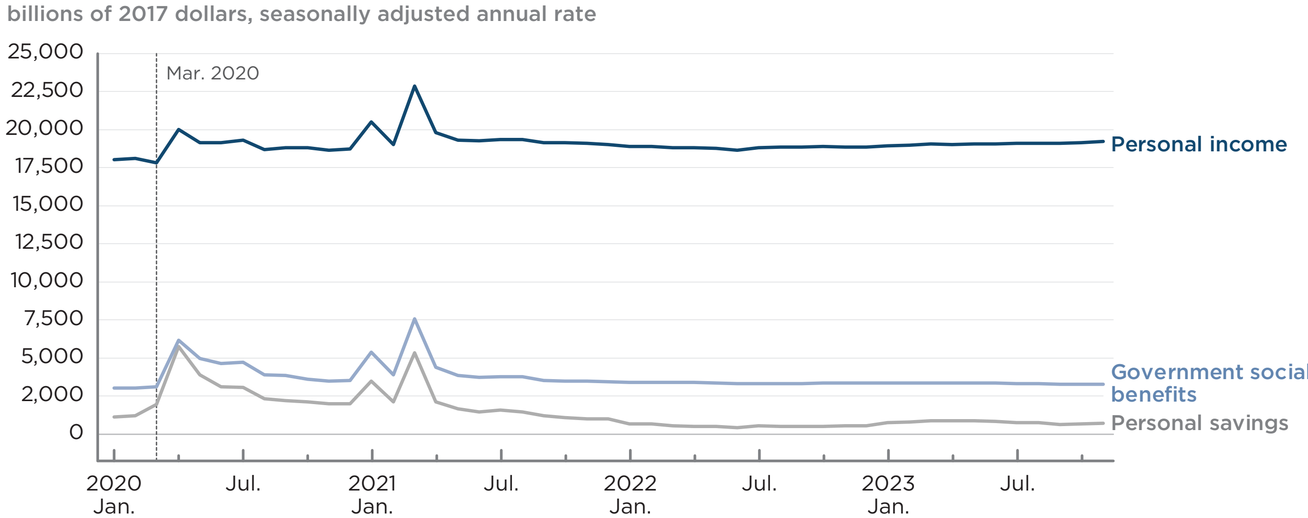
Without taking a stand on whether the documented surge in goods demand was due to fiscal support, to changes in how people shopped, or to monetary stimulus, there is no shortage of explanations for where a demand shock may have originated.[13]

11 This is not to argue that local supply chains are more resilient than global ones. Local supply chains (toilet paper, eggs) were not immune to a pervasive global shock. And a global supply chain allows diversification away from local shocks. See Davide Malacrino, Adil Mohommad, and Andrea F. Presbitero, "Global Trade Needs More Supply Diversity, Not Less," *IMF Blog*, April 12, 2022.

12 See Flexport, "Post-Covid Indicators," December 18, 2023.

13 This paper has focused on US conditions, but the shift toward consuming more goods was not confined to the United States. For the United Kingdom, if one looks over the last 10 years of real consumption data, the share of goods in total consumption, from 2013:Q4 to 2020:Q1 ranged from 39.5 percent to 40.7 percent. From 2020:Q2 through 2021:Q2 the figure ranged from an initial high of 45.7 percent to a low 44.1 percent. Of course, this ratio could reflect either increased goods consumption or lower services consumption. Though 2020:Q2 goods consumption in the United Kingdom was the highest quarterly value over a decade; subsequent levels were in a more normal range. It would be useful to characterize other countries' demand patterns through the pandemic in more detail. See Office for National Statistics, "Consumer Trends: Chained Volume Measure, Seasonally Adjusted," June 29, 2024.

Figure 10
Real US income and savings, January 2020 to November 2023



Source: Bureau of Economic Analysis via Federal Reserve Economic Data.

CONCLUSION: POLICY IMPLICATIONS

To make an indelible impression, it helps to have a good visual. For the supply chain crisis we had empty shelves and queued ships. There was no corresponding image to convey the massive surge in demand for goods. As the crisis preceded a sharp increase in inflation that originated among goods, it was easy (and popular) to explain that supply chain failures caused inflation.[14]

The appropriate assessment of causality has important consequences for policy. For supply chains, there is the danger of erroneous conclusions and prescriptions, such as a pullback from international trade or a need to dramatically expand infrastructure and capacity. For policies intended to stimulate demand, there is the need to find the balance between insufficient and excessive that must be informed by a clear-eyed look at the consequences.

The story that emerges from the data presented in this paper is that global supply chains were heavily stressed by an extraordinary surge in demand. This surge came from consumers facing very low interest rates, enhanced income and savings, and new constraints pushing consumption toward goods, especially durable goods. The consequence was too much money chasing too few goods—and thus, inflation.

14 There is a burgeoning literature that attempts to assign blame for inflation in much more sophisticated ways than this work. Two notes of caution are warranted. First, it helps tremendously if one uses a good measure of supply chain strain. Importantly, there are problems with the popular but opaque Global Supply Chain Pressure Index put out by the Federal Reserve Bank of New York that drives some of the empirical work. That index mixes a number of disparate measures of supply and demand in an opaque way. This need not be a problem if the index correlated well with more readily observable measures of supply chain performance, but it does not. This became most apparent when in early 2023 the index showed that supply chain conditions were actually *better* than they had been in the prepandemic year. That conclusion conflicted with direct evidence of transit times (see figure 2) as well as with US, Canadian, and European survey data on shortages and bottlenecks. (See Chris Clague, "Are We There Yet? Tracking the Recovery in Global Supply Chains," Flexport, June 8, 2023.) Finally, for sophisticated empirical work, there is always the danger of misattribution with imperfectly specified models. This paper has opted for Occam's razor instead.

PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

24-13 US Monetary Policy and the Recent Surge in Inflation

David Reifschneider

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ABSTRACT

Federal Reserve policy in the wake of the COVID pandemic has been widely criticized as responding too slowly to surging inflation and an overheated labor market, thereby exacerbating the inflation problem and impairing macroeconomic performance more generally. This paper challenges this view by exploring the likely effects of a markedly more restrictive counterfactual monetary policy starting in early 2021. Under this policy, the Federal Open Market Committee (FOMC) would have strictly followed the prescriptions of a benchmark policy rule with labor utilization gauged using the ratio of vacancies to unemployment, thereby causing the federal funds rate to rise faster and by much more than it actually did. In addition, consistent with the alternative rule-based strategy, the FOMC would have provided less accommodative forward guidance than what it implicitly provided over time, based on the post-COVID evolution of the economic projections made by FOMC participants and major financial institutions. Finally, the Fed would have ended its large-scale asset purchases earlier and begun shrinking its balance sheet sooner. Because of uncertainty about inflation dynamics, simulations of the effects of the counterfactual policy are run using different specifications of the Phillips curve drawn from recent studies, with each in turn embedded in a large-scale model of the US economy that provides a detailed treatment of the monetary transmission mechanism. Using a range of assumptions for expectations formation and the interest sensitivity of aggregate spending, the various model simulations suggest that a more restrictive strategy on the part of the FOMC would have done little to check inflation in 2021 and 2022, although it probably would have sped its return to 2 percent thereafter. Because the modest reductions in inflation suggested by these simulations would have come at a cost of higher unemployment and lower real wages, the net social benefit of a more restrictive policy response on the part of the FOMC seems doubtful; the paper also questions the wisdom of a more rapid and pronounced tightening on risk-management grounds.

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1. Introduction

Federal Reserve monetary policy has been widely criticized in recent years. For example, reacting to guidance from the Federal Open Market Committee (FOMC), the Fed's policymaking group, that the federal funds rate was likely to remain near zero for some time to come despite the enactment of several major fiscal packages, Lawrence Summers warned in the spring of 2021 that the FOMC had "underestimated the risks, very substantially, both to financial stability as well as to conventional inflation of protracted extremely low interest rates."[1] This early warning received widespread attention, as did his reaction later in the year to the Fed's initially sanguine assessment of a string of elevated monthly price increases: "It's past time for team 'transitory' to step down."[2] As the FOMC continued to hold the federal funds rate near zero into early 2022 despite headline PCE inflation as measured by the personal consumption expenditures (PCE) index surging to around 7 percent, Summers was joined by a number of other prominent economists, including Jason Furman, Michael Bordo, Mickey Levy, John Taylor, and John Cochrane.[3] In their view, the Fed was moving far too slowly and fueling what was becoming, or even in some eyes had already become, a chronic inflation problem. In the wider world, a headline in *The Economist* expressed what may have been a common view at the time: "The Federal Reserve has made a historic mistake on inflation."[4]

Against this criticism, one might defend the Fed's delayed tightening by noting the difficulty of gauging in real time the persistence of the upward surprises to prices, the actual tightness of the labor market, and the prospects for future growth; in addition, a slow-to-tighten strategy could be seen as appropriate given the stimulative forward guidance provided by the FOMC in 2020 in order to mitigate the adverse consequences of the effective lower bound (ELB) on nominal interest rates.[5] Certainly, most outside observers at the time shared the FOMC's expectation that inflation was likely to fall back to 2 percent quickly without a need for a marked tightening in monetary policy. In June 2021, for example, after several months of elevated price increases and the recent passage of a yet another major fiscal package, major financial institutions and private forecasters, like the FOMC, anticipated that headline PCE inflation would run close to 2 percent in 2022 accompanied by only a modest tightening of monetary policy—an expectation that was

[1] "Armchair Discussion with Larry Summers and Dave Altig," remarks at a conference held on May 17-18, 2021, *Fostering a Resilient Economy and Financial System: The Role of Banks*, at the Center for Financial Innovation and Stability, Federal Reserve Bank of Atlanta, Atlanta. Available at www.atlantafed.org/news/conferences-and-events/conferences/2021/05/17/financial-markets-conference.

[2] Lawrence H. Summers, "It's Past Time for Team Transitory to Step Down," November 16, 2021, larrysummers.com/2021/11/16/on-inflation-its-past-time-for-team-transitory-to-stand-down/.

[3] See Jason Furman, "This Inflation Is Demand-Driven and Persistent," Project Syndicate (April 20, 2022), www.project-syndicate.org/commentary/inflation-demand-driven-persistent-by-jason-furman-2022-04?barrier=accesspaylog and "America's Wage-Price Persistence Must Be Stopped," Project Syndicate (August 2, 2022), www.project-syndicate.org/commentary/inflation-wage-price-spiral-requires-fed-tightening-by-jason-furman-2022-08?barrier=accesspaylog; and the papers presented by Bordo and Levy (2023), Taylor (2023), and Cochrane (2023) at a conference sponsored by the Hoover Institution in May 2022.

[4] *The Economist*, "Why the Federal Reserve Has Made a Historic Mistake on Inflation," April 23, 2022, www.economist.com/leaders/2022/04/23/why-the-federal-reserve-has-made-a-historic-mistake-on-inflation.

[5] Federal Reserve Board governor Waller made these points in a speech given at the May 2022 Hoover Institution conference, www.federalreserve.gov/newsevents/speech/waller20220506a.htm. With regard to the FOMC's slow-to-tighten forward guidance, one difficulty with using this tool is that its effectiveness in future ELB episodes will be greatly impaired if policymakers come to be seen as likely to quickly jettison this guidance when conditions begin to improve.

largely unchanged at the end of the year.[6] As for households, their expectations for inflation over the next five years were about the same in mid-2021 as they had been at the start of the year and by year's end had still barely risen.[7]

Fed policy changed course starting in the spring of 2022. In an effort to rein in inflation that had proved to be more persistent than expected, and in the face of what appeared to be quite tight labor conditions, the FOMC carried out an extended sequence of unusually large rate hikes that raised the federal funds rate by more than 500 basis points between the March 2022 and July 2023 meetings. In the wake of this policy response, inflation has slowed markedly with unemployment remaining low, and as a result the FOMC's post-COVID policy has come to be viewed more favorably. But there still seems to be a general belief that the Federal Reserve erred in not responding more proactively and thus allowed economic conditions to be worse than they might have been. For example, Eggertsson and Kohn (2023) argue that the Fed's adoption of flexible average inflation targeting in August 2020 unwisely incorporated an inflationary bias into FOMC policymaking that inappropriately delayed tightening, although they do not provide any estimates of its actual consequences for inflation.

But did the FOMC's delayed response in fact materially contribute to inflation and more broadly impair macroeconomic performance? This paper finds that it probably did not. This conclusion is based on an analysis of how economic conditions would likely have evolved under a much tighter monetary policy. Under this counterfactual policy, the FOMC in early 2021 would have begun following the prescriptions of a benchmark policy rule that would have called for raising the federal funds rate appreciably earlier than the FOMC did, and over time by considerably more, in response to both the surge in inflation and evidence that the labor market was far more overheated than the unemployment rate alone suggested. Consistent with the alternative rule-based strategy, the FOMC would also have simultaneously provided much less stimulative forward guidance about the likely future path of interest rates than it did. Finally, the proposed counterfactual strategy would have ended the Federal Reserve's large-scale asset purchases earlier and begun normalizing the size of its balance sheet sooner.

[6] The medians of the Q4/Q4 headline PCE inflation projections submitted by the individual FOMC participants for the June 2021 meeting were 3.4 percent, 2.1 percent, and 2.2 percent for 2021, 2022, and 2023, respectively; see the *Summary of Economic Projections*, www.federalreserve.gov/monetarypolicy/fomcprojtabl20210616.htm.These FOMC forecasts were the same as the projections made in early June 2021 by the major financial institutions that act as counterparties to the Fed's open-market operations; see the Federal Reserve Bank of New York *Survey of Primary Dealers*, www.newyorkfed.org/markets/primarydealer_survey_questions. Similarly, the median projections reported in the 2021 Q2 *Survey of Professional Forecasters* (SPF) (released in May) showed that this group expected Q4/Q4 PCE inflation to be 2¾ percent in 2021 but then to moderate to around 2.2 percent in both 2022 and 2023; see www.philadelphiafed.org/surveys-and-data/real-time-data-research/survey-of-professional-forecasters. In all three cases, the median forecast for the level of short-term interest rates at the end of 2022 was only 0.13 percent, with the projected level at the end of 2023 ranging from 0.63 percent to 1.25 percent. By late 2021, FOMC participants, the primary dealers, and private forecasters all projected PCE inflation to moderate markedly in 2022 from the elevated 2021 rate and to be close to 2 percent in 2023, with short-term interest rates projected to stand no higher than 1.3 percent at the end of 2023 and 2.1 percent in 2024.

[7] The median expectation for inflation over the next five years reported in the University of Michigan household survey was 2.7 percent in January 2021, 2.8 percent in June 2021, and 2.9 percent in December 2021. These figures are essentially the same as the median expectation reported on average from 2000 to 2019, prior to the onset of COVID. Note that the household inflation expectations reported in the Michigan survey tend to be noticeably higher than either the PCE or the consumer price index (CPI) measures of actual inflation. See data.sca.isr.umich.edu/tables.php.

Given this counterfactual policy, which probably would have been even more restrictive than critics would have advocated at the time, the paper then assesses its likely consequences for recent US inflation and real activity using model simulations. In light of considerable uncertainty about the forces that have actually driven inflation over time, this paper reports simulations carried out using four different specifications of the Phillips curve. One of these specifications is based on the wage and price equations of FRB/US, the Federal Reserve Board's model of the US economy, while the other three are based on estimated wage and price equations reported in three recent papers—Bernanke and Blanchard (2023), Cecchetti and others (2023), and Gagnon and Collins (2019). These specifications differ in various ways, including the estimated response of wages and prices over time to movements in resource utilization—that is to say, in the slope of the Phillips curve. The flatter this slope, the more policymakers have to raise interest rates and boost unemployment to offset short-to-medium-run increases in inflation, all else equal. For the analysis in this paper, another important feature of these Phillips curve specifications is the estimated persistence of short-run movements in inflation, and the potential for them to become embedded in long-run inflation expectations over time, either explicitly or implicitly. The better anchored such expectations, the smaller the longer-run cost of the "easy" policy followed by the FOMC and thus the smaller the potential gain from the counterfactual policy.

To run the simulations, each Phillips curve is in turn incorporated into the structure of the FRB/US model, which among other things includes a detailed treatment of how current and expected changes in monetary policy influence overall financial conditions, expectations for inflation and other factors, and aggregate demand and supply. As a robustness check, for all four model specifications a range of assumptions are used for expectations formation and the interest sensitivity of aggregate spending. A striking feature of these various simulations is that, across almost all the permutations of the Phillips curve and other simulation assumptions, the counterfactual monetary policy does little to check inflation in 2021 and reduces it by only a few tenths of a percentage point in 2022, although the simulations do show PCE inflation moving somewhat more quickly back to the FOMC's 2 percent target in 2023 and 2024. Overall, these results suggest that the Phillips curve is too flat and long-run inflation expectations too well anchored for monetary policy to have been able to do much to prevent the inflation surge that occurred. Moreover, the simulations suggest that costs in reduced employment and household income would have been appreciable had the FOMC tried: The more restrictive policy would not only have pushed the economy back into recession, but relative to actual conditions it also would have likely resulted in lower real wages, not higher.

One might question these simulation results on the grounds that the rule-based counterfactual policy is too gradual, or that inflation expectations might have responded by more than the model predicts, or that the simulations ignore the effect tighter monetary policy would have had on supply shocks. After considering these possibilities, the paper presents evidence that they were either unimportant or improbable. That said, uncertainty about the "true" monetary transmission mechanism is considerable, and another model might well yield a more substantial effect. For example, Gagliardone and Gertler (2023) use a dynamic stochastic general equilibrium (DSGE) model to estimate the economic effects of recent shocks to monetary policy and oil prices, and they find that "easy" monetary policy and accompanying forward guidance added about 1½ percentage points to inflation in both 2021 and 2022, in contrast to the small effects found using FRB/US.

Finally, a different caveat about the simulation results presented in this paper is that they ignore an important risk-management consideration. Even if the FOMC is indeed on track to the desired soft landing, with inflation apparently coming back to target without any significant increase in unemployment, its delay in tightening as inflation surged arguably risked inflation expectations becoming unanchored. If that had occurred, the persistent cost in diminished macroeconomic stability would have been considerable. Having said that, whether this was ever a serious risk and thus worth the assured cost of higher unemployment seems questionable given the slowness with which long-run inflation expectations have historically responded to persistent movements in actual inflation—something that has continued in recent years. Also, as noted above, risk management concerns related to the ELB constraint at least initially pointed in the direction of taking a cautious approach to tightening. That said, the FOMC certainly can never count on expectations remaining anchored no matter what it does, and for that reason it was correct to raise interest rates quickly over the course of 2022 and 2023 in response to elevated inflation and the strength of real activity.

The structure of the paper is as follows. Section 2 presents the rationale for an alternative strategy under which the FOMC would have adjusted the federal funds rate in response to movements in real activity and inflation as prescribed by a modified version of a standard policy benchmark, the "balanced approach" rule. A key feature of the counterfactual rule is that it measures labor utilization using the ratio of vacancies to unemployment (V/U) instead of the unemployment rate, on the grounds that the latter appears to have markedly understated the actual tightness of the labor market in recent years. The paper then considers the other two components of recent FOMC monetary policy, forward guidance and quantitative easing (QE). Based on the evolution of economic projections made by FOMC participants and a group of major financial institutions since 2020, section 3 shows that since COVID hit, the FOMC has implicitly signaled that conditions would likely lead it to keep the federal funds rate well below the prescriptions of the counterfactual rule for an extended period—stimulative forward guidance that is eliminated under the counterfactual rule-based strategy. Section 4 completes the counterfactual strategy by specifying an alternative path for the Fed's balance sheet and discussing the effects it likely would have had on term premiums. Section 5 reviews the main features of the different Phillips curve specifications and the rest of the FRB/US model, and then it presents simulation results for some simple shocks that illustrate the ways in which real activity and inflation respond to changes in the federal funds rate, forward guidance, and QE-influenced term premiums in the model. Section 6 then uses the various permutations of model structure and simulation assumptions to assess how history might have evolved under the counterfactual strategy and considers some possible ways in which the model's predictions could err. Finally, section 7 concludes with a discussion of what the net benefits of a more restrictive policy might have been and what risk-management considerations might have suggested.

2. Counterfactual monetary policy based on the balanced approach rule

Although monetary policy cannot be realistically reduced to following a simple rule, a useful way to assess the stance of monetary policy in the wake of COVID is to compare the actual path of the federal funds rate since early 2020 to that prescribed by a benchmark rule of the sort highlighted by Taylor (1999) and later dubbed the "balanced approach" (BA) rule by Fed chair Yellen:[8]

$$I_t = \rho I_{t-1} + (1-\rho)[R^* + \pi_t + 0.5(\pi_t - \pi^*) - 2.0(U_t - U^*)]$$

In this expression, I_t is the rule's prescription for the end-of-quarter value of the federal funds rate, π_t is the 4-quarter rate of core PCE inflation, U_t is the quarterly average value of the unemployment rate, π^* denotes the FOMC's announced inflation target (equal to 2 percent), and $R^*$and U^* are the values of the real federal funds rate and the unemployment rate estimated to be consistent with full employment and price stability in the longer run. The parameter ρ determines the degree to which policymakers respond gradually to movements in real activity and inflation.[9]

In analyses of expected macroeconomic performance under different policy rules in a stochastic environment—such as Bernanke, Kiley, and Roberts (2019); Chung and others (2019); and Bernanke (2020)—the BA rule is found (in the context of stochastic model simulations) to do a reasonably good job in helping to stabilize the economy under a range of conditions, including situations in which the ELB frequently binds. That said, the same studies suggest that other, more complicated rules may potentially do better, so no claim is made here that this benchmark rule is the "best" of the many different policy rules that have been proposed over time. However, the BA rule, particularly when policymakers are assumed to respond gradually to changes in real activity and inflation ($\rho > 0$), has the advantage of mimicking the FOMC's behavior in the two decades or so prior to the first ELB episode.[10] As discussed by English, Nelson, and Sack (2003) and Bernanke (2004), such gradualist behavior reflects policymakers' legitimate concerns about the reliability of initial readings on economic conditions and other types of uncertainty, aversion to overreacting to transitory shocks, and the potential for abrupt interest rate movements to generate financial instability.[11] Thus, financial market participants and others would likely have

[8] See the speech given by Janet Yellen, "The Economic Outlook and the Conduct of Monetary Policy," at the Stanford Institute for Economic Policy Research, Stanford University, Stanford, California, on January 19, 2017, available at www.federalreserve.gov/newsevents/speech/yellen20170119a.htm. For a discussion by the Federal Reserve about the uses and limitations of policy rules in informing monetary policy decisions, see www.federalreserve.gov/monetarypolicy/policy-rules-and-how-policymakers-use-them.htm and www.federalreserve.gov/monetarypolicy/challenges-associated-with-using-rules-to-make-monetary-policy.htm. Also, see the discussion of rules in Taylor and Williams (2011). The Federal Reserve regularly reports the prescriptions of the balanced approach rule (along with others) in its semiannual *Monetary Policy Report*.
[9] The BA rule differs from the original Taylor (1993) rule by being twice as responsive to resource utilization (adjusting for lags when $\rho > 0$) and by responding to core rather than headline inflation. In this specification, the unemployment gap (multiplied by -2.0, the approximate value of the Okun's Law coefficient) is used in place of the more difficult to estimate output gap.
[10] Using quarterly data from 1991Q1 to 2008Q3, the FOMC's implicit pre-ELB reaction function is estimated to equal $I_t = .64 I_{t-1} + .36[15.55 - .068 TT_t + 1.53\pi_t - 2.27 U_t]$, where a linear time trend, TT_t, is included in the regression to control for changes over time in the equilibrium real interest rate, the FOMC's implicit inflation target, and the natural rate of unemployment. Based on a log-likelihood ratio test, the long-run responses to inflation and unemployment in the estimated reaction function are insignificantly different from their values in the balanced approach rule, 1.5 and -2.0. Note that estimating a reaction function using data from 2008Q4 on would yield downwardly biased estimates of the *desired* response of the FOMC to movements in unemployment and inflation because the ELB has periodically constrained downward movements in the federal funds rate since December 2008.
[11] Ben S. Bernanke also addresses this issue in "Gradualism," a speech delivered at an economics luncheon cosponsored by the Federal Reserve Bank of San Francisco (Seattle Branch) and the University of Washington, Seattle, on May 20, 2004.

viewed a counterfactual strategy based on a gradualist version of this benchmark rule as one that was aligned with both past practice and good policy outcomes and thus credible.

Figure 1 compares the actual path of the federal funds rate through late 2023, extended through late 2025 using the FOMC's latest projections, to the paths prescribed by the unconstrained BA rule using two different settings for ρ, zero and 0.85. For the latter setting, results are also shown when the ELB is imposed.[12] The rule-based paths are computed conditional on actual and projected real activity and inflation, with R^* and U^* set to 0.5 percent and 4.1 percent, respectively.[13] Unconstrained, the nongradualist version of the BA rule would have called for pushing the federal funds rate far below zero in 2020 and keeping below zero through early 2021 in response to high unemployment, but as the unemployment rate fell and inflation surged, the same version would have called for a much more rapid and marked degree of tightening than what the FOMC did. With $\rho = 0.85$, however, the unconstrained rule would have instead prescribed a path of the federal funds rate similar to the actual path, albeit still with a noticeable excursion below zero for a time. Finally, the gradualist version of the BA rule with the ELB imposed yields an intermediate case in which tightening would have begun in 2021Q2 and tightened at a relatively moderate pace thereafter, with the result that the federal funds rate would have been on average ¾ percentage points higher than its actual/projected path from early 2021 to late 2025.

This figure would seem to suggest that the average stance of FOMC policy since early 2021 has been moderately but not dramatically easy, ignoring any additional stimulus that may have been provided through forward guidance and quantitative easing. But that interpretation overlooks an important issue confronting the Federal Reserve in recent years, the measurement of labor utilization. In the years prior to 2020, the unemployment rate was closely correlated with a variety of labor market indicators, suggesting that policymakers could safely focus on it when assessing how far the economy was from the level of full employment consistent with long-run price stability. Figure 2 illustrates these historical close correlations using the quits rate, the job openings rate, the prime-age employment-to-population ratio, a composite index of the level of labor market activity published by the Federal Reserve Bank of Kansas City, and the V/U ratio; note that the numerator of V/U equals the number of job openings.[14] In the figure, the five alternative indicators have been rescaled to be comparable to the unemployment rate and, like the unemployment rate, are expressed as utilization rates by subtracting 4.1 percent.[15] As the

[12] The ELB is assumed to equal 12.5 basis points, the midpoint of the lowest target range for the federal funds rate used by the Federal Reserve to date, zero to 25 basis points. In principle, the FOMC could have opted for a somewhat lower range given that the European Central Bank and some other central banks have at times set their policy rates as much as 50 basis points below zero.

[13] The projected 2024-25 values of the federal funds rate, real activity, and inflation are based on the medians of the medium-term forecasts submitted by FOMC participants for the December 2023 FOMC meeting and reported in the *Summary of Economic Projections*, www.federalreserve.gov/monetarypolicy/fomcprojtabl20231213.htm, while the assumed values of *R** and *U** equal the median values of their longer-run projections. For the inertial specification of the rule, the lagged federal funds rate term equals the dynamically computed value generated by the rule starting in 2019Q2, not its actual value.

[14] The composite index is the first principal component of 24 different monthly labor series. See www.kansascityfed.org/data-and-trends/labor-market-conditions-indicators/ for further details.

[15] Specifically, each alternative labor market indicator *X* is rescaled as c1 + c2 * T + c3 * X, where *T* is a linear time trend and *c1, c2,* and *c3* are the coefficients obtained by regressing the unemployment rate on *T* and *X* using data from 2001Q1 to 2019Q4.

figure shows, all the rescaled alternatives closely tracked the unemployment rate from 2001 to 2019. But since COVID hit, several of them have diverged markedly from the unemployment rate, implying that the initial contraction was less deep and the subsequent swing to tight conditions was more pronounced, although the magnitude of the divergence has declined appreciably in recent quarters.

Figure 3 illustrates the implications of the post-COVID divergence in these various indicators for the prescriptions of the gradualist version of the BA rule subject to the ELB constraint, computed conditional on the actual and projected path of core PCE inflation and on the paths of the various measures of labor conditions.[16] Gauging labor utilization using the rescaled prime-age employment-to-population ratio yields a prescribed path similar to the one generated using the unemployment rate through late 2022, while a path based on the broad-based labor conditions index runs consistently somewhat higher over the entire 2020-25 period. Prescribed paths computed using the other three indicators are much more restrictive. On average, the path constructed using V/U is 3 percentage points higher than the actual path from 2020 to 2023, while the path constructed with the job openings rate is 6½ percentage points higher. Although these various calculations make no allowance for the weaker economic conditions that would have prevailed under a tighter policy and which would have moderated the BA rule's prescriptions to some extent, the various paths do suggest that actual FOMC policy has probably been and continues to be comparatively quite easy relative to what a "normal" rule-based strategy would have called for.

With the information available at the time, should the FOMC have placed more weight on these alternative indicators of labor utilization and so have tightened earlier and more aggressively? Probably, although saying so begs the question of when policymakers should have been expected to recognize that the unemployment rate was no longer an adequate guide to the actual tightness of the labor market. Certainly 2020 would have been too early: Abandoning years of experience on the basis of two or three quarters of data would have been hard to justify, particularly at a time when determining the persistence of the discordant signals from different labor market indicators would have been extremely difficult. More importantly, the fact that uncertainty about "true" labor utilization was unusually high immediately after the pandemic started was, to a large degree, irrelevant at the time from a risk-management perspective. In light of plunging employment, highly stressed financial markets, and massive uncertainty about the prospects for recovery—particularly given the asymmetric risks created by the ELB constraint on nominal interest rates and the unknown magnitude of the fiscal actions that would eventually be taken—it was clearly appropriate in the spring of 2020 for the FOMC to lower the federal funds rate to the ELB and hold it there until the situation became clearer.

Conditions changed appreciably in 2021. Financial markets by then were under much less stress, monthly readings on prices came in surprisingly strong over the course of the year, and a wide range of indicators increasingly suggested that the labor market was not only recovering rapidly but was even overheating. With regard to the FOMC's recognition of the last development, the

[16] Because the FOMC does not report forecasts for the alternative labor indicators, illustrative projections for these series are constructed by assuming that FOMC participants would have expected the wedge between the unemployment rate and each alternative rescaled indicator to continue to fade away in 2024 and 2025 at a rate of 15 percent per quarter.

minutes from the June 2021 meeting note that "many participants pointed to the elevated number of job openings and high rates of job switching as further evidence of the improvement in labor market conditions."[17] By the September meeting, this concern had escalated: "Private-sector job openings, as measured by the Job Openings and Labor Turnover Survey, increased further in July and continued to suggest that labor demand was *extraordinarily* high"[18] (italics added). Given this evidence, and the fact that the unemployment rate was still 5.9 percent in June 2021, far above the FOMC's estimate of its longer-run sustainable level (then 4 percent), one can argue that around this time policymakers should have gauged the appropriate stance of monetary policy using some alternative to the unemployment rate to measure resource utilization.[19] Moreover, the risk-management case for systematically deviating from the prescriptions of a benchmark rule in a lower-for-longer direction weakened substantially over the course of 2021 as it became increasingly clear that a robust economic recovery was solidly under way. Nevertheless, the FOMC would have faced considerable communication challenges initially if it had begun tightening in response to one or more of the alternative labor market indicators, as it was only later in the year that they suggested monetary policy was markedly easy.

If the FOMC had decided to focus on an alternative measure of labor utilization, which one should it have chosen? Although the labor conditions index has some appeal because it attempts to summarize the signal from a wide range of indicators, a stronger candidate to replace the unemployment rate might have been the ratio of vacancies to unemployment. In an Economics Letter published by the Federal Reserve Bank of San Francisco in October 2021, Barnichon, Oliveira, and Shapiro (2021) argued that the V/U measure performed better empirically than the unemployment rate as a predictor of both contemporaneous and past wage and price pressures. These Fed staffers also stressed that from a theoretical standpoint the ratio was a better measure of labor utilization because it reflects both demand and supply factors, something that became particularly important post-COVID because of shifts in the Beveridge curve and other signs of impairments to the normal functioning of the labor market. What FOMC participants made of this argument at the time is as yet unknown, but certainly it is now common for many economists to treat V/U as the preferred measure of labor utilization to use in studies of both recent and past inflation developments; see, for example, Bernanke and Blanchard (2023); Barnichon and Shapiro (2022); Ball, Leigh, and Mishra (2022); and Cecchetti and others (2023). Accordingly, the counterfactual monetary policy used in the model simulations discussed below is one that

[17] See www.federalreserve.gov/monetarypolicy/fomcminutes20210616.htm. The June 2021 FOMC minutes also show, however, that participants still placed great weight on the unemployment rate and other traditional indicators: "Many participants remarked, however, that the economy was still far from achieving the Committee's broad-based and inclusive maximum-employment goal, and some participants indicated that recent job gains, while strong, were weaker than they had expected."

[18] See www.federalreserve.gov/monetarypolicy/fomcminutes20210922.htm.

[19] Of course, utilization measurement issues extend beyond the labor market. Since COVID hit, disruptions to global supply chains as well as shocks to food and energy prices arising from the Russian invasion of Ukraine, avian flu, and other factors have hit a variety of product markets, making it difficult to judge the balance between aggregate demand and supply. Nevertheless, to the extent FOMC participants focused on the labor market in assessing aggregate resource utilization, and thereby implicitly looked through nonlabor supply-side disruptions to product markets by treating them as transitory shocks, they were probably wise. With time, these shocks have faded appreciably and do not appear to have had permanent macroeconomic effects by, for example, altering long-run inflation expectations or trend productivity. Moreover, tighter monetary policy would likely have done little to directly reduce the shocks to food, energy, and supply chains, barring draconian actions that would have prevented the US economy from recovering and, for example, reducing global oil consumption and so damping energy prices.

strictly follows the prescriptions of the ELB-constrained BA rule beginning in early 2021, with labor utilization gauged using the rescaled V/U measure (from here on denoted as ZVU) expressed as a difference from the estimated value of the sustainable rate of unemployment, U^*.[20]

3. Forward guidance and financial market expectations

If the FOMC had announced in early 2021 that going forward it intended to strictly follow the prescriptions of the BA rule with labor utilization gauged using ZVU-U^*, its guidance about the likely future path of the federal funds rate would presumably have changed to be consistent with the counterfactual strategy. If deemed credible, that change in forward guidance would in turn have altered the expectations of presumably well-informed financial market participants about future economic conditions, resulting in contractionary shifts in longer-term interest rates, corporate equity prices, and other financial factors, thereby damping real activity and thus inflation. (Less realistically, the change in forward guidance might also have altered the expectations of households and other less well-informed agents as well, causing further changes in aggregate spending and inflation.) This section reviews the coevolution since 2020 of the economic projections made both by the FOMC and by major financial institutions, with the objective of measuring changes over time in each group's implicit expectations for the degree to which future monetary policy would deviate from the prescriptions of the counterfactual BA rule—expected deviations that would presumably have disappeared once the counterfactual strategy was announced. This analysis shows that at each forecast date the two groups always had similar expectations for these implicit deviations from the rule, and as time passed the expected future deviations became quite large and persistent. As a result, the forward guidance the FOMC actually provided over time was implicitly much more accommodative than what it presumably would have provided under the more restrictive counterfactual policy.

For the March, June, September, and December meetings of the FOMC, the 7 members of the Federal Reserve Board and the 12 regional Reserve Bank presidents each submit their individual projections for economic activity over the medium term and in the longer run, conditioned on their individual assessment of appropriate monetary policy. Summary information about these forecasts is released at the press conference immediately following these meetings and later reported in the *Summary of Economic Projections* (SEP). The dashed lines of figures 4, 5, and 6 illustrate how the medians of participants' individual medium-term forecasts for core PCE inflation, the unemployment rate, and the federal funds rate, respectively, have evolved at selected dates since June 2020. To see how the evolving expectations of policymakers compared to the views of financial market participants, the figures also report the corresponding forecasts

[20] The assumption that the long-run sustainable value of ZVU is equal to U^* is consistent with the results plotted in figure 2: The remarkable similarity of the movements in the unemployment rate and the rescaled indicators pre-COVID indicates that they all must have had more or less the same long-run value prior to 2020, while the ongoing realignment of the indicators seen recently suggests that this is still true post-COVID. Of course, one cannot rule out the possibility that the equilibrium value of ZVU may have shifted after COVID hit given that such a shift would be almost impossible to estimate with any precision within such a short sample period; if so, the ZVU-U^* measure may overstate or understate the actual inflationary pressure recently coming from the labor market. That said, the results reported by both Bernanke and Blanchard and Cecchetti and others show that one can account for recent movements in inflation using a Phillips curve in which labor utilization is measured using V/U rather than the unemployment rate, with the long-run sustainable level of the former implicitly or explicitly assumed to be unchanged post-COVID.

made by the primary dealers, the large financial institutions who serve as the trading counterparties to the Federal Reserve's open-market operations. Specifically, the solid lines show the medians of the projections made by these institutions roughly a week or so before the same four FOMC meetings and subsequently reported in the New York Fed's *Survey of Primary Dealers* (SPD) when the FOMC minutes are released.[21] The SPD projections likely have no direct effect on the FOMC's projections because committee participants, who submit their individual projections prior to each meeting and generally do not modify them before they are summarized at the postmeeting press conference, are first briefed on the SPD results at the meeting.

The three figures show that FOMC participants and the primary dealers have consistently had quite similar views about the evolving outlook since COVID hit.[22] In many respects, this similarity is not all that surprising: As Reifschneider and Tulip (2015) document, the forecast errors made by the FOMC in recent decades have been about the same as those made by other forecasters, presumably because everyone has access to essentially the same set of information. Nevertheless, the similarity is particularly striking in the case of core PCE inflation, where for each forecast date the inflation paths projected by the two groups differ by at most a tenth or two (figure 4). With regard to changes in the projected inflation paths over time, neither group anticipated the 2021-22 surge, and both were slow to recognize how high it would go until past the actual peak. In addition, both groups always expected core PCE inflation (as well as headline PCE inflation, not shown) to fall back to around 2 percent within two or three years. As for the unemployment rate, both groups initially underestimated the speed at which the labor market would recover, and later, after inflation surged, both came to anticipate that the unemployment rate would likely overshoot its longer-run level for a time before gradually converging to around 4 percent in the longer run (figure 5). Finally, both the FOMC and the primary dealers projected in late 2020 that the federal funds rate would likely remain near zero through late 2023, the last year of the medium-term forecast period for that release (figure 6). Then, with inflation surging and labor market conditions becoming increasingly robust, both shifted for a time to forecasting a steady rise in the federal funds rate for several years and later shifted again to projecting that the federal funds rate would overshoot its longer-run level for several years.[23]

[21] There are currently 24 primary dealers, although not all of them necessarily answer all the survey questions. One question with the use of this survey is the degree to which the reported projections are representative of the views of market participants overall; unfortunately, the answer is unknowable owing to a lack of data. That said, the Federal Reserve Bank of New York also regularly conducts a survey of roughly 30 other major financial market participants, and the federal funds rate projections reported there are quite similar to those reported in the primary dealers survey. Because the latter *Survey of Market Participants* provides less detail on other aspects of the expected economic outlook, however, it is not used for this study.

[22] In the case of the FOMC, the plotted values in the first three quarters of each year are linear interpolations of the end-of-year projections reported in the *Summary of Economic Projections*. As a result, the trajectories of these plotted paths are probably smoother than what FOMC participants actually anticipated, particularly in the case of the federal funds rate. The same is true for the plotted projections of inflation and the unemployment rate for the primary dealers. The plotted SPD projections for the federal funds rate, however, are much less affected by such smoothing because the *Survey of Primary Dealers* reports median expectations for the federal funds rate on a meeting-by-meeting basis or end-of-quarter basis for the first two or three years of the projection period. As a result, the plotted SPD projections are affected by interpolation only for years well into the future.

[23] With regard to long-run inflation expectations, from 2020 on both the FOMC participants and the primary dealers always projected it to equal 2 percent. For the unemployment rate, the median of its projected longer-run value reported in releases of the SEP equaled 4.1 percent from June through December 2020 and 4 percent thereafter until December 2023, when it ticked up again to 4.1 percent. Similarly, the median estimate of the long-run

Each group's forecasts for real activity, inflation, and the federal funds rate can be used to infer its implicit expectations for the degree to which future monetary policy would deviate from the prescriptions of the BA rule. To do that for the version of the BA rule used in this study, however, requires projections of V/U, which unfortunately neither the FOMC nor the primary dealers provide. But without going too far out on a limb, one can make a reasonable guess about what their expectations for this labor indicator would have looked like. To do this, let us assume that forecasters at time *t* would have projected the rescaled ratio *j* quarters ahead, $\widehat{ZVU}_{t,j}$, using the rule of thumb

$$\widehat{ZVU}_{t,j} = \widehat{U}_{t,j} + \widehat{\omega}_{t,j},\ \ \widehat{\omega}_{t,0} = \omega_t \text{ and } \widehat{\omega}_{t,j} = \rho\widehat{\omega}_{t,j-1} \text{ for } j>0\,.$$

In this expression, $\widehat{U}_{t,j}$ is the forecaster's expectation at time *t* for the unemployment rate *j* quarters ahead, and $\widehat{\omega}_{t,j}$ is the expected path of the difference between the rescaled ratio of vacancies to unemployment and the unemployment rate. At each forecast date, the wedge $\widehat{\omega}_{t,j}$ is initially assumed to equal its last observed actual value, ω_t. Thereafter, $\widehat{\omega}_{t,j}$ declines geometrically at quarterly rate ρ, implying that in the long run $\widehat{ZVU}_{t,j}$ converges to $\widehat{U}_{t,j}$. Using this method with $\rho = 0.9$, figure 7 shows what the forecasts of ZVU would have looked like.[24]

Using these projections of real activity, core inflation, and the federal funds rate, figure 8 shows the future paths of the deviations from the BA rule implicitly expected by FOMC participants and the primary dealers at different points in time. This exercise is not particularly informative for forecasts made in 2020 because FOMC participants and the primary dealers at the time both expected, and the rule called for, the federal funds rate to be stuck at the ELB well into the future. From 2021 on, however, both groups implicitly anticipated that the federal funds rate would run persistently well below the prescriptions of the rule for two or three years before gradually returning to a more neutral stance. Moreover, by this metric both the FOMC and the primary dealers have always been in fairly close agreement since COVID hit about the extent to which future policy would be comparatively easy.

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unemployment rate reported in the SPD equaled 4.3 percent in June 2020 and 4 percent in all subsequent releases except in September 2023, when it briefly ticked up to 4.05 percent. Since COVID hit, the medians of FOMC participants' expectations for the longer-run level of the federal funds rate have always equaled 2½ percent, implying a constant estimate of R^* equal to 50 basis points. Over the same period, the corresponding medians reported in the SPD varied a bit but always stayed within a relatively narrow range of 2¼-2¾ percent, so that their estimates of R^* have always been between 25 and 75 basis points.

[24] The fading-away property of the hypothetical ZVU projections is consistent with the economic projections made by the FOMC and the primary dealers, as they always showed inflation, real activity, and interest rates stabilizing in the longer run, thereby implying that they always anticipated that the initial post-COVID disruptions to labor market functioning would dissipate over time. Accordingly, these forecasters do not appear to have shared the pessimistic view of Blanchard, Domash, and Summers (2022) that the Beveridge curve was unlikely to revert to the pre-COVID relationship over the foreseeable future but instead implicitly agreed with the more optimistic view expressed by Figura and Waller (2022). Of course, forecasters' real-time expectations for the speed at which the wedge between ZVU and U would dissipate are unknowable, and so setting $\rho = 0.9$ is somewhat arbitrary. Calibrating this parameter to the actual average rate of decline in the wedge between its peak in early 2022 and its current value would have yielded a lower value, 0.84, thereby causing the constructed expected future deviations from the BA rule to be less persistent than shown in figure 8. But it seems unlikely that forecasters would have anticipated labor market functioning to recover as fast as it has, particularly early on when the wedge was rising.

If the FOMC had announced in early 2021 that it intended to follow the counterfactual policy described in the prior section, how might the forward guidance implicitly provided by FOMC participants' forecasts have changed? Presumably, the median SEP forecasts for real activity, inflation, and interest rates in this counterfactual world would no longer imply any future deviations from the rule. And in that case, how might the expectations of the primary dealers and others in the financial markets have responded? In the base-case simulations reported below, financial market participants are assumed to be both well-informed about the economic implications of changes in monetary policy and to regard the change in the FOMC's forward guidance as completely credible. (In other simulations, households and other agents are, less realistically, also assumed to be similarly well-informed.) As a result, the anticipated future deviations from the rule implicit in the baseline expectations of well-informed agents disappear in the simulations of the counterfactual strategy. This assumption does not mean, however, that well-informed agents have perfect foresight about how economic conditions will unfold in the future. Instead, their expectations at each point in time for the future paths of the federal funds rate, inflation, and real activity in the simulations are based only on the shocks to real activity and inflation that had already manifested themselves in their real-time projections, not on the unanticipated shocks that had yet to occur.

The perfect credibility assumption used in the simulation analysis raises the question of how even sophisticated financial market participants might have initially greeted an announcement in early 2021 that the unemployment rate would no longer be used to gauge labor utilization. Certainly, the communication challenges for the FOMC would have been considerable given both the historical centrality of the unemployment rate in public discussions and a general lack of public familiarity with V/U at the time. Under the circumstances, the announcement of the counterfactual rule-based strategy might not have been initially viewed as completely credible until the FOMC had demonstrated its commitment through concrete actions, particularly as the motivation for focusing on V/U instead of the unemployment rate probably would not have been clear until later in 2021. If so, then the simulation results reported below will tend to overstate the economic consequences of the more restrictive counterfactual strategy to some degree.

4. Quantitative easing and term premium effects

The third and last policy tool used by the FOMC in the wake of COVID was large-scale purchases of Treasury securities and agency mortgage-backed securities (MBSs).[25] This section begins by reviewing the quantitative easing actions that the Federal Reserve took after COVID hit and the evolving objectives of those actions. It then proposes an alternative path for the Federal Reserve's asset holdings to accompany the adoption of the more restrictive rule-based strategy and the accompanying adjustment to forward guidance outlined above. Under the counterfactual QE policy, the FOMC would have announced in early 2021 that it intended to

[25] Agency MBSs are issued by the Government National Mortgage Association (Ginnie Mae), the Federal National Mortgage Association (Fannie Mae), and the Federal Home Loan Mortgage Corporation (Freddie Mac). Ginnie Mae obligations are officially backed by the full faith and credit of the US government, and Fannie Mae and Freddie Mac obligations have effectively enjoyed this status since 2008, when both agencies were placed in conservatorship by the US government. Agency MBSs are therefore similar to Treasury securities with respect to default risk given the agencies' pledge to buy back any loans in the underlying pools that default.

quickly suspend asset purchases and cease the reinvestment of principal and earnings on its holdings, thereby causing the size of the Fed's balance sheet to peak at a much lower level and then return it to a more normal ratio to nominal GDP earlier than currently anticipated under the FOMC's actual policy. The section concludes with a discussion of the likely effect of the counterfactual QE policy on term premiums, the channel through which asset purchases influence financial conditions, real activity, and inflation in the macro model simulations.

To begin, in mid-March 2020 the FOMC announced that, in conjunction with cutting the federal funds rate to near zero, it would increase its holdings of Treasury securities by at least $500 billion, increase its holdings of agency MBSs by at least $200 billion, and reinvest all principal payments on its holdings in these securities. Subsequent meeting statements through November 2020 advised that purchases would continue at a rapid pace, with the result that the overall size of the Federal Reserve's balance sheet exploded from $4.2 trillion in February to $7.3 trillion by the end of the year. Thereafter purchases continued at a more moderate pace through April 2022, at which point the Federal Reserve stopped its large-scale asset purchase program altogether and ended its policy of reinvesting principal repayments, thereby allowing its portfolio to shrink passively. All told, the size of the Federal Reserve's balance sheet rose from less than 20 percent of nominal GDP pre-COVID to over 35 percent in early 2022; holdings have since declined to around 28 percent of GDP, and in December 2023 the primary dealers projected that they will fall below 23 percent by late 2025 (blue line of figure 9).

The Fed's large-scale asset purchases had two objectives. The first was to ease the widespread financial market stress that developed in the spring of 2020, when even the normally smooth functioning of the huge Treasury market was temporarily impaired. As financial market stress declined appreciably over the course of 2020, the main objective shifted to providing additional economic support in an environment in which the federal funds rate was expected to remain stuck at the ELB for some time to come. By purchasing longer-term Treasury securities and MBSs in volume, with those purchases funded by expanding the amount of short-term commercial bank reserves held at the Federal Reserve, the Federal Reserve would reduce the stock of long-duration, high-quality, interest-bearing securities available for investors to hold. In principle, that reduction would cause term premiums for these and other assets to fall, all else equal, thereby pushing down long-term interest rates even while short-term interest rates were trapped at the ELB. Lower bond yields in turn would help to support aggregate spending by reducing loan rates to businesses and households, supporting equity valuations, and putting downward pressure on the real exchange rate.[26]

What alternative path for the Fed's balance sheet might have been consistent with the FOMC announcing in early 2021 that the federal funds rate would from then on strictly follow the BA rule with labor utilization gauged by V/U? The answer is unclear because there is no generally accepted benchmark rule for how to adjust the size of the Federal Reserve's asset holdings in response to changing economic conditions.[27] The lack of a benchmark reflects in large part

[26]See Kuttner (2018) for a general overview of these and other possible effects of large-scale asset purchases.
[27] This not to say that no rules have been proposed; see Gagnon and Sack (2018) for an example. Also, Kiley (2018), Chung and others (2019), and Bernanke (2020) have used stochastic simulations of the FRB/US model to explore the consequences of employing illustrative simple rules for adjusting the size of the Fed's balance sheet in response to changes in economic conditions in environments in which the ELB periodically binds.

considerable uncertainty about the quantitative effects of asset purchases on financial conditions, real activity, and inflation; as Kuttner (2018) and Kim, Laubach, and Wei (2020) document, the range of estimates is wide. Another complicating factor is that, once free of the ELB, adjustments in the level of the federal funds rate can substitute for adjustments in the size of the FOMC's balance sheet, making the "optimal" setting of each tool dependent on the other; see Crawley and others (2022).

For these reasons, the paper takes the simple approach of defining the QE portion of the counterfactual monetary policy as a fixed alternative path for the Fed's asset holdings, expressed as a percentage of GDP (red line of figure 9). In 2020 the counterfactual QE policy is the same as the one the FOMC actually implemented: With the federal funds rate at the ELB, widespread financial market stress, extremely weak labor market conditions, and highly uncertain prospects for economic recovery, a massive expansion of the balance sheet was appropriate at the time. A different situation arguably prevailed starting in 2021, however, with financial markets operating normally, the labor market recovering more quickly than had been anticipated, and inflation unexpectedly surging. Under those circumstances, it seems reasonable to assume that the FOMC would have paired an announcement of the counterfactual rule-based interest rate strategy with more restrictive guidance about the future path of its asset holdings. Specifically, under the counterfactual QE policy, the FOMC would have announced at the beginning of 2021 that it is ending its purchase program and will no longer reinvest principal and interest payments, thereby putting its holdings of Treasury securities and agency MBSs as a percent of GDP on a steady downward path that would have tracked well below the actual one. For convenience, this alternative "autopilot" path is assumed to be independent of movements in the federal funds rate or other changes in economic conditions.

What effect might this counterfactual QE strategy have had on term premiums, the primary channel through which asset purchases influence economic activity in the model simulations reported below?[28] Crawley and others (2022) report results that can be used to answer this question. Among other things, they estimate how alternative scenarios for the evolution of the Fed's balance sheet from 2022 to 2027 would shift the projected path of term premiums. To do this, they use the arbitrage-free term structure model developed by Li and Wei (2013), which has the feature that term premiums today depend in part on the expected future path of the duration-adjusted stock of Treasury securities and agency MBSs held by the public, expressed as a ratio to nominal GDP. Although none of their balance sheet scenarios correspond exactly to the counterfactual policy proposed here, their results suggest that the 10-year Treasury term premium would have jumped about 35 basis points in early 2021 relative to baseline in response to the FOMC's announcement of the counterfactual QE policy, based on the average difference from 2021 to 2025 between the counterfactual path and the actual and SPD-projected path of asset holdings.[29] Thereafter, the initial 10-year term premium effect relative to baseline would

[28] In the versions of the FRB/US model used in the simulation analysis, asset purchases can also influence economic activity by reducing the risk and liquidity premiums embedded in mortgage rates and other assets. These additional QE channels are assumed not to be at work in the model simulations, however, because financial markets had more or less resumed normal functioning by early 2021.

[29] This estimate is based on the following back-of-the-envelope calculation. Crawley and others (2022) present term premium estimates for three balance sheet scenarios—a baseline path, a no-runoff path, and a full-runoff path. Based on their implementation of the Li-Wei term model, the announcement of their no-runoff path in early 2022 causes the 10-year term premium to immediately fall 50 basis points relative to baseline. Expressed as a percent of GDP,

have faded gradually and by late 2025 be close to zero, given that the difference between the baseline path and the counterfactual path would be quite small by that point and would presumably be expected to disappear altogether in the near future.

5. Inflation dynamics and monetary policy

Rerunning history to see what might have happened to inflation had the FOMC followed the proposed counterfactual strategy involves simulating its effects using a complete model of the macroeconomy. In such an exercise, the specification of the macro model's wage and price equations—that is, its Phillips curve—is of central importance. Because there is considerable debate currently about the "true" dynamics of wages and prices, fueled in large part by the failure of almost all forecasters to anticipate the recent inflation surge, this paper takes the approach of simulating the effects of changes in monetary policy using four different specifications of the Phillips curve, with each one in turn embedded in the structure of FRB/US, a large-scale estimated model of the US economy developed and maintained at the Federal Reserve Board.[30] One of these specifications is based on the wage and price equations in the standard version of the FRB/US model, whereas the other three are drawn from recent empirical studies. This section begins by discussing the properties of the different Phillips curve specifications. It then reviews their implications for the response of real activity and inflation to illustrative shocks to monetary policy in the context of the full model, setting the stage for the presentation in the next section of the simulated effects of the counterfactual monetary policy contemplated in this paper.

Beginning with the standard FRB/US specification, its Phillips curve is a complicated wage-price system with a New Keynesian design based on Cogley and Sbordone (2008) in which the two key equations are for the employment cost index (ECI) measure of hourly compensation and core PCE prices, both estimated using data from 1987 to 2017.[31] In this system, costly adjustment of wages and prices causes inflation to depend on both lagged actual inflation and expected near-term inflation, all expressed relative to 'trend' inflation, where the latter is defined using a survey-based measure of expected long-run inflation. In addition, actual and expected inflation depend on resource utilization because of its association with movements in marginal

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the difference between expected holdings along the no-runoff path and along the baseline path equals 6.6 percentage points on average from 2022 to 2026. By comparison, the average 2021-25 difference between the counterfactual holdings path considered here and the actual and SPD-projected path is -4.6 percentage points. Thus, the announcement effect of the counterfactual QE strategy should be roughly equal to -50*(-4.6/6.6), or 35 basis points. Calibrating the term premium effect of the counterfactual QE policy using their estimates for their full-runoff scenario yields a slightly smaller figure.

[30] FRB/US has been used extensively to analyze a wide range of policy issues and to assist the Federal Reserve staff in forecasting. Complete documentation of the model's equations and properties, as well as links to related research papers, can be found at the FRB/US project website, www.federalreserve.gov/econres/us-models-about.htm. Laforte (2018) provides an overview of the current version of the model. As the FRB staff note on the website, the specification of FRB/US assumes optimizing behavior on the part of forward-looking households, nonfinancial firms, and financial market participants, and in that sense is similar in spirit to the design of DSGE models. But as the staff also note, in comparison to DSGE models, "FRB/US applies optimization theory more flexibly, which permits its equations to better capture patterns in historical data and facilitates modeling the economy in greater detail."

[31] In addition, the FRB/US Phillips curve includes various auxiliary equations used to determine headline PCE prices, nonpetroleum import prices, and the prices of the major components of GDP.

costs, with utilization measured by the unemployment rate less a time-varying estimate of *U**. Finally, the FRB/US wage and price equations include additional explanatory terms to control for the effects on headline and core inflation of a variety of identifiable exogenous "shocks," including such things as movements in the relative prices of food, energy, and imports; the imposition of wage and price controls in the early 1970s; exogenous shifts in trend productivity and *U**; and so forth.[32]

The dynamics of the FRB/US Phillips curve, and in general those of the other specifications considered in this paper, have several important implications for monetary policy:

- Long-run inflation expectations are reasonably well anchored in simulations and respond only slowly to movements in actual inflation, consistent with the observed behavior of survey measures over the past 30 years. That said, the experience of the 1960s through the late 1980s shows that this stability is not structural but instead depends on the commitment of monetary policymakers to keeping inflation low and stable.
- Movements in labor utilization are estimated to account for only a small portion of the quarter-to-quarter or year-to-year movements in inflation seen historically, even prior to the late 1980s. Instead, short-run deviations of headline and core inflation from trend primarily reflect the effects of exogenous disturbances of various sorts, either identifiable ones, such as movements in the relative prices of food, energy, and imports, or unexplained shocks.
- As long as long-run inflation expectations are slow to respond to movements in actual inflation and other factors, the ability of monetary policy to influence inflation in the short to medium run primarily depends on three things: the sensitivity of real activity and labor utilization to changes in policy, the direct sensitivity of inflation to resource utilization (that is, the slope of the Phillips curve), and the speed at which inflation adjusts to utilization pressures. The flatter the slope and the slower the speed, the less effective a given policy action will be in checking undesirable movements in inflation from year to year. In this regard, the FRB/US Phillips curve is rather flat and adjustment is gradual.
- Finally, and perhaps most importantly, temporarily tight or weak labor market conditions have no persistent effect on inflation as long as long-run inflation expectations remain reasonably well anchored. But if these expectations are instead allowed to drift appreciably in response to movements in inflation or other factors, perhaps because the FOMC fails to convince the public about its commitment to keep inflation under control, then allowing the economy to run hot (cold) for a time will cause inflation to be permanently higher (lower) unless offset by a subsequent period of weak (strong) economic conditions. The same expectational dynamics apply to the longer-run inflation effects of transitory movements in the growth rates of relative food, energy, and import prices, and other temporary shocks.

For the purpose of gauging the post-COVID contribution of monetary policy to inflation, one issue with using the FRB/US wage and price equations is that, as noted earlier, they

[32] The FRB/US Phillips curve also incorporates an estimated "error-correction" mechanism that causes both wages and prices to adjust slowly over time to bring the ratio of prices to unit labor costs in line with the equilibrium markup. This mechanism has only a small effect on the dynamics of inflation in the short to medium run, however.

unsatisfactorily attribute most of the recent surge to unexplained shocks to wages and prices. On a Q4-over-Q4 basis, headline PCE inflation rose from just under 1½ percent in 2019 to almost 6 percent in both 2021 and 2022. Of this 4½ percentage point increase, the standard version of the model attributes about 2¾ percentage points averaged across the two years to unexplained post-COVID shocks, a little under 1 percentage point to increases in relative food and energy prices, and almost a percentage point to other factors, including labor utilization but also other factors. Another potential issue is that, while the FRB/US Phillips curve is essentially linear, there are reasons to suspect that inflation dynamics may actually be nonlinear.[33] If so, then the actual effect of changes in monetary policy on inflation may differ appreciably from the predictions of the standard version of FRB/US.

To a degree, these issues with the FRB/US wage and price equations are addressed by the three alternative specifications of the Phillips curve drawn from recent studies: a linear wage-price system estimated by Bernanke and Blanchard (2023), a mildly nonlinear Phillips curve estimated Cecchetti and others (2023), and a more highly nonlinear set of wage and price equations estimated by Gagnon and Collins (2019). Details are provided in the appendix. The following summarizes the key features of the three alternative specifications and how they differ from the standard FRB/US Phillips curve:

- Similar to the one in FRB/US, the wage-price system in Bernanke and Blanchard has ECI labor costs influencing consumer prices and vice versa. In contrast, the Phillips curve specification derived from the Gagnon-Collins study has separate equations for ECI wage growth and inflation without any interaction of wages and prices. The Phillips curve specification derived from Cecchetti and others explains core PCE inflation alone without conditioning on wages.[34]
- Like the FRB/US specification, all three alternative Phillips curves are estimated using pre-COVID data only. However, the start dates of their estimation periods differ appreciably in the case of the inflation equation, ranging from the late 1950s and early 1960s in the case of Gagnon and Collins and Cecchetti and others to 1990 in the case of Bernanke and Blanchard. Both Bernanke and Blanchard and Gagnon and Collins use similar start dates for estimating their ECI equations, 1990 and 1984, respectively, because of limited data availability.
- The specifications derived from Bernanke and Blanchard and Cecchetti and others use V/U as their measure of labor utilization, in contrast to the unemployment measure used

[33] One possible nonlinearity arises from the fact that, as documented by Fallick, Villar, and Wascher (2020), there is a pileup at zero in the distribution of individual changes in nominal wage rates when aggregate wage growth has been low in the recent past because workers are extremely reluctant to accept actual reductions in nominal wage rates. Because of this reluctance, the pressure on wage costs and prices exerted by labor utilization should depend in part on the prevailing trend inflation rate.
[34] Because the main price inflation measure varies across the four Phillips curve specifications, incorporating the alternative specifications into FRB/US requires additional simple bridge equations that link movements in core CPI inflation to movements in headline CPI inflation (or vice versa, depending on the main price measure), and movements in core PCE to movements in core CPI inflation (or again, vice versa). As a result, all four specifications control for the direct effect of movements in the relative prices of food and energy on headline inflation in a consistent manner. In addition, the bridge equation linking core CPI inflation to core PCE inflation (or vice versa) controls for the greater cyclical sensitivity of the former relative to the latter, again in a consistent manner.

in both the specification preferred by Gagnon and Collins and the standard FRB/US specification.

- Inflation responds nonlinearly to labor utilization in the Phillips curves derived from the "hot/cold" specification preferred by Cecchetti and others as well as in the "low-inflation-bend" specification preferred by Gagnon and Collins. In the former, weak labor market conditions are estimated to put almost no downward pressure on inflation whereas strong conditions act to boost it modestly. In the latter, inflation is estimated to be quite responsive to labor utilization except when trend inflation and labor utilization are both low, in which case inflation becomes almost completely insensitive to slack.[35] In contrast, the Bernanke-Blanchard and the standard FRB/US specifications respond linearly and modestly to movements in labor utilization.[36]
- In contrast to the FRB/US and the Gagnon-Collins specifications, the Phillip curves proposed by Bernanke and Blanchard and by Cecchetti and others attempt to control for the effects of disruptions to aggregate supply by including an additional explanatory term intended to proxy for such effects. In the former, this term is an index of Google searches related to supply chain disruptions; in the latter, it is the manufacturing supplier deliveries index published by the Institute of Supply Management (ISM).
- The Phillips curves estimated by Bernanke and Blanchard and by Cecchetti and others include explicit measures of long-run expected inflation as explanatory variables, as does the FRB/US specification. In contrast, the Gagnon and Collins specification does not include any explicit expected inflation terms but implicitly treats them as adaptive.
- The inherent persistence of inflation varies across the different specifications. Controlling for long-run inflation expectations, persistence is relatively low in both the preferred Bernanke-Blanchard specification and in the standard FRB/US specification compared to the preferred specification of Cecchetti and others, reflecting in part the use of a longer estimation period for the latter. Persistence in the preferred Gagnon-Collins specification is also relatively low.
- In the specifications proposed by Bernanke and Blanchard and Cecchetti and others, as in the standard FRB/US Phillips curve, long-run inflation expectations respond slowly to movements in actual inflation. In the Cecchetti and others and the FRB/US versions,

[35] Specifically, Gagnon and Collins estimate that the responsiveness of inflation to labor utilization falls almost to zero in states where the eight-quarter moving average of core CPI inflation is less than 3 percent and the unemployment rate is simultaneously greater than the Congressional Budget Office's estimate of the noncyclical rate of unemployment (that is, U*).

[36] Because the specifications by Bernanke and Blanchard and Cecchetti and others use V/U to measure labor conditions instead of the unemployment rate, their estimated slope coefficients must be adjusted before they can be compared to the U-based ones of the Gagnon-Collins and standard FRB/US specifications. A simple way to make this adjustment is to multiply the sum of the estimated V/U slope coefficients (-0.6934 in the case of the Bernanke-Blanchard linear specification and -0.6824 in the case of the Cecchetti and others for a "hot" labor market) by the ratio of the historical standard deviations of V/U and U. From 1990Q1 to 2019Q4, this ratio equals 0.26/1.60, or 0.1625, which implies that the slope of these two Phillips curves is about -0.11 in unemployment space. In contrast, the Gagnon and Collins estimate of the slope in a high inflation environment equals -0.63—roughly six times as steep. Determining the effective slope of the Phillips curve in unemployment space in the standard FRB/US model is not straightforward because of its more complicated expectational structure, but a back-of-the-envelope calculation suggests that its slope is about the same as the Bernanke-Blanchard specification; this calculation assumes that expectations are based on the forecasts of a small vector auto-regression (VAR) model. Note that these calculations of comparative slopes abstract from the effects of differences in the lag structures of the four Phillips curves or in their treatment of long-run inflation expectations.

long-run inflation expectations are also directly influenced by the FOMC's announced inflation target, which acts to limit the extent to which they can drift in simulation compared to the Bernanke-Blanchard specification.[37] In the Gagnon-Collins specification, no unit root is imposed on inflation and wage growth and thus long-run inflation expectations are implicitly fixed.[38]

As Bernanke and Blanchard and Cecchetti and others document, their preferred specifications do a reasonably good job of tracking recent movements in actual and expected inflation and, in the former case, movements in ECI wage growth as well, despite being estimated using only pre-COVID data. The reason they do so appears to be primarily as result of two things: the use of V/U in place of the unemployment rate to measure labor utilization, and their inclusion of terms that attempt to measure the effects of supply disruptions.[39] In contrast, the recent out-of-sample predictive performance of the Gagnon-Collins model is less clear. As Gagnon recently notes, this specification would require a large temporary increase in the effective value of U* post-COVID to be able to account for the recent surge in inflation and its subsequent moderation—that is to say, what amounts to large unexplained shocks, as in the standard FRB/US specification.[40]

Monetary policy is only one of many factors affecting inflation in the short to medium run. For that reason, the recent importance of unexplained shocks to the Gagnon-Collins and standard FRB/US specifications does not necessarily imply that either is a poor way to gauge the inflation effects of recent FOMC policy, as long as those shocks are more or less exogenous to changes in monetary policy. Symmetrically, the fact that the other two specifications are better able to account for recent inflation without resorting to unexplained shocks does not necessarily mean that they yield more reliable or even, as will soon be seen, materially different estimates of the inflation effects of the counterfactual policy.

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[37] Specifically, the updating formula for long-run inflation expectations used by financial market participants, nonfinancial firms, and households in the standard FRB/US simulations is $\pi_t^{LREXP} = .9\pi_{t-1}^{LREXP} + .05\pi_{t-1} + .05\pi_{t-1}^{*}$, where π_t^{LREXP} is expected long-run inflation, π_t is core PCE inflation expressed at an annual rate, and π_t^{*} is the FOMC's announced inflation target. As noted in the appendix, a similar formula is used in the simulations based on the Cecchetti and others Phillips curve. In both cases, agents change their long-run inflation expectations gradually in response to a permanent change in the target, abstracting from the effects of any accompanying changes in actual inflation.

[38] This statement needs to be qualified because Gagnon and Collins allow the intercept and the sum of the lagged inflation coefficients in their estimated core CPI and ECI equations to change over time. As a result, trend inflation in their model implicitly shifts over time and is estimated to be markedly higher from the late 1960s to 1994 than it was from 1995 to 2019. This shift presumably reflects systematic changes in monetary policy over the past 50 years, and thus their specification also implicitly allows for the possibility that a persistently lax monetary policy could cause these coefficients to shift again. The simulations reported below, however, hold these coefficients constant at their 1995-2019 estimated values.

[39] Both specifications (with their accompanying PCE-CPI bridge equations) are also more than able to account for the marked declines in both headline and core PCE inflation recorded in 2023, assuming that the Bernanke-Blanchard shortage variable has continued to gradually move back in line with its pre-COVID level after 2022, as the ISM index used by Cecchetti and others has. Both specifications estimate that the decline in V/U from its peak in 2022Q2 was a relatively minor factor in the 2023 moderation in headline PCE inflation, subtracting only three- or four-tenths of a percentage point; declines in relative food and energy prices and especially an easing of supply disruptions are estimated to have been much more important.

[40] See Joseph E. Gagnon, "Why US Inflation Surged in 2021 and What the Fed Should Do to Control It," Peterson Institute for International Economics, Real-time Economics Blog (March 11, 2022), www.piie.com/blogs/realtime-economic-issues-watch/why-us-inflation-surged-2021-and-what-fed-should-do-control-it.

Regardless of which specification of the Phillips curve is incorporated into the overall FRB/US model, its monetary transmission mechanism can be roughly characterized as follows. The primary way the FOMC influences the economy is through policy actions and forward guidance that influence the expectations of financial market participants and others about the future path of the federal funds rate. If the FOMC acts to raise the average level of this expected path, corporate bond yields, residential mortgage rates, and other borrowing costs rise, corporate equity prices and household wealth fall, and the real exchange rate appreciates, all else equal. This general tightening in financial conditions, which is augmented in simulations by endogenous increases in risk and term premiums, as well as additional QE-driven exogenous shifts in term premiums, in turn puts direct downward pressure on consumer spending, residential and nonresidential investment, and net exports; weaker spending in turn prompts firms to reduce employment and hours. Magnifying these direct financial effects on aggregate spending and the labor market are additional expectational effects as households and firms become more pessimistic about future income and sales. Finally, current wage growth and price inflation moderate in response to the decline in resource utilization and the implications it has for expected future inflation as described above.

To simulate the effects of monetary policy using the four different Phillips curves as well as the BA rule, the standard model must be modified to include equations for V/U and ZVU. Consistent with its behavior pre-COVID, ZVU is assumed to move one for one with the unemployment rate relative to baseline, whereas the equation for V/U is the inverted rescaling formula.[41] This linearity assumption is important because of the possibility that tighter monetary policy would have altered the extent to which post-COVID labor market disruptions caused the Beveridge curve first to shift up and later begin shifting back. Presumably, tighter policy would not have improved labor market functioning, implying that it would not have caused a larger increase in ZVU relative to history compared to the accompanying increase in the unemployment rate. But there is the possibility that it might have worsened labor market functioning, thereby resulting in a smaller increase in ZVU relative to the unemployment rate than the model would predict and so causing the simulations to overstate the actual ability of tighter monetary policy to have reduced inflationary pressures arising from an overheated labor market.[42]

Figure 10 illustrates the dynamics of the FRB/US transmission mechanism by showing the simulated full-model response of interest rates, real activity, and inflation to a percentage point hike in the federal funds rate that the FOMC announces will last for four quarters, with monetary

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[41] The inverted formula is $V/U_t = 1.107 - 0.146\, ZVU_t + 0.005\, TTREND_t$, implying that a change in monetary policy that increases ZVU and U by one percentage point reduces V/U by -0.146. The intercept and the time trend are suppressed in simulations of the model without any effect on results because baseline tracking residuals are applied to all the model's equations.

[42] A somewhat different possibility is implied by the analysis in Figura and Waller (2022) of the forces that led to an upward shift in the Beveridge curve after COVID hit. In that study, they suggested that the upward shift might unwind by vacancies declining appreciably without the unemployment rate rising—a prediction that appears to have been correct. In principle, these same dynamics may suggest that firms would have responded to tighter monetary policy and thus weaker sales by, relative to their actual paths from 2021 to 2023, reducing posted job openings noticeably while simultaneously cutting employment by less than would be expected based on its historical relationship to aggregate output. If so, then the FRB/US simulations would tend to overstate the effect of the counterfactual monetary policy on the unemployment rate while perhaps accurately gauging its effect on V/U.

policy thereafter following the prescriptions of the BA rule. The simulations are run using the four different specifications of the Phillips curve and a baseline consistent with being in the steep portion of the nonlinear Phillips curves estimated by Cecchetti and others and by Gagnon and Collins, as has been the case for the US economy since 2021. In the simulations, financial market participants are assumed to be well-informed about the economic implications of the FOMC's announcement, which they treat as completely credible; specifically, their expectations are assumed to be consistent with the predictions of the full model. In contrast, households and other economic agents are assumed to be less well-informed and revise their expectations in line with the average historical behavior of the economy in response to observed changes in economic conditions as they occur, based on the predictions of a small VAR model.

As the figure shows, the temporary rise in the federal funds rate causes real activity to weaken appreciably for a time, with the peak effect occurring about a year and a half after the initial hike; these effects are largely the same across all four Phillips curves. In contrast, inflation responses are extremely modest across all the specifications, with the limited exception of the highly nonlinear Gagnon-Collins version, where the peak decline in inflation is similar in magnitude to the peak increase in the unemployment rate. Nevertheless, the results for even this optimistic trade-off case would not seem to suggest much of an ability for monetary policy to check undesirable short-run movements in inflation: Taken literally, they imply that the FOMC would have had to hike the federal funds rate by 30 percentage points in early 2021 to keep headline PCE inflation near 2 percent in 2022.[43]

These effects may seem surprisingly small given the standard view that Fed monetary policy played a major role in first allowing trend inflation to rise to a high level during the 1970s, then engineering a major disinflation over the course of the 1980s and early 1990s, and finally anchoring the trend at around 2 percent thereafter (at least prior to COVID). For three of the specifications, the difference between the simulation results and the inflation dynamics of the 1970-90 period partly reflects currently estimated slopes of the Phillips curve that are much lower than those estimated back in the 1980s, which were derived using data from a period in which inflation was quite volatile and persistent. In contrast, the direct short-run effects of resource utilization on inflation in the steep portion of the Gagnon-Collins Phillips curve are similar in magnitude to estimates reported in the mid-1980s; for example, the estimated Phillips curves reported by Gordon and Hall (1985) have slope coefficients—after adjustment to put them on an unemployment basis—that are also roughly equal to -0.6. The difference, however, is that resource utilization effects on inflation are symmetric in the Gordon-Hall specification and, more importantly, are much more persistent, with no apparent anchoring of long-run inflation expectations, unlike the situation since the mid-1990s.

Although these simulation results help to illustrate the basic dynamics of FRB/US, they are only so useful in gauging what the counterfactual monetary policy might have accomplished: Not only does a temporary hike in the federal funds rate differ importantly from a permanent switch to a rule-based policy, but the counterfactual strategy also incorporates important changes in

[43] If the baseline had instead been constructed to mimic conditions in the years immediately prior to COVID, then the Gagnon-Collins specification would have generated essentially no response of inflation to the hike in the federal funds rate. Similarly, inflation would be essentially unaffected by the policy shock in the Cecchetti and others version if the unemployment rate had been greater than U^* in the baseline.

forward guidance and QE policy—things not at play in figure 10. To get a sense of how forward guidance operates in the model, figure 11 compares the effects of unannounced and preannounced temporary hikes in the federal funds rate using the standard version of the FRB/US Phillips curve. (Effects using the other three versions are similar.) Again, financial market participants are assumed to have model-consistent expectations and to view the announced hikes as completely credible, whereas households and other agents are less well-informed and do not react directly to the hikes until they occur. The main takeaway from the figure is that forward guidance in FRB/US, if credible, has an immediate effect on long-term interest rates and other financial conditions that influence real activity and inflation in advance of the actual change in the federal funds rate. In fact, the economic effects of a preannounced temporary tightening are actually larger than those of an unexpected one because households and nonfinancial firms have more time to adjust to the tighter financial conditions.[44]

Finally, figure 12 illustrates the effects in FRB/US of a jump in term premiums that thereafter gradually fades away, using the four different versions of the Phillips curve and the same expectational assumptions. The size of the initial jump in the 10-year term premium and its subsequent path is calibrated to match that estimated in the previous section to accompany the counterfactual QE policy; consistent with previous research using the Li-Wei term structure model, accompanying shifts in 5-year and 30-year term premiums are scaled by 0.70 and 0.30 of the 10-year shift.[45] Real activity declines in response to tighter financial conditions created by the higher term premiums, with the peak effect on unemployment occurring two years after the initial shock. Again, inflation is little affected. In response to these weaker economic conditions, the BA rule prescribes a modestly lower path of the federal funds rate, which serves to mitigate somewhat the contractionary effects of the higher term premiums—an effect that illustrates the way in which QE actions can serve as a partial substitute for interest rate actions.

6. Simulation results for the counterfactual strategy

With the basic dynamics of FRB/US established, the paper now turns to a full-model assessment of how conditions might have evolved under the counterfactual monetary policy. In doing so, the base-case assumption continues to be that financial market participants are well-informed about the economic implications of changes in monetary policy and have no doubt that the FOMC will strictly follow the prescriptions of the BA rule with V/U used to gauge labor utilization, whereas other agents are less well-informed and revise their expectations in line with the predictions of a small VAR model. However, financial market participants are *not* assumed to have perfect foresight about the specific path the federal funds rate would have eventually followed under the BA rule because that would have unrealistically required them to know in advance the future shocks to real activity and inflation that would drive the rule-based policy over time. Instead, the simulations assume that well-informed agents learn about these shocks only as they occur, as embodied in the evolution of the SPD projections from early 2021 to late 2023. To do this requires the use of a sequence of SPD-release-specific baselines for the simulations, where each

[44] This perhaps surprising behavior is sometimes referred to as the forward-guidance puzzle. As documented in Chung (2015), the effect in FRB/US appears to be appreciably smaller and hence more plausible than it is in some DSGE models of the US economy, such as the Federal Reserve Board’s Economic Dynamic Optimization (EDO) model and especially the well-known Smets-Wouters model.
[45] See, for example, Engen, Laubach, and Reifschneider (2015); Kiley (2018); and Bernanke (2020).

baseline corresponds to history up to the date of each release and the release's projections past that date. The model simulations then rerun events from early 2021 on subject to the evolving shocks to the economy embedded in the baselines, both realized and anticipated in the SPD projections, with the exception of the past and projected baseline deviations from the BA rule, which are set to zero. (See the appendix for further details.)

Figure 13 and table 1 summarize the model's predictions for how interest rates, real activity, and core inflation would have evolved relative to history and the December 2023 SPD projection if the FOMC had followed the counterfactual monetary policy beginning in early 2021. For all four versions of the Phillips curve, the simulations show the federal funds rate climbing much more rapidly in 2021 and 2022 than it actually did, peaking at just over 8 percent before beginning to decline steadily back toward its projected longer-run level as prescribed by the gradualist rule. In turn, the versions predict that these tighter financial conditions would have pushed the economy into a mild slump in which the unemployment rate would have climbed to around 5 percent by 2022 and stayed there into 2024, with V/U falling back to its pre-COVID level by 2024. Despite the weaker labor market conditions, however, the simulations generally predict that tighter monetary policy would have had little or no effect on the surge in inflation in 2021 and 2022 and only modest effects thereafter. Results using the Gagnon-Collins specification are somewhat of an exception: While this version of the model also suggests that the counterfactual monetary policy would have done little to check inflation in 2021, it does predict that inflation would have been reduced more appreciably later on, with PCE inflation reduced by a little over ½ percentage point in 2022 and slightly more than 1 percentage point in 2023.

Why are the predicted short-term inflation effects of the counterfactual strategy so modest? The primary reason was discussed in the previous section: The estimated slope of the Phillips curve is fairly low in all four cases, even in the Gagnon-Collins specification. Another limiting factor is that inflation is estimated to respond only gradually to changes in labor utilization in all four specifications. Moreover, in the three versions of the Phillips curve that explicitly control for movements in long-run inflation expectations (FRB/US, Bernanke and Blanchard, and Cecchetti and others), these expectations adjust slowly and only modestly to the policy-driven reduction in inflation, as shown in table 1. Thus, none of the specifications supports the claim that the FOMC should have been able to head off much if any of the inflation surge in 2021-22, although the Gagnon-Collins version does suggest that tighter policy could have brought inflation back to target somewhat faster than the other specifications.

Another factor limiting the ability of the counterfactual policy to check inflation involves the evolution of market expectations in the simulations, illustrated in figure 14 for the standard version of FRB/US. (Results generated using the three other versions of the model are similar.) In the simulations, when the new counterfactual policy would have been announced in early 2021, financial market participants would have initially anticipated that this alternative policy would hold the federal funds rate at the ELB through 2021 and then put it on a gradual upward trajectory back toward its expected long-run level—a path that would have been only marginally more restrictive than the one the primary dealers actually expected in March 2021 (see figure 6). This similarity reflects the fact that financial markets at the time did not anticipate either the coming surge in inflation or the speed at which the labor market would tighten, with the result that the announced change in policy would not have initially signaled a radically different future path for the federal funds rate. Given such a modest initial effect on expectations, long-term interest rates increased only slightly in early 2021 in the simulation relative to baseline, abstracting from the modest effect of the rise in term premiums caused by the announcement of the counterfactual QE policy. As a result, the switch to the alternative policy would not have initially caused overall financial conditions to tighten markedly, thereby limiting the policy's initial contractionary effect. Of course, as time passed the implications of the incoming news on inflation and real activity for the expected future path of the federal funds rate under the counterfactual policy would have been considerable. By 2021Q4, for example, the simulated expected path under the counterfactual policy for 2022-24 was almost 340 basis points higher on average than the one the primary dealers and the FOMC actually expected in December 2021. Nevertheless, because the full implications of the alternative policy for future interest rates would have taken time to emerge, and thereby increased the already substantial inherent lag in the effects of monetary policy on the economy, the FOMC would have had little ability to check inflationary pressures quickly.

For some of the Phillips curve specifications, the assumption that only financial markets are well-informed about the effects of the change in monetary policy acts to noticeably damp the response of inflation. Although this base-case assumption seems much more realistic than an alternative one in which nonfinancial firms and especially households are also well-informed, table 2 reports simulation results for the latter expectational case.[46] For the version of FRB/US that incorporates the model's standard wage and price equations, the effect is to modestly boost the inflation effects of the counterfactual policy because wage and price setters now recognize the persistence of the change in policy, which acts to boost their near-term inflation expectations and thus actual inflation relative to the results reported in table 1. Predicted inflation effects also increase in the Bernanke-Blanchard version of the model when all agents are well-informed, for the same reason. In both cases, the somewhat larger inflation effects result in somewhat smaller upward shifts in the path for the federal funds rate relative to baseline—something that helps to buffer the now more contractionary effects of shifts in expected household income and business sales under this expectational assumption. For the other two specifications of the Phillips curve, however, altering this expectational assumption matters less for inflation because the short-run inflation expectations implicit in these estimated inflation equations remain essentially adaptive.

The simulation results reported in tables 1 and 2 suggest that the counterfactual strategy would have resulted in a fairly moderate recession by historical standards. Even though the interest sensitivity of aggregate spending in FRB/US appears to be, if anything, somewhat larger than what a simple reduced-form equation would suggest,[47] one might nonetheless wonder about the

[46] In these simulations, all agents are assumed to update their long-run inflation expectations only gradually in response to persistent movements in actual inflation—the same assumption used when only financial market participants are well-informed.

[47] The simple equation is $x_t = 1.159x_{t-1} - 0.244x_{t-2} - 0.076\sum_{j=1}^{6}\left(r_{t-j} - r_{t-j}^*\right) - 0.0132 - 0.0004T_t$, where x_t is the Congressional Budget Office (CBO) measure of the output gap, r_t is the federal funds rate less the four-quarter rate of core PCE inflation, r_t^* is the Holston-Laubach-Williams estimate of the equilibrium real interest rate, and T_t is a linear time trend. The coefficients are from a regression using data from 1970Q3 to 2019Q4. When this equation is simulated subject to shocks to the 2021-25 path of the real federal funds rate calibrated to match those in the standard FRB/US simulation of the counterfactual monetary policy when financial market participants are well-informed, it predicts a 2 percentage point reduction in the output gap, somewhat smaller than the FRB/US prediction.

possibility of a more substantial contractionary response given that the economic effects of interest rate shocks are larger in some DSGE models than they are in FRB/US.[48] As a somewhat extreme test of this possibility, the simulations are rerun with the sensitivity of consumption, investment, and net exports to movements in the cost of capital, loan rates, household wealth, and the real exchange doubled; as in the base case, only financial market participants are assumed to be well-informed about the economic implications of the more restrictive policy. Results from this exercise are reported in table 3. As might be expected, the much greater interest sensitivity of spending causes real activity and inflation to decline more appreciably in response to the counterfactual policy even though the path of the federal funds rate is now somewhat lower relative to the standard sensitivity case. Nevertheless, inflation in 2021 remains essentially unchanged under all four specifications of the Phillips curve, although somewhat more substantial reductions in inflation are now predicted for 2022 and 2023.

One reaction to these simulation results might be that the counterfactual policy is too gradualist, and that the FOMC should have responded to the enactment of several major fiscal packages and other post-COVID developments by tightening even more quickly and aggressively in 2021. In that way, one might argue, the Fed could have done more to check the initial surge in inflation. Such a preemptive response would have been quite difficult for the FOMC to justify at the time, given that a nongradualist version of the balanced rule would have called for a negative federal funds rate as late as the April 2021 FOMC meeting.[49] Moreover, and as noted in the introduction, well past that date most outside forecasters did not see a need for a marked tightening in monetary policy. But if the FOMC had started tightening rapidly in early 2021, steadily raising the federal funds rate to around 5¾ percent by year's end with policy thereafter following the prescriptions of the gradualist balanced approach rule, then model simulations suggest that it would not have materially changed the predicted outcomes for real activity and inflation, for two reasons. First, well-informed financial market participants would have recognized that the more rapid upfront rise in short-term rates under this policy would be followed by a corresponding more rapid easing in 2022 and 2023, with the result that long-term interest rates and other financial factors are not greatly altered in the simulation relative to the base-case simulation results reported in table 1. Second, real activity and inflation respond to changes in financial conditions with a lag, which acts to damp their short-run responses to changes in financial conditions in the simulation.

Another reaction to these results might be that something important is missing from the FRB/US-based analysis. One possibility is that the FOMC's delay in tightening in 2021, or perhaps its adoption of flexible average inflation targeting in August 2020, spurred some change in inflation dynamics not captured by the different specifications of the Phillips curve.[50] One way such a

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[48] Chung (2015) shows this is case for two DSGE models, the Smets-Wouters model and the Federal Reserve Board's EDO model. Both models are much more sensitive to preannounced hikes in the federal funds rate.

[49] At the time of the late April 2021 meeting, the FOMC had readings on 12-month core CPI inflation and the unemployment rate through March (1.6 percent and 6.0 percent, respectively). It also had readings on V/U through February (0.78); rescaled, the latter figure equals 6.7 percent. Plugging these numbers into the BA rule with $\rho = 0$ yields a prescribed level of the federal funds rate equal to -3.4 percent. In contrast, a similar calculation using updated data would have yielded a positive value by the time of the June 2021 meeting.

[50] In its consensus statement on longer-run goals and strategy issued at that time and since reaffirmed annually, the FOMC stated that from now on it intends "to achieve inflation that averages 2 percent over time" rather than continuing its previous strategy of ignoring past misses. The statement then went on to clarify that "following

change might have manifested is through surprisingly large movements in measures of expected inflation. But as Bernanke and Blanchard note, the evolution in their measure of short-run inflation expectations post-COVID is about what one would have expected given the pre-COVID historical relationship between such expectations and lagged actual inflation. This unsurprising behavior is illustrated in figure 15 for median expectations reported in both the Michigan University Surveys of Consumers and the Survey of Professional Forecasters, which shows that the two survey measures rose in line with the out-of-sample predictions of a simple model estimated using pre-COVID data.[51]

As for measures of long-run inflation expectations, figure 16 shows that they have remained remarkedly well anchored in the face of an extremely large and persistent rise in actual inflation.[52] This apparent stability suggests that, had the counterfactual monetary policy succeeded in damping movements in these measures even further, any marginal reduction in actual inflation achieved through this channel would have been quite small. In addition, this stability helps to explain why inflation has moderated so appreciably in recent quarters. As long as long-run inflation expectations remain reasonably well anchored, the standard New Keynesian Phillip curve predicts that, once labor utilization is back to its long-run sustainable level, inflation should gradually move back to its long-run trend in the absence of new shocks. Thus, it is not particularly surprising that inflation has fallen substantially since its peak in early 2022 given that the labor market now appears to be much less overheated and indications that supply chain disruptions have faded appreciably in recent quarters. Of course, the slowing in inflation would have presumably been less pronounced if the FOMC had not begun to tighten aggressively starting in March 2022. If policy had continued to be extremely easy through the present, labor market conditions and the overall economy would certainly have been even stronger than they have been, thereby putting more upward pressure on wages and prices. In addition, a failure to tighten might have caused long-run inflation expectations to drift up more noticeably, potentially giving rise to a chronic inflation problem.

One might also speculate that easy monetary policy might have changed inflation dynamics in a way that caused the effects of shocks to become inherently more persistent, even after explicitly controlling for movements in long-run inflation expectations. The findings of Bernanke and Blanchard do not support this possibility, however, as their specification of the Phillips curve does a reasonably good job of explaining recent inflation developments out of sample. However,

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periods when inflation has been running persistently below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time." Importantly, the committee then or later did not say how it would respond if past average inflation was running *above* target, an omission implying that the new strategy is asymmetric. (See www.federalreserve.gov/newsevents/pressreleases/monetary20200827a.htm.) The practical import of the change in strategy for the FOMC's actual policy actions and forward guidance is not clear, however.

[51] The equations are based on regressions of each survey measure on a constant, its own lag, current CPI inflation, and lagged headline CPI inflation over the previous five quarters, using quarterly data from 1990Q1 to 2019Q4. The forecasts presented in figure 15 are dynamic and conditioned on the predicted lagged value of the survey, not its actual value.

[52] In fact, long-run inflation expectations appear to have been more stable than might have been expected given the marked rise in actual inflation. For example, the FRB/US equation used to account for movements in the median SPF projection of PCE inflation over the next 10 years—the measure of the expected long-run inflation used in the standard version of the model—predicts that this measure would have risen from 2.0 percent in early 2020 to 2.8 percent by late 2023 in the absence of own-shocks in response to higher core inflation and an unchanged FOMC inflation target, rather than only edging up to 2.2 percent.

Cecchetti and others do consider this possibility and conclude that persistence probably has in fact changed by reverting back to the higher level estimated to have prevailed on average from the early 1960s through 2019. Nevertheless, the simulation results generated using their preferred more-persistent specification suggest that, even if persistence has increased, a tighter monetary policy would nonetheless have had only a modest effect on inflation.

Another possibility is that the model simulations do not take adequate account of the effect easy monetary policy might have had on the relative prices of food, energy, and imports or other supply shocks. And in fact, these relative prices, along the two supply disruption measures used by Bernanke and Blanchard and Cecchetti and others, are assumed to be completely invariant in the simulations to changes in monetary policy. As a check on the validity on this assumption, the relative price terms used in the various Phillips curve specification were regressed on their own lags plus lags in the real federal funds rate and the output gap (separately and jointly) using pre-COVID data. The result was that the output gap and the real federal funds rate generally explain little of the historical movement in these series; moreover, p-values from exclusion tests are typically greater than 5 percent, providing statistical support for treating these relative price terms as exogenous. Similar regressions and exclusion tests were run for the ISM manufacturing supplier delivery index, with the same result. Finally, simulations of the counterfactual monetary policy were run using versions of the model to which were added simple estimated equations for the relative price terms and for the ISM index. This exercise yielded results for core PCE inflation that were only a tenth or two different from those reported in table 1 for the 2021-23 period, although effects for the 2024-25 period increased by somewhat more for the three non-FRB/US Phillips curves.[53]

Because the Bernanke-Blanchard supply disruption measure shows no noticeable variation prior to 2020, no similar regression or simulation tests were run for this explanatory variable. One can, however, speculate on whether tighter monetary policy might have helped to mitigate the severity of such disruptions, whether measured by this variable or as manifested in other ways. In general, it seems improbable that monetary policy could have noticeably affected the direct fallout from such events as the war in Ukraine, avian bird flu, production lags in ramping up the global supply of semiconductors, or the increased demand for rental living space in the wake of COVID pandemic. Still, it does seem possible that tighter monetary policy might have limited to some extent the surge in consumer spending on goods during the pandemic, thereby easing capacity pressures in the manufacturing and distribution of these goods, with potentially sizable effects on their prices. Higher interest rates might also have helped to restrain the surge in travel-related demand somewhat as fears of COVID diminished, as well as reduced the upward pressure on home values. Unfortunately, not enough research has been done on such sector-specific disaggregated transmission channels to be able to say much about their likely aggregate effect.

In contrast to the results presented here, Gagliardone and Gertler (2023) find that easy FOMC monetary policy substantially contributed to the inflation surge. Using a DSGE model to parse the contributions of policy and energy prices, they estimate that policy "shocks" contributed

[53] Out-year results generated using the Cecchetti and others Phillips curve are the most affected by endogenizing the supply-shock terms, causing the simulated effects of the counterfactual policy on core PCE inflation to more than double to almost a full percentage point reduction in both 2024 and 2025.

about 1½ percentage points to core PCE inflation in both 2021 and 2022, with the 2023 contribution turning negative, in the version of their model that controls for the effects of FOMC forward guidance by matching a proxy rate. Determining why their model yields such a large inflation effect relative to the one predicted by FRB/US is difficult because the model structures differ in important ways; for example, FRB/US has a more detailed monetary transmission mechanism and the design of the DSGE model is more tightly tied to theory. In addition, their monetary shocks—identified as movements in interest rate futures occurring in a narrow window after FOMC policy announcements—are conceptually different from the policy "surprise" considered in this paper, which primarily takes the form of an unexpected announcement in early 2021 of a permanent change in how the federal funds rate will be set in the future. Finally, the procedures used to estimate the two models are quite different.

These differences in model structure and methodology have their respective pros and cons, and no assertion is made here that the FRB/US-based estimates reported in this paper are obviously better than the ones reported by Gagliardone and Gertler. But two aspects of their model and analysis are noteworthy. First, it appears that the effective slope of the Phillips curve embedded in their DSGE model is much steeper than even the Gagnon-Collins one.[54] Second, some of the results reported in their paper seem counterintuitive, such as their estimate that monetary policy shocks subtracted more than 1 percentage point from the average annual rate of inflation from 2016 through early 2020. Their estimate that monetary policy was persistently tight pre-COVID seems hard to reconcile with an average level of the federal funds rate during this period that, at 1.3 percent, was quite low by historical standards. It also seems hard to reconcile with the forecast errors made by the primary dealers. In late 2015, the primary dealers projected a path for the federal funds rate from 2016 to 2018 that turned out to be 60 basis points higher on average than the one the FOMC actually implemented, while projecting an accompanying path for core PCE inflation that was close to what actually occurred—a combination of forecast errors that seems inconsistent with the claim that monetary policy was surprisingly tight during these years.

Finally, one has to acknowledge that despite all the variations of the FRB/US model considered in this paper, the range of reported simulation results almost certainly understates how much uncertainty there is about what would have actually happened had the FOMC actually pursued a more restrictive policy of the sort considered here. Ball, Leigh, and Mishra (2022), for example, propose an extremely nonlinear and rather unorthodox specification of the Phillips curve in which the median PCE inflation series is a cubic function of both V/U and the difference between headline PCE inflation and median inflation. Evaluated at the recent peak level of V/U, their specification implies that a policy-induced decline in V/U of the magnitude reported in table 1 would have reduced median inflation by 3.9 percentage points in 2021-22. Although an effect of this magnitude leads one to wonder about the robustness of their estimated unconventional model, especially as it implies the FOMC should have had a remarkable ability

[54] The marked difference in slopes is apparent in some unpublished simulation results using the Gagliardone-Gertler model that Mark Gertler has graciously provided. In this simulation, the federal funds rate counterfactually begins rising rapidly starting in mid-2021, reaching 3¼ percent by the end of the year and 5¼ percent by late 2022, where it remains thereafter. In response, the unemployment rate follows a path that on average is about 1 percentage point higher than its actual path, while four-quarter inflation is reduced about 1 percentage point in 2021 and by 2 percentage points in 2022 and 2023 relative to history. Thus, the response of inflation to unit change in labor utilization in their model is roughly twice as large as the one-for-one response reported for the Gagnon-Collins Phillips curve reported in table 1.

to fine-tune inflation historically, it does illustrate that there might well be some reasonable alternative specification of the Phillips curve that would generate larger inflation effects than the ones reported in this paper. Another possibility is that the FRB/US-based simulations underestimate the contractionary effect of the counterfactual policy on real activity, and thus inflation, even in those simulations in which the interest sensitivity of aggregate spending is doubled. Perhaps a policy this restrictive would have inadvertently triggered widespread financial distress, pushing the economy into a much deeper recession than shown in the simulations, with larger attendant effects on inflation. After all, macro models and forecasters more generally have a poor track record in predicting financial crises and recessions. That said, the economy so far has remained remarkably strong despite the 500 basis point increase in the federal funds rate.

7. Conclusions

This paper uses simulations of the FRB/US model incorporating different specifications of the Phillips curve derived from several recent studies, run under different assumptions about expectations formation and the interest sensitivity of aggregate spending, to assess what might have happened had the FOMC implemented a much more restrictive monetary policy in the wake of COVID. Under the counterfactual policy, the FOMC would have adjusted the level of the federal funds rate over time as prescribed by the benchmark BA rule, with V/U used as the measure of labor utilization rather than the standard unemployment rate; in addition, the FOMC would have issued much less accommodative forward guidance about the likely future path of the federal funds rate and would have ended its large-scale asset purchase program earlier. As a result, the federal funds rate would have started rising rapidly in 2021 and would have stood 4 percentage points or so higher than it actually did by early 2022.

Under the base-case assumptions for expectations and interest sensitivity, the model predicts that real activity would have been materially weaker as a result of the more restrictive strategy, with the unemployment rate running at around 5 percent in 2022 and 2023, more than a percentage point higher than it actually did. Nevertheless, for all the specifications of the Phillips curve considered in this paper, the base-case simulations also suggest that the counterfactual policy would have done essentially nothing to check the initial surge in inflation in 2021 and would have reduced it by only a few tenths in 2022. The counterfactual policy would, however, have helped to bring PCE inflation somewhat more quickly back to 2 percent thereafter, albeit at a risk of temporarily undershooting the FOMC’s inflation target for a time. Qualitatively, the simulation results are not greatly affected by alternative (and less realistic) simulation assumptions.

Overall, what do these results suggest about the degree to which a more restrictive monetary policy would have improved recent macroeconomic performance? A crude way to address this issue is to measure performance using a quadratic loss function that penalizes deviations of PCE inflation from 2 percent and values of the unemployment rate greater than 4.1 percent (the FOMC’s current estimate of U^*), all cumulated over the period 2021Q1 to 2025Q4. As shown in table 4, by this simple metric the loss under the policy actions actually taken by the FOMC is less than the simulated loss under the counterfactual policy for all the different permutations of Phillips curve specification, expectations formation, and interest sensitivity, with the exception of two out of the three estimates derived using the Gagnon-Collins Phillips curve. For these two cases, the trade-off between unemployment and inflation is sufficiently favorable to suggest that tighter monetary policy might have been worthwhile.

Of course, there are many economic developments that affect social welfare but are not factored into these simple loss calculations, such as changes in the distribution of real household incomes. Unfortunately, the structure of the FRB/US model is too simple to estimate how tighter monetary policy might have affected these more micro considerations. An additional macro consideration that the model can address, however, is how tighter monetary policy might have affected average real wage rates. As shown in tables 1-3, tighter policy causes the nominal growth rate of ECI hourly compensation to consistently fall by more than PCE inflation for three of the four specifications of the Phillips curve, with the result that the level of real ECI hourly compensation is 1 to 1½ percent lower by late 2025 under the base-case simulation assumptions. The exception again is the Gagnon-Collins Phillips curve, where the simulation results would seem to imply that tighter monetary policy would have raised the level of the real wage. However, this result is most likely an artifact of the different sample periods used to estimate the ECI and core inflation equations in that study, as the former uses data that start in the 1980s while the latter uses data that start in 1959. If the core inflation equation estimates had instead estimated using the shorter ECI sample period, the simulation results would be consistent with the standard finding that wages are more sensitive than prices to movements in labor utilization.[55] On balance, the simulation results do not support the notion that overly easy monetary policy hurt households by allowing elevated price inflation to erode their real incomes; instead, a more aggressive responsive would have made the situation worse.

Another limitation of these simple loss calculations is that they abstract from risk-management concerns. For example, one could argue that, by delaying the onset of tightening, the FOMC unwisely courted the *risk* of inflation expectations becoming unmoored, and the fact that in the end they remained well anchored is in some ways beside the point: The cost to the long-run stability of the economy would have been considerable if they had reverted to the behavior of the 1970s, although that cost has to be weighted by its probability of occurring. In this regard, history suggests that the odds of expectations becoming unmoored were extremely low as long as the FOMC did not delay too long—and after a relatively short delay, the FOMC did rapidly make up for lost time in a series of unusually large rate hikes.[56] Moreover, other risk-management concerns arguably worked in the opposite direction initially: In an environment in which the ELB can be expected to frequently constrain monetary policy, a lower for longer strategy is advisable coming out of a severe economic slump, as was the case in 2020. The highly unusual nature of the various shocks hitting the economy at the time also argued for a go-

[55] A simple way to illustrate this differential sensitivity is to regress the annualized quarterly growth rate of ECI wages and salaries deflated by core PCE prices on a constant, two own lags, and the two-quarter moving average of the CBO measure of the unemployment gap. Using data from either 1982Q1 to 2019Q4 or from 1982Q1 to 2023Q4 yields a negative coefficient on the unemployment gap equal to -0.17 with a standard error equal to 0.05, indicating that nominal ECI hourly wage growth tends to fall more than core PCE inflation in response to slack.

[56] Using data that starts in the early 1980s, simple regressions run using survey-based measures of long-run inflation expectations show that they respond only slowly to changes in actual inflation. Although similar regressions cannot be run for the 1960s and 1970s because of a lack of data, the results reported in Stock and Watson (2007) suggest that expectations were slow to adjust during this period as well based on their estimates of the time-varying unit-root component of trend inflation.

slow approach, at least until it was clear that the step-up in inflation was less transitory than originally thought.

Finally, uncertainty about the monetary transmission mechanism is almost certainly greater than the range of results reported in this paper, and some other model might well predict that an earlier and more aggressive tightening on the part of the FOMC would have done more to keep inflation in check in recent years. Alternatively put, it may be that the model simulations understate the role of easy monetary policy in contributing to the recent surge in inflation. But taking the simulation results at face value, do they suggest that tighter FOMC policy would have resulted in better overall macroeconomic performance? Based on simple loss calculations, the likely effect of tighter policy on real wage rate, and risk-management considerations, the answer appears to be "no."

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Appendix. Additional information on model modifications and simulations

This appendix documents the modifications to the standard FRB/US wage and price equations used to align the model's Phillips curve with alternative specifications proposed in three recent studies; other modifications to the model's equations; and the procedure used to sequentially simulate the model subject to a changing set of baselines consistent with the evolution of the median projections of real activity, inflation, and the federal funds rate reported in releases of the *Survey of Primary Dealers* from early 2021 through the end of 2023.

Phillips curve modifications

The simulation analysis uses four modified versions of the FRB/US model that incorporate different specifications of the wage and price equations. One of these versions is based on the model's standard equations, whereas the other three use alternative specifications based on estimates of the Phillips curve reported in Bernanke and Blanchard (2023), Cecchetti and others (2023), and Gagnon and Collins (2019). The equation modifications used to incorporate the specifications of the latter three into FRB/US are described below.

Bernanke and Blanchard (2023)

This modified version of FRB/US uses an alternative specification for the ECI compensation equation; adds new equations for headline CPI inflation, expected CPI inflation over the next four quarters and the next 10 years; and uses bridge equations to link core CPI inflation and core PCE to the new main price variable, headline CPI inflation. The revised/added equations are as follows:

$$
\begin{aligned}
\pi_t^{ECI} = {} & .1603\,\pi_{t-1}^{ECI} + .1243\,\pi_{t-2}^{ECI} + .1725\,\pi_{t-3}^{ECI} + .0032\,\pi_{t-4}^{ECI} \\
& + .3370\,E\pi4_{t-1}^{CPI} - .0273\,E\pi4_{t-2}^{CPI} + .2034\,E\pi4_{t-3}^{CPI} + .0265\,E\pi4_{t-4}^{CPI} \\
& + 3.7736\,vu_{t-1} - 1.8126\,vu_{t-2} - 3.6427\,vu_{t-3} + 2.3751\,vu_{t-4} \\
& - .0079\,(\pi4_{t-1}^{CPI} - E\pi4_{t-1}^{CPI}) + .0126\,(\pi4_{t-1}^{CPI} - E\pi4_{t-1}^{CPI}) \\
& - .0040\,(\pi4_{t-1}^{CPI} - E\pi4_{t-1}^{CPI}) - .0243\,(\pi4_{t-1}^{CPI} - E\pi4_{t-1}^{CPI}) \\
& + .0312\,glprod_{t-1} - .2653
\end{aligned}
$$

$$
\begin{aligned}
\pi_t^{CPI} = {} & .0440\,\pi_{t-1}^{CPI} + .1765\,\pi_{t-2}^{CPI} + .2277\,\pi_{t-3}^{CPI} - .1136\,\pi_{t-4}^{CPI} \\
& + .3689\,\pi_t^{ECI} + .1751\,\pi_{t-1}^{ECI} + .0380\,\pi_{t-2}^{ECI} + .0344\,\pi_{t-3}^{ECI} + .0480\,\pi_{t-4}^{ECI} \\
& + .0922\,grpe_t + .0005\,grpe_{t-1} - .0149\,grpe_{t-2} - .0213\,grpe_{t-3} + .0093\,grpe_{t-4} \\
& + .1112\,grpf_t - .0155\,grpf_{t-1} - .0008\,grpf_{t-2} - .0044\,grpf_{t-3} + .0355\,grpf_{t-4} \\
& + .1077\,shtg_t - .0333\,shtg_{t-1} + .0006\,shtg_{t-2} - .0330\,shtg_{t-3} - .0238\,shtg_{t-4} \\
& - .1430\,glprod_{t-1} - .1055
\end{aligned}
$$

$$
\begin{aligned}
E\pi4_t^{CPI} = {} & .3034\,E\pi4_{t-1}^{CPI} - .2262\,E\pi4_{t-2}^{CPI} + .1760\,E\pi4_{t-3}^{CPI} + .1162\,E\pi4_{t-4}^{CPI} \\
& + 1.2008\,E\pi10Y_t^{CPI} - .4692\,E\pi10Y_{t-1}^{CPI} + .0171\,E\pi10Y_{t-2}^{CPI} \\
& + .1351\,E\pi10Y_{t-3}^{CPI} - .3777\,E\pi10Y_{t-4}^{CPI} \\
& + .0379\,\pi_t^{CPI} + .1035\,\pi_{t-1}^{CPI} + .0009\,\pi_{t-2}^{CPI} + .0064\,\pi_{t-3}^{CPI} - .0243\,\pi_{t-4}^{CPI}
\end{aligned}
$$

$$
E\pi10Y_t^{CPI} = .8543\,E\pi10Y_{t-1}^{CPI} - .0457\,E\pi10Y_{t-2}^{CPI} + .1991\,E\pi10Y_{t-3}^{CPI} - .0325\,E\pi10Y_{t-4}^{CPI}
$$

$$+ .0293\, \pi_t^{CPI} + .0099\, \pi_{t-1}^{CPI} - .0125\, \pi_{t-2}^{CPI} - .0005\, \pi_{t-3}^{CPI} - .0013\, \pi_{t-4}^{CPI}$$

$$\pi_t^{CPIX} = \pi_t^{CPI} - .0845 grpe_t - .1176 grpf_t$$
$$\pi_t^{PCEX} = \pi_t^{CPIX} + .4085(\pi_{t-1}^{PCEX} - \pi_{t-1}^{CPIX}) + .0639 \sum_{j=1}^{2} .5\left(U_{t-j} - U_{t-j}^*\right)$$

In these expressions, π_t^{ECI} is the annualized quarterly growth rate of ECI hourly compensation (model mnemonic *PIECI*). π_t^{CPI}, π_t^{CPIX}, and π_t^{PCEX} are the annualized quarterly inflation rates for the headline CPI, the core CPI, and the core PCE price indexes (model mnemonics *PICPI*, *PICPIX*, and *PICXFE*). $\pi 4_{t-1}^{CPI}$ is the four-quarter growth rate of headline CPI inflation (model mnemonic *PICPI4*). $E\pi 4_t^{CPI}$ and $E\pi 10Y_t^{CPI}$ denote expected CPI inflation over the next four quarters and next 10 years, respectively (model mnemonics *EPI4Q* and *EPI10Y*). $glprod_t$ is the annualized growth rate of actual labor productivity (model mnemonic *LPROD*) over the past eight quarters. $grpe$ and $grpf$ are, respectively, the annualized quarterly growth rates of relative energy prices (model mnemonic *PCER*) and relative food prices (model mnemonic *PCFR*). $shtg$ is an index of supply chain disruptions (model mnemonic *SHORTAGE*). U_t and U_t^* are, respectively, the actual and natural rate of unemployment (model mnemonics LUR and *LURNAT*). In the model simulations, $grpe$, $grpf$, and $shtg$ are assumed to be unaffected by changes in monetary policy.

Cecchetti and others (2023)

This modified version of FRB/US replaces the standard FRB/US equation for core PCE inflation with the following nonlinear specification:

$$\begin{aligned}\pi_t^{PCEX} = {} & .6824\,(VUGAP_t \text{ } if \text{ } VUGAP_t > 0) - .0255\,(VUGAP_t \text{ } if \text{ } VUGAP_t < 0)\\ & + .4596\,\pi_{t-1}^{PCEX} + .2644\pi_{t-2}^{PCEX} + .0286\,\pi_{t-3}^{PCEX} + .0995\,\pi_{t-4}^{PCEX} + .1479 E\pi_{t-1}^{LR}\\ & + .0301\, grpmgx_{t-1} - .0293\, grpmgx_{t-2} + .0300\, grpmgx_{t-3} + .0106\, grpmgx_{t-4}\\ & + .0169\, ism_{t-1} + .0131\, ism_{t-2} - .0177\, ism_{t-3} + .0190\, ism_{t-4} - 1.7559\end{aligned}$$

In this expression, π_t^{PCEX} is the annualized quarter rate of core PCE inflation (model mnemonic *PICXFE*); $VUGAP_t$ is the difference between V/U and its equilibrium value; $E\pi_t^{LR}$ is expected long-run inflation (model mnemonic *PTR*), $grpmgx$ is the annualized quarterly growth rate of the relative price of nonpetroleum imported goods weighted by its expenditure share (model mnemonic *RPIMGX*); and ism is the ISM manufacturing supplier deliveries index (model mnemonic *ISM*). In the model simulations, RPIMGX and ISM are assumed to be exogenous.

In addition to revising the main core PCE price equation, this version also follows Cecchetti and others by modifying the coefficients of the standard FRB/US equation for $E\pi_{t-1}^{LR}$ (PTR) in a way that makes expected long-run inflation somewhat less sensitive to movements in actual inflation. Also, bridge equations linking core CPI inflation to core PCE inflation and headline CPI inflation to core CPI inflation are added to this version of the model (as well as to the standard version) to ensure consistency of differences in CPI and PCE inflation predictions across the four specifications; these bridge equations are the mirror image of the ones added to the Gagnon-Collins version:

$$\pi_t^{PCPIX} = \pi_t^{PCEX} + .4085(\pi_{t-1}^{CPIX} - \pi_{t-1}^{PCEX}) - .0639 \sum_{j=1}^{2} .5\left(U_{t-j} - U_{t-j}^{*}\right)$$
$$\pi_t^{CPI} = \pi_t^{CPIX} + .0845 grpe_t - .1176 grpf_t$$

Gagnon and Collins (2019)

This modified version of FRB/US replaces the standard linear equation for ECI compensation with a nonlinear specification, replaces the main core PCE inflation equation with a nonlinear one for core CPI inflation, and adds bridge equations to link core PCE inflation to core CPI inflation and headline CPI inflation to core CPI inflation.

$$\begin{aligned}\pi_t^{ECI} &= 1.99 - .022 \sum_{j=1}^{4} .25\, \pi_{t-j}^{ECI} + .334 \sum_{j=5}^{8} .25\, \pi_{t-j}^{ECI} \\ &\quad - .555\, UGAP_t + .264\, (UGAP_t \text{ if } UGAP_t > 0, 0 \text{ otherwise})(1 - DHIPI_t)\end{aligned}$$

$$\begin{aligned}\pi_t^{CPIX} &= .857 + .499 \sum_{j=1}^{4} .25\, \pi_{t-j}^{CPIX} + .016 \sum_{j=5}^{8} .25\, \pi_{t-j}^{CPIX} \\ &\quad - .627\, UGAP_t + .606\, (UGAP_t \text{ if } UGAP_t > 0, 0 \text{ otherwise})(1 - DHIPI_t) \\ &\quad + .381\, grpmg_{t-1}\end{aligned}$$

$$DHIPI_t = 1 \text{ if } \textstyle\sum_{j=1}^{8} .125\, \pi_{t-j}^{CPIX} \geq 3, 0 \text{ otherwise}$$

$$\pi_t^{CPIX} = \pi_t^{CPI} - .0845 grpe_t - .1176 grpf_t$$
$$\pi_t^{PCEX} = \pi_t^{CPIX} + .4085(\pi_{t-1}^{PCEX} - \pi_{t-1}^{CPIX}) + .0639 \sum_{j=1}^{2} .5\left(U_{t-j} - U_{t-j}^{*}\right)$$

In these expressions, π_t^{ECI} is the annualized quarterly growth rate of ECI hourly compensation (model mnemonic PIECI). π_t^{CPI}, π_t^{CPIX}, and π_t^{PCEX} are the annualized quarterly inflation rates for the headline CPI, the core CPI, and the core PCE price indexes (model mnemonics *PICPI*, *PICPIX*, and *PICXFE*). $DHIPI_t$ is a dummy variable that equals one when trend inflation is high and zero otherwise. $grpmg$ is the annualized quarterly growth rate of the relative price of imported goods weighted by the ratio of nominal imported goods to nominal GDP (model mnemonic *GRPMG*); it is assumed to be exogenous.

Other model modifications

Because the policy rule measures labor utilization using the rescaled ratio of vacancies to unemployment, all versions of the model are modified to include an equation that makes ZVU move one for one with the unemployment rate in simulations. In addition, because two of the Phillips curve specifications use the unadjusted ratio in place of the unemployment rate, all versions of the model include an equation that makes V/U move inversely with the unemployment rate as indicated by the inverted renormalization formula. As a result, a 1 percentage point increase in the unemployment rate causes V/U to fall 0.146 in the simulations.

Another modification concerns the equations for the term premiums embedded in 5-year, 10-year, and 30-year Treasury yields. The standard specification of these equations is problematic because it causes Treasury term premiums to be excessively sensitive to expected movements in future resource utilization, to a point that the model becomes unstable under some conditions; see Brayton and Reifschneider (2022) for a discussion of this problem. In some previous studies, such as Chung and others (2019), this instability problem is mitigated by exogenizing these term premiums. Here, an alternative approach is used in which the standard term premium equations are replaced by estimated ones that cause term premiums to respond to movements in current but not expected resource utilization. This modification somewhat reduces the sensitivity of real activity to changes in monetary policy in model simulations; it also better aligns the simulated behavior of the FRB/US term premium measures with the behavior of an alternative measure of term premiums, such as the ones generated by the Kim-Wright term structure model. The revised specifications of the Treasury bond yield equations also allow for the application of exogenous QE-related shocks to term premiums.

Finally, bridge equations are added to the model that allow it to keep track of three separate sets of baseline data: (1) as denoted by the suffix *FINAL*, the paths of real activity, inflation, and the federal funds rate that match the currently published historical data with the extrapolated December 2023 SPD projections appended; (2) as denoted by the suffix *RTIME*, the paths of real activity, inflation, and the federal funds rate that match the extrapolated SPD projections made at different release dates between June 2021 and December 2023, with values along the path prior to the RTIME release data consistent with published data at the time; and (3) as denoted by no suffix, the series in the FRB/US database posted on the Federal Reserve website in late September 2023, which includes past and projected values for the much larger set of variables included in the model. These bridge equations ensure that the RTIME and FINAL values of the unemployment rate, V/U, and core PCE and CPI inflation move one-for-one with the standard model variables in simulation. In the case of the federal funds rate, a bridge equation is used to make the standard variable for the federal funds rate (RFF) move one-for-one with movements in the inertial BA rule's prescriptions for RFF_RTIME.[57]

Simulation procedure using evolving SPD-consistent baselines

As discussed in the main text, the simulations assume that financial market participants—and in some cases, other agents as well—are fully knowledgeable about the implications of changes in monetary policy for future economic conditions. In particular, in the simulations the expectations of such well-informed agents are assumed to be model consistent, in that their expectations revise relative to baseline in response to the counterfactual monetary policy as predicted by the full FRB/US model. However, these well-informed agents are ***not*** assumed to have had perfect foresight about the actual shocks to real activity and inflation that would hit the economy in the future, and that in turn would influence the simulated path of the federal funds rate under the rule-based strategy over time. Instead, in the baseline(s) financial market participants and other well-informed agents are more realistically assumed to revise their expectations for the future

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[57] The arguments of the policy rule also use RTIME values for inflation, the unemployment rate, *R**, and *U** to ensure consistency with the SPD projections. The nonlinear nature of the Phillips curve proposed by Cecchetti and others and Gagnon and Collins requires a similar use of RTIME variables to ensure that the timing of any switching behavior in simulations is consistent with the SPD projections. The application of baseline tracking residuals to all equations means that RTIME variables are not needed for the linear FRB/US and Bernanke-Blanchard specifications of the Phillips curve.

path of the shocks to real activity and inflation over time as they actually did, based on the evolution of the economic projections made by the primary dealers. To do this, the following multistep simulation procedure is employed:

A. A sequence of baselines is first constructed for the federal funds rate, labor market conditions, and inflation. Each baseline corresponds a specific primary dealer survey released in the last month of each quarter from late 2019 to the present, in which the paths of the RTIME suffix variables in each baseline equal the published historical data up to the release date and the contemporaneous SPD-consistent projections thereafter. (In the baselines, model variables without suffixes, both endogenous and exogenous, equal their values in the currently posted FRB/US dataset.) Each of these evolving baselines includes a release-specific set of tracking residuals for all the equations in the model.

B. A first simulation is run that begins in 2021Q1, the starting date of the counterfactual monetary policy. (The end date of all simulations is set far into the future to enable the calculation of model-consistent expectations.) In this simulation, the current and projected values of all endogenous variables and tracking residuals match those in the 2021Q1 baseline, except that the tracking residuals on the policy rule are set to zero to ensure that the simulated path of the federal funds rate strictly follows the prescriptions of the inertial BA rule. In simulations that also incorporate a counterfactual path of asset purchases, the Treasury yield equations are additionally hit by exogenous QE-related shocks to the future path of their term premiums. After the simulation is completed, the 2021Q1 values of the endogenous variables are overwritten with their simulated values in that quarter.

C. Next, the starting date of the simulation is advanced to 2021Q2 and the current and projected tracking residuals are updated to match those in the 2021Q2 baseline. Once again, the model is simulated with the tracking residuals on the policy rule set to zero and, if appropriate, the Treasury yield equations subject to the same set of shocks to the path of their term premiums. Once the simulation is complete, the 2021Q2 values of the endogenous variables are overwritten with their simulated values in that quarter.

D. This sequential simulation procedure continues through 2023Q4, the release date of the most recently released end-of-quarter SPD projections.

If this sequential procedure is run without zeroing out the policy rule tracking residuals and without applying the term premium shocks, the past and projected FINAL paths of the federal funds rate, labor market conditions, and inflation in the last simulation exactly match those in the December 2023 SPD release.

Table 1. Simulated Effects of the Counterfactual Monetary Policy Using Different Specifications of the Phillips Curve Assuming that Only Financial Market Participants are Well Informed about its Economic Implications
(results expressed as changes from baseline)

	2021	2022	2023	2024	2025
Standard FRB/US specification					
Federal funds rate (Q4)	2.60	3.42	2.00	0.66	0.08
10-year Treasury yield (Q4)	1.57	1.21	0.43	0.08	-0.10
GDP gap (Q4)	-0.58	-2.32	-2.44	-1.64	-0.89
Unemployment rate (Q4)	0.26	1.21	1.33	1.04	0.71
V/U (Q4)	-0.04	-0.18	-0.19	-0.15	-0.10
PCE inflation (Q4/Q4)	-0.01	-0.14	-0.22	-0.21	-0.20
ECI inflation (Q4/Q4)	-0.02	-0.26	-0.49	-0.53	-0.45
Long-run inflation expectations (Q4)	-0.00	-0.02	-0.05	-0.07	-0.08
Bernanke and Blanchard (2023) specification					
Federal funds rate (Q4)	2.60	3.46	2.08	0.75	0.15
10-year Treasury yield (Q4)	1.60	1.24	0.45	0.10	-0.10
GDP gap (Q4)	-0.58	-2.34	-2.46	-1.65	-0.89
Unemployment rate (Q4)	0.26	1.22	1.35	1.06	0.73
V/U (Q4)	-0.04	-0.18	-0.20	-0.15	-0.11
PCE inflation (Q4/Q4)	-0.00	-0.07	-0.11	-0.13	-0.15
ECI inflation (Q4/Q4)	-0.02	-0.22	-0.28	-0.27	-0.24
Long-run inflation expectations (Q4)	-0.00	-0.01	-0.03	-0.05	-0.07
Cecchetti and others (2023) hot/cold specification					
Federal funds rate (Q4)	2.60	3.42	1.92	0.51	-0.05
10-year Treasury yield (Q4)	1.47	1.13	0.39	0.05	-0.12
GDP gap (Q4)	-0.58	-2.32	-2.41	-1.54	-0.74
Unemployment rate (Q4)	0.26	1.21	1.32	0.99	0.64
V/U (Q4)	-0.04	-0.18	-0.19	-0.15	-0.09
PCE inflation (Q4/Q4)	-0.01	-0.16	-0.38	-0.42	-0.32
ECI inflation (Q4/Q4)	-0.02	-0.25	-0.48	-0.51	-0.42
Long-run inflation expectations (Q4)	-0.00	-0.00	-0.02	-0.03	-0.04
Gagnon and Collins (2019) low-inflation-bend specification					
Federal funds rate (Q4)	2.60	3.27	1.45	-0.06	-0.19
10-year Treasury yield (Q4)	1.50	1.17	0.29	0.00	-0.09
GDP gap (Q4)	-0.57	-2.25	-2.16	-1.15	-0.45
Unemployment rate (Q4)	0.25	1.17	1.19	0.80	0.51
V/U (Q4)	-0.04	-0.17	-0.17	-0.12	-0.07
PCE inflation (Q4/Q4)	0.01	-0.60	-1.11	-0.96	-0.17
ECI inflation (Q4/Q4)	-0.03	-0.50	-0.76	-0.66	-0.37
Long-run inflation expectations (Q4)	NA	NA	NA	NA	NA

Table 2. Simulated Effects of the Counterfactual Monetary Policy Using Different Specifications of the Phillips Curve Assuming that All Agents are Well-Informed about its Economic Implications
(results expressed as changes from baseline)

	2021	2022	2023	2024	2025
Standard FRB/US specification					
Federal funds rate (Q4)	2.44	3.05	1.59	0.21	-0.43
10-year Treasury yield (Q4)	1.32	0.88	0.19	-0.10	-0.25
GDP gap (Q4)	-0.86	-2.33	-2.52	-1.98	-1.31
Unemployment rate (Q4)	0.49	1.27	1.39	1.22	0.94
V/U (Q4)	-0.07	-0.19	-0.20	-0.18	-0.14
PCE inflation (Q4/Q4)	-0.13	-0.41	-0.40	-0.33	-0.28
ECI inflation (Q4/Q4)	-0.26	-0.70	-0.80	-0.68	-0.51
Long-run inflation expectations (Q4)	-0.01	-0.07	-0.11	-0.13	-0.14
Bernanke and Blanchard (2023) specification					
Federal funds rate (Q4)	2.50	3.29	1.81	0.16	-0.82
10-year Treasury yield (Q4)	0.95	0.46	-0.24	-0.60	-0.80
GDP gap (Q4)	-0.77	-2.17	-2.36	-1.80	-1.07
Unemployment rate (Q4)	0.45	1.19	1.30	1.12	0.79
V/U (Q4)	-0.07	-0.17	-0.19	-0.16	-0.12
PCE inflation (Q4/Q4)	-0.02	-0.21	-0.51	-0.81	-1.07
ECI inflation (Q4/Q4)	-0.08	-0.45	-0.81	-1.09	-1.29
Long-run inflation expectations (Q4)	-0.00	-0.03	-0.09	-0.16	-0.24
Cecchetti and others (2023) hot/cold specification					
Federal funds rate (Q4)	2.47	3.19	1.70	0.20	-0.48
10-year Treasury yield (Q4)	1.30	0.88	0.19	-0.10	-0.25
GDP gap (Q4)	-0.88	-2.38	-2.56	-1.99	-1.28
Unemployment rate (Q4)	0.50	1.29	1.40	1.22	0.92
V/U (Q4)	-0.07	-0.19	-0.20	-0.18	-0.13
PCE inflation (Q4/Q4)	-0.02	-0.21	-0.43	-0.45	-0.35
ECI inflation (Q4/Q4)	-0.25	-0.69	-0.78	-0.65	-0.48
Long-run inflation expectations (Q4)	-0.00	-0.01	-0.02	-0.04	-0.05
Gagnon and Collins (2019) low-inflation-bend specification					
Federal funds rate (Q4)	2.50	3.12	1.34	-0.31	-0.60
10-year Treasury yield (Q4)	1.33	0.88	0.09	-0.15	-0.23
GDP gap (Q4)	-0.82	-2.15	-2.15	-1.50	-0.92
Unemployment rate (Q4)	0.47	1.17	1.21	1.02	0.79
V/U (Q4)	-0.07	-0.17	-0.18	-0.15	-0.12
PCE inflation (Q4/Q4)	0.02	-0.66	-1.14	-1.03	-0.18
ECI inflation (Q4/Q4)	-0.06	-0.54	-0.78	-0.73	-0.46
Long-run inflation expectations (Q4)	NA	NA	NA	NA	NA

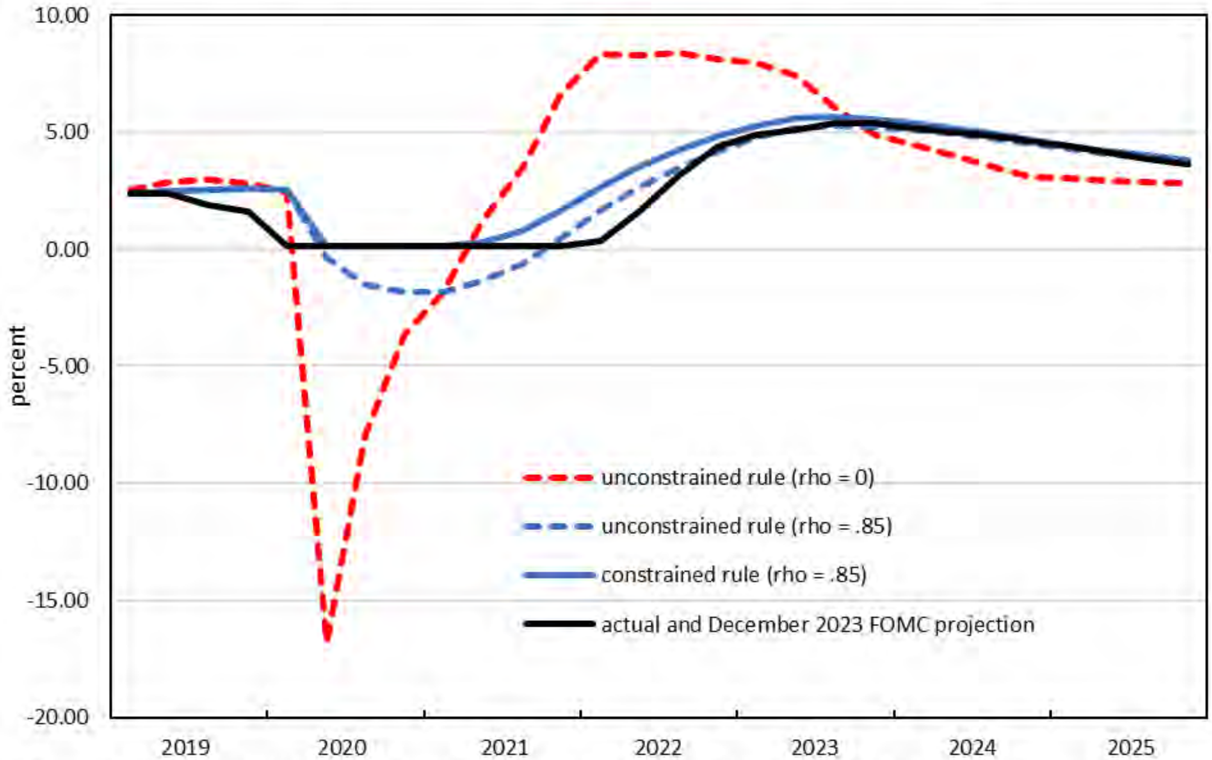
Table 3. Simulated Effects of the Counterfactual Monetary Policy with Heightened Interest Sensitivity and Different Specifications of the Phillips Curve Assuming that Only Financial Market Participants are Well-Informed about its Economic Implications
(results expressed as changes from baseline)

	2021	2022	2023	2024	2025
Standard FRB/US specification					
Federal funds rate (Q4)	2.54	2.98	1.13	-0.37	-0.84
10-year Treasury yield (Q4)	1.15	0.84	0.14	-0.19	-0.32
GDP gap (Q4)	-0.89	-3.53	-3.81	-2.53	-1.22
Unemployment rate (Q4)	0.38	1.73	1.96	1.54	0.99
V/U (Q4)	-0.06	-0.25	-0.29	-0.22	-0.15
PCE inflation (Q4/Q4)	-0.01	-0.19	-0.29	-0.28	-0.26
ECI inflation (Q4/Q4)	-0.02	-0.33	-0.68	-0.76	-0.63
Long-run inflation expectations (Q4)	-0.00	-0.02	-0.06	-0.09	-0.10
Bernanke and Blanchard (2023) specification					
Federal funds rate (Q4)	2.55	3.05	1.26	-0.24	-0.76
10-year Treasury yield (Q4)	1.19	0.89	0.18	-0.17	-0.31
GDP gap (Q4)	-0.87	-3.49	-3.81	-2.56	-1.23
Unemployment rate (Q4)	0.37	1.72	1.96	1.56	1.02
V/U (Q4)	-0.05	-0.25	-0.29	-0.23	-0.15
PCE inflation (Q4/Q4)	-0.01	-0.09	-0.16	-0.19	-0.21
ECI inflation (Q4/Q4)	-0.03	-0.31	-0.41	-0.40	-0.35
Long-run inflation expectations (Q4)	-0.00	-0.02	-0.05	-0.07	-0.10
Cecchetti and others (2023) hot/cold specification					
Federal funds rate (Q4)	2.54	2.96	0.98	-0.60	-1.01
10-year Treasury yield (Q4)	1.04	0.78	0.12	-0.20	-0.30
GDP gap (Q4)	-0.90	-3.58	-3.82	-2.41	-0.99
Unemployment rate (Q4)	0.39	1.76	1.96	1.49	0.89
V/U (Q4)	-0.06	-0.26	-0.29	-0.22	-0.13
PCE inflation (Q4/Q4)	-0.01	-0.23	-0.54	-0.53	-0.40
ECI inflation (Q4/Q4)	-0.02	-0.33	-0.67	-0.73	-0.59
Long-run inflation expectations (Q4)	-0.00	-0.01	-0.03	-0.05	-0.06
Gagnon and Collins (2019) low-inflation-bend specification					
Federal funds rate (Q4)	2.55	2.75	0.33	-1.31	-1.05
10-year Treasury yield (Q4)	1.12	0.79	0.02	-0.23	-0.23
GDP gap (Q4)	-0.88	-3.44	-3.39	-1.72	-0.42
Unemployment rate (Q4)	0.38	1.69	1.75	1.15	0.62
V/U (Q4)	-0.06	-0.25	-0.26	-0.17	-0.09
PCE inflation (Q4/Q4)	0.01	-0.86	-1.62	-1.16	-0.21
ECI inflation (Q4/Q4)	-0.04	-0.71	-1.10	-0.86	-0.53
Long-run inflation expectations (Q4)	NA	NA	NA	NA	NA

Table 4. Macroeconomic Performance from 2021 to 2025:
Loss Based on Actual and December 2023 SPD Projected Economic Conditions
Versus Simulated Loss under the Counterfactual FOMC Policy,
Penalizing Deviations of Four-Quarter PCE Inflation from 2 Percent
and Unemployment Greater than 4.1 Percent

	Loss
Actual and December 2023 SPD projected conditions	91.2
Simulated conditions under counterfactual monetary policy	
Only financial markets well-informed and standard interest sensitivity	
Using standard FRB/US wage-price equations	102.9
Using Bernanke and Blanchard (2023) wage-price equations	106.7
Using Cecchetti and others (2023) wage-price equations	99.7
Using Gagnon and Collins (2023) wage-price equations	83.0
All agents well-informed and standard interest sensitivity	
Using standard FRB/US wage-price equations	98.4
Using Bernanke and Blanchard (2023) wage-price equations	102.5
Using Cecchetti and others (2023) wage-price equations	105.1
Using Gagnon and Collins (2023) wage-price equations	87.6
Only financial markets well-informed and heightened interest sensitivity	
Using standard FRB/US wage-price equations	121.4
Using Bernanke and Blanchard (2023) wage-price equations	125.8
Using Cecchetti and others (2023) wage-price equations	117.1
Using Gagnon and Collins (2023) wage-price equations	93.5

Figure 1. Prescriptions from the Balanced Approach Rule for Setting the Federal Funds Rate In Response to Core PCE Inflation and Unemployment

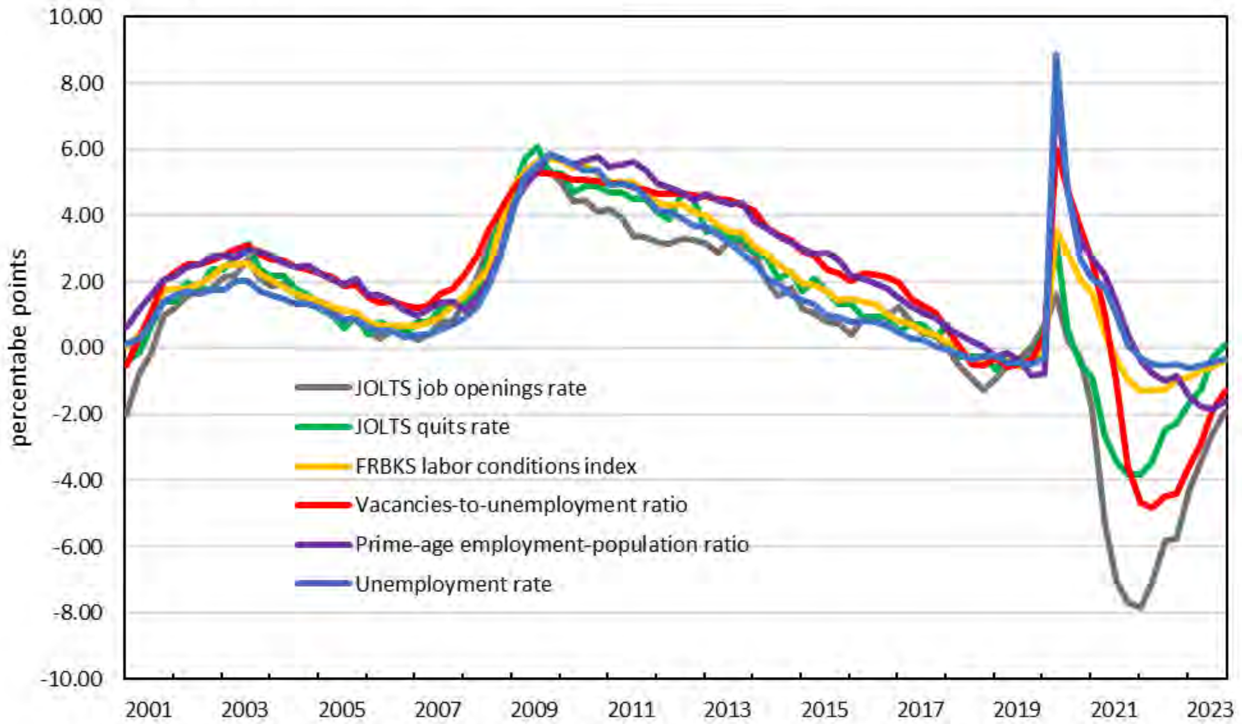


Source: Bureau of Labor Statistics, Bureau of Economic Analysis, Federal Reserve Board, and author's calculations.

The rule is $I_t = rho\, I_{t-1} + (1 - rho)[R^* + \pi_t + 0.5(\pi_t - \pi^*) - 2.0(U_t - U^*)]$, where I_t is the end-of-quarter value of the federal funds rate; R^* is the long-run value of the real federal funds rate; π_t is the four-quarter rate of core PCE inflation; π^* is the FOMC's long-run inflation target; U_t is the quarterly average value of the unemployment rate; and U^* is the long-run value of the unemployment rate. Rule prescriptions are calcuated using published historical data for U_t and π_t through 2023Q3 and the medians of the projections reported in the December 2023 release of the FOMC's Summary of Economic Projections thereafter. In computing the rule's prescriptions, the I_{t-1} term equals its actual value in 2019Q1 but thereafter is computed dynamically. R^*, π^*, and U^* are assumed to equal 0.5%, 2.0%, and 4.1%, respectively.

The figure shows that the unconstrained benchmark policy rule, with or without inertia, would have called for pushing the federal funds rate below zero in 2020Q2. Thereafter, the prescribed pace and extent of tightening in response to falling unemployment and surging inflation depends on both rho and whether the ELB is imposed. With no inertia (rho=0), tightening begins in 2021Q2 and by the end of the year the prescribed setting of the federal funds rate is 8 percentage points higher than its actual value. With inertia (rho=.85) and the ELB imposed, tightening also begins in 2021Q2 but thereafter is comparatively more moderate, albeit still more restrictive than the policy actually followed by the FOMC.

Figure 2. Estimates of Labor Utilization Derived from Different Indicators

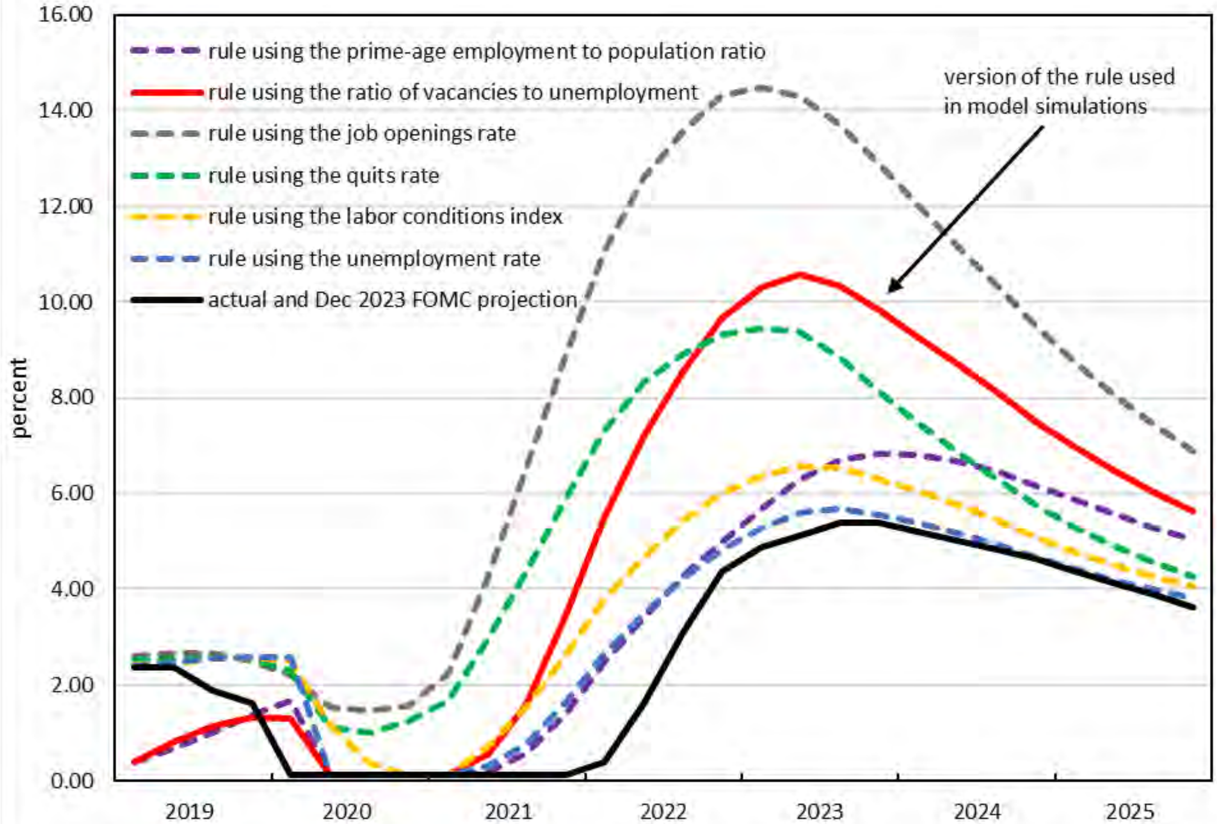


Source: Bureau of Labor Statistics, Federal Reserve Bank of Kansas City, and author's calcuations.

To ensure comparability with the unemployment rate, each alternative indicator X is rescaled as c1+c2*T+c3*X, where T is a time trend and c1, c2, and c3 are the coefficients obtained by regressing the unemployment rate on T and X using data from 2001q1 to 2019q4. The unemployment rate and the rescaled alternative indicators are then converted into utilization gaps by subtracting 4.1%.

The figure shows that, in the two decades prior to the pandemic, alternative indicators of labor utilization yielded similar estimates to the standard unemployment rate measure. Since early 2020, however, many of these indicators imply that the initial contraction was less deep , and the subsequent swing to tight conditions was more prounounced, than suggested by the unemployment rate.

Figure 3. Prescriptions of the ELB-Constrained Balanced Approach Rule Computed with Different Measures of Labor Utilization

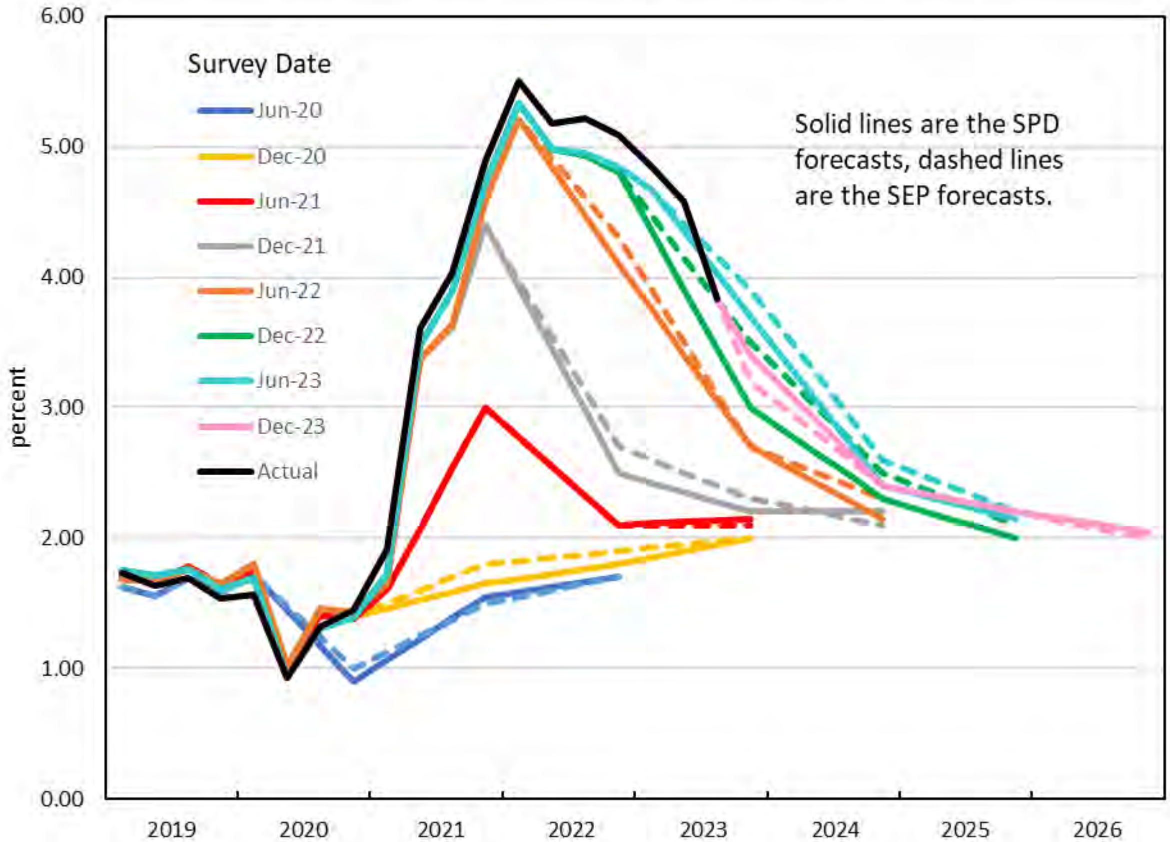


Source: Bureau of Labor Statistics, Bureau of Economic Analysis, Federal Reserve, and author's calculations.

The rule is $I_t = \max\{.13, .85I_{t-1} + .15[0.5 + \pi_t + 0.5(\pi_t - 2.0) - 2.0(Z_t - 4.1)]\}$, where I_t is the end-of-quarter value of the federal funds rate; 0.5 is the long-run real federal funds rate; π_t is the four-quarter rate of core PCE inflation; 2.0 is the FOMC's long-run inflation target; Z_t is the quarterly average value of the specified labor indicator; and 4.1 is the long-run unemployment rate. All the indicators are rescaled to make them comparable to the unemployment rate. To compute rule prescriptions, I_{t-1} is set to its actual value in 2019Q1 but thereafter is computed dynamically. FOMC projected values for the unemployment rate, inflation and the federal funds rate are the median projections from *Summary of Economic Projections* released in December 2023. Projected values for the other rescaled indicators assume that the difference between them and the unemployment falls over time, with almost 75 percent of the 2023Q4 difference gone by 2025Q4.

The figure illustrates that, for all the measures of labor utilization shown (including V/U, the measure used in the model simulations), the benchmark rule would have called for monetary policy to have been more restrictive after Covid hit, and in some cases markedly so. That said, the figure overstates the extent to which actual policy was relatively easy because the rule calculations do not take account of the effects of tighter policy on real activity and inflation, which would have endogenously moderated the prescribed degree of tightening.

Figure 4. Core PCE Inflation Forecasts from the *Survey of Primary Dealers* (SPD) and the FOMC's *Summary of Economic Projections* (SEP)

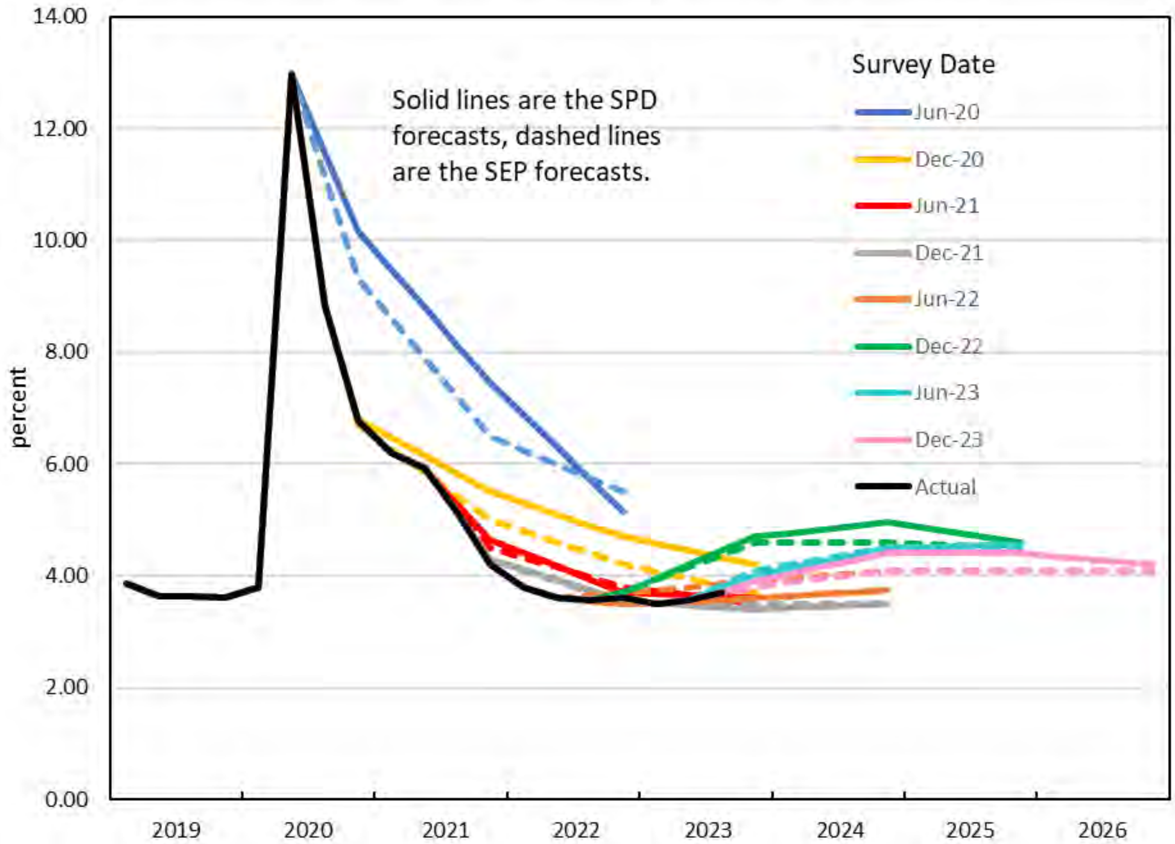


Source: Bureau of Economic Analysis, Federal Reserve Bank of New York, and Federal Reserve Board.

Projections are the medians of the 4-quarter core PCE inflation forecasts reported in the two surveys with published historical data at the time of the projection appended. Linear interpolations are used for quarters 1 to 3.

The figure shows that since June 2020 FOMC participants and financial markets (as represented by the primary dealers) have always been in close agreement about the evolving outlook for inflation, with their projections differing by only a few basis points. Importantly, neither anticipated the surge and both always expected inflation to fall back to 2 percent over the medium term.

Figure 5. Unemployment Rate Forecasts from the *Survey of Primary Dealers* (SPD) and the FOMC's *Summary of Economic Projections* (SEP)

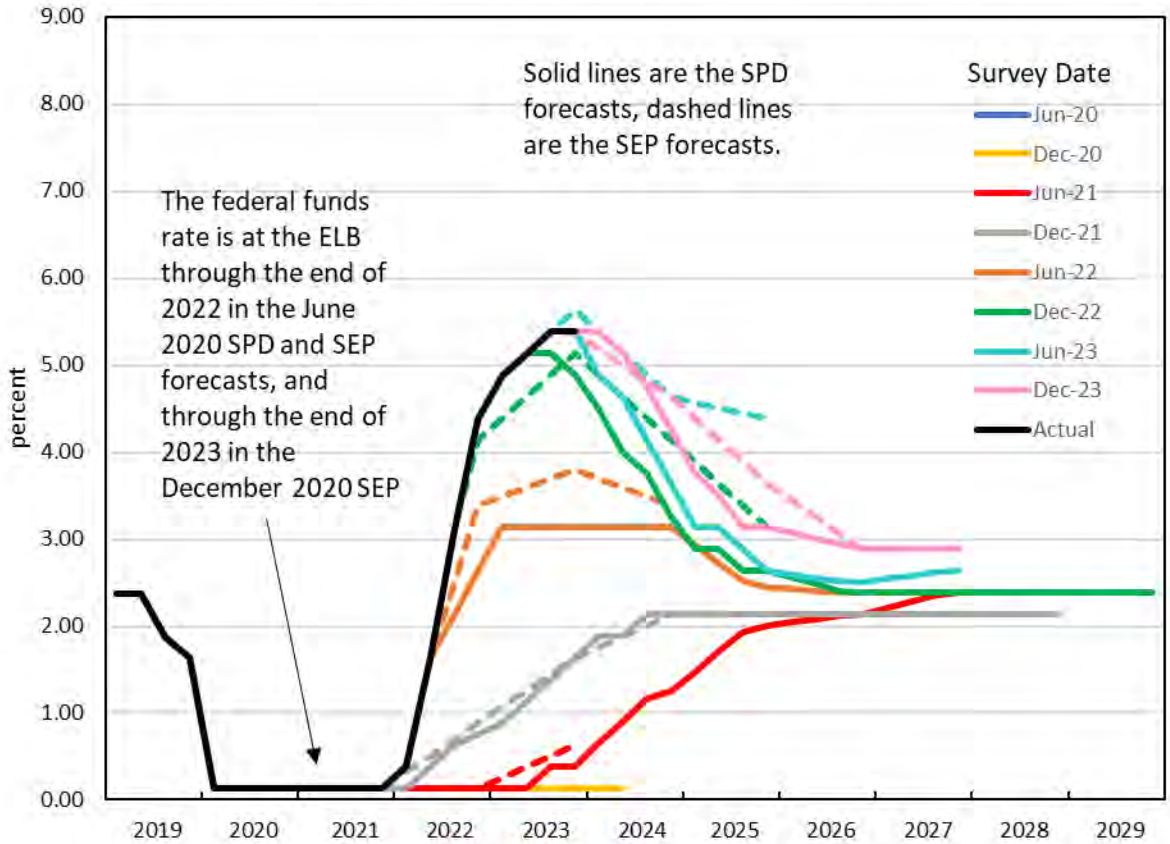


Source: Bureau of Economic Analysis, Federal Reserve Bank of New York, and Federal Reserve Board.

Projections are the medians of the Q4 unemployment rate forecasts reported in the two surveys with published historical data appended. Linear interpolations are used for quarters 1 to 3.

The figure shows that since June 2020 the FOMC and financial markets (as represented by the primary dealers) have always had similar views about the evolving outlook for unemployment. For example, neither initially anticipated how quickly the labor market would rebound after Covid hit, and both later expected for a time that the unemployment rate would need to run somewhat above its estimated long-run level for two or three years.

Figure 6. Federal Funds Rate Forecasts from the *Survey of Primary Dealers* (SPD) and the FOMC's *Summary of Economic Projections* (SEP)

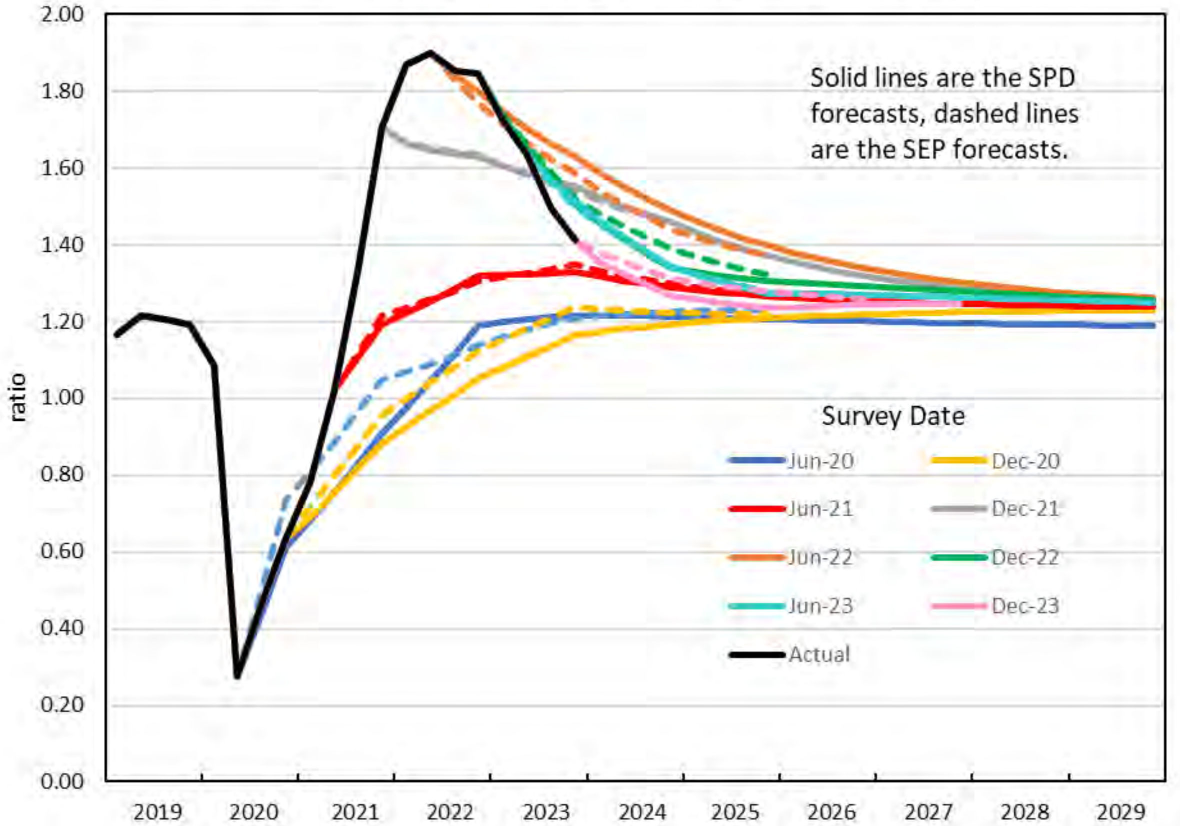


Source: Federal Reserve Bank of New York and Federal Reserve Board.

Projections are the medians of end-of-quarter federal funds rate forecasts reported in the two surveys. Linear interpolations are used for quarters 1 to 3 when forecasts are only reported for the fourth quarter of a year.

The figure shows that since June 2020 the FOMC and financial markets (as represented by the primary dealers) have generally agreed about the evolving outlook for the likely future path of the federal funds rate. Initally, both anticipated that rates would remain at the ELB for a prolonged period. Later, as labor market conditions improved and inflation surged, both were slow to recognize how much monetary policy would eventually tighten. Finally, by mid-2022 both had come to expect that the federal funds rate would need to overshoot its longer-run level for a time, with the FOMC anticipating more overshooting than the primary dealers.

Figure 7. Projections of V/U Constructed to be Consistent with Unemployment Rate Forecasts from the *Survey of Primary Dealers* (SPD) and the FOMC's *Summary of Economic Projections* (SEP)

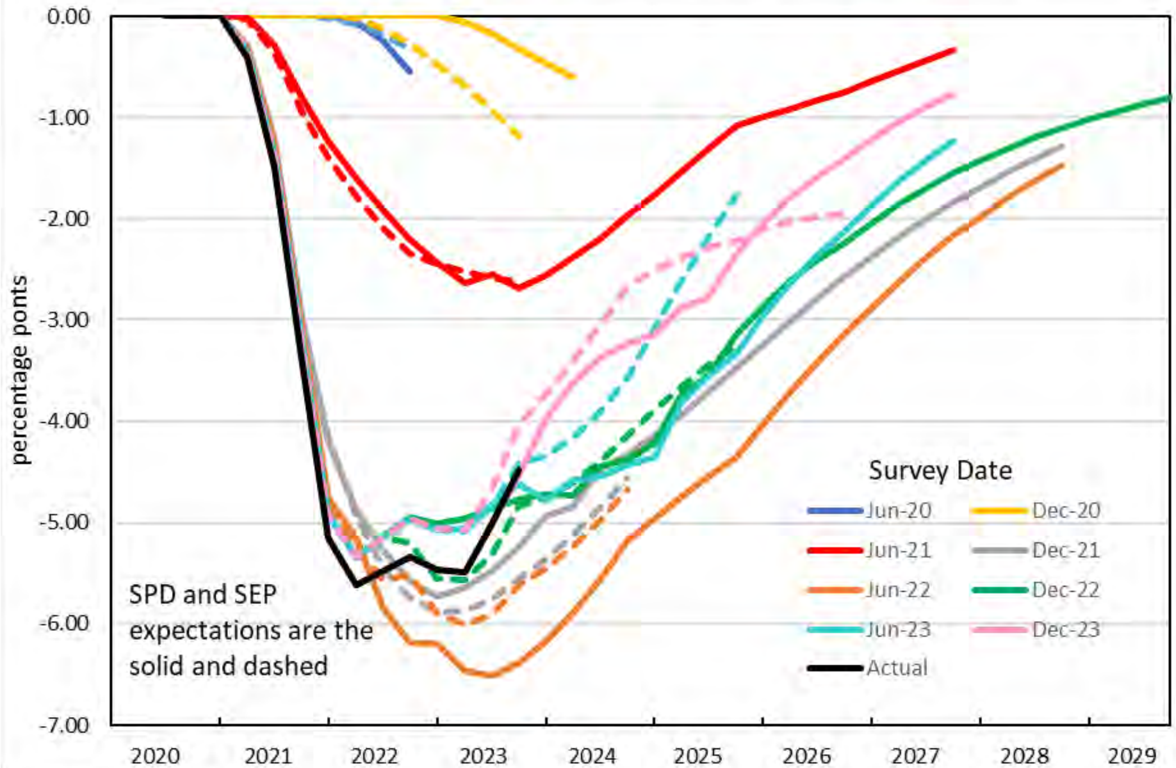


Source: Bureau of Labor Statistics, Federal Reserve Bank of New York, Federal Reserve Board, and author's calculations.

Forecasts of the unadjusted ratio of vacancies to unemployment V/U are constructed to be consistent with the SPD and SEP projections of the unemployment rate U under the assumption that forecasters would have always projected the last observed difference between the rescaled ratio ZVU and U to gradually fade to zero at a constant rate of 10 percent per quarter.

The figure suggests that forecasters in June 2021 would probably have expected V/U to stay relatively close to its pre-Covid level over the extended horizon. By the end of the year and into 2022, the outlook would have changed markedly to one in which labor market conditions would have been projected to remain tight for several years into the future.

Figure 8. Expected Deviations of the Federal Funds Rate from the V/U Version of the BA Rule Implied by the SPD and SEP Projections

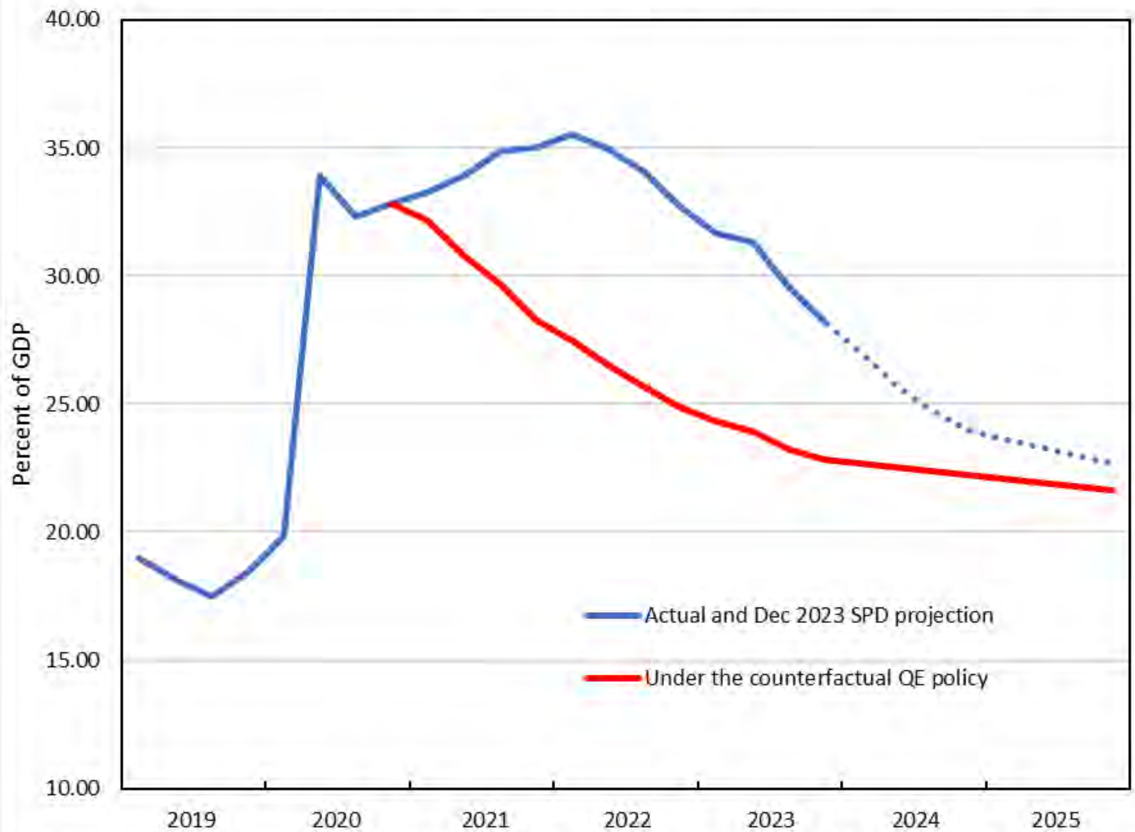


Source: Bureau of Economic Analysis, Bureau of Labor Statistics, Federal Reserve Bank of New York, Federal Reserve Board, and author's calculations.

The BA rule is $I_t = \max\{.13,\ .85I_{t-1} + .15[R^* + \pi_t + 0.5(\pi_t - \pi^*) - 2.0(ZVU_t - U^*)]\}$, where I_t is the prescribed federal funds rate; π_t is the projected four-quarter rate of core PCE inflation in the surveys; ZVU_t is the rescaled ratio of vacancies to unemployment, constructed to be consistent with the SPD/SEP unemployment forecasts; and R^*, π^*, and U^* are the projected longer-run values of the real federal funds rate, PCE inflation, and the unemployment rate, respectively. I_{t-1} is set to the actual value of the federal funds rate in 2020Q2 but thereafter is computed dynamically. Actual deviations are computed using the estimates of R^*, π^*, and U^* reported in the December 2023 SPD.

The figure shows that by June 2021 both the FOMC and the primary dealers implicitly expected the federal funds rate to run persistently well below what the rule would have prescribed given their respective outlooks for real activity and inflation. In subsequent projections, their expectations that policy would be persistently easy relative to the rule became even more pronounced, although that expectation has moderated somewhat since mid-2022.

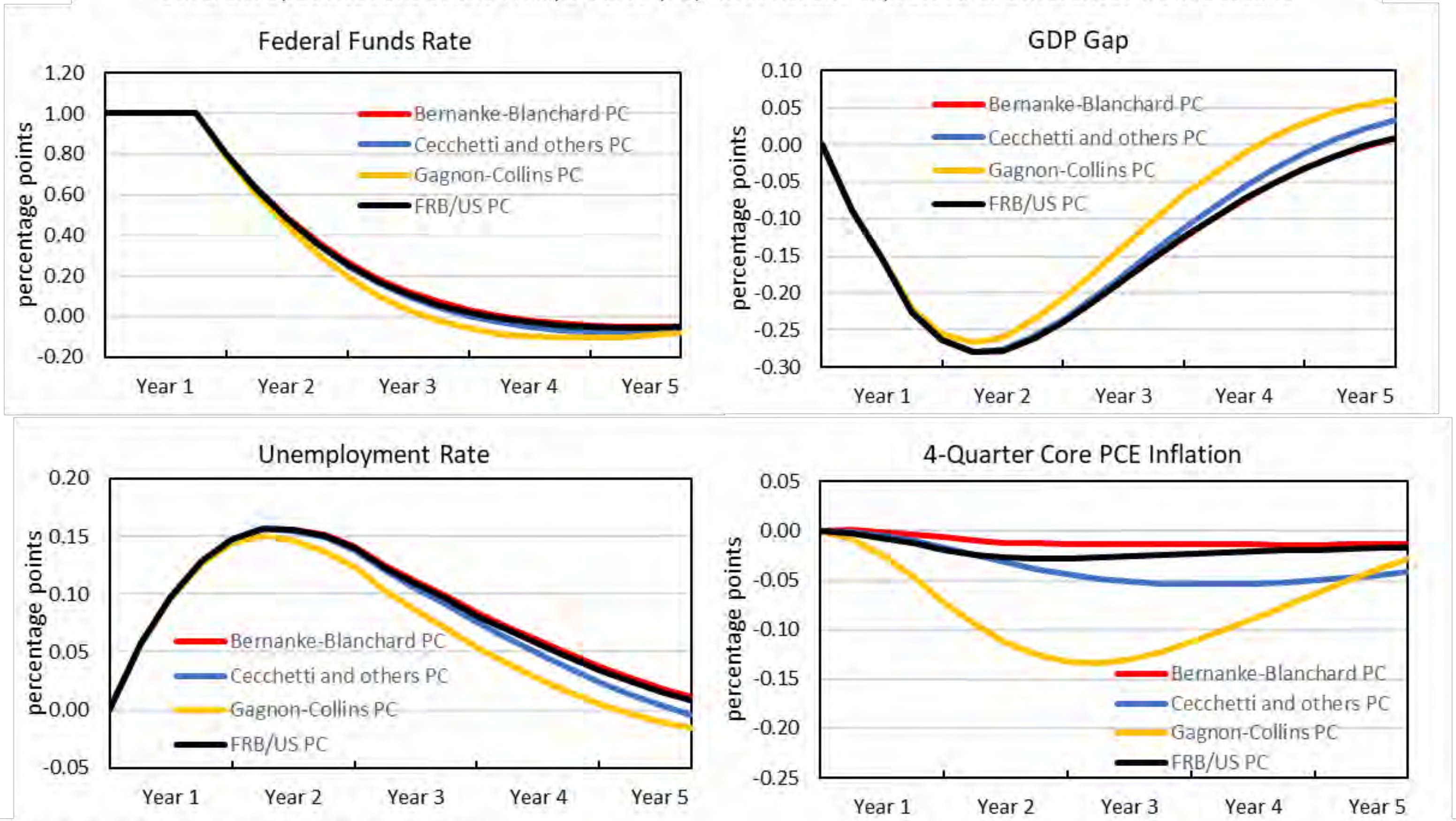
Figure 9. Total Assets held on the Federal Reserve's Balance Sheet



Source: Federal Reserve Bank of New York, Federal Reserve Bank of St. Louis, and author's calculations.

In addition to its interest rate actions and forward guidance after Covid hit, the FOMC sought to ease financial stress and provide additional accommodation through large-scale purchases of MBS and Treasury securities. These purchases continued through April 2022, at which point the FOMC switched to allowing its holdings to run off passively. Under the counterfactual QE strategy, the FOMC instead announces in late January 2021 that it has ceased purchases and has begun gradually normalizing the size of the balance sheet. As a result, the counterfactual path of the Fed's balance sheet expressed as a percent of nominal GDP runs well below the actual path.

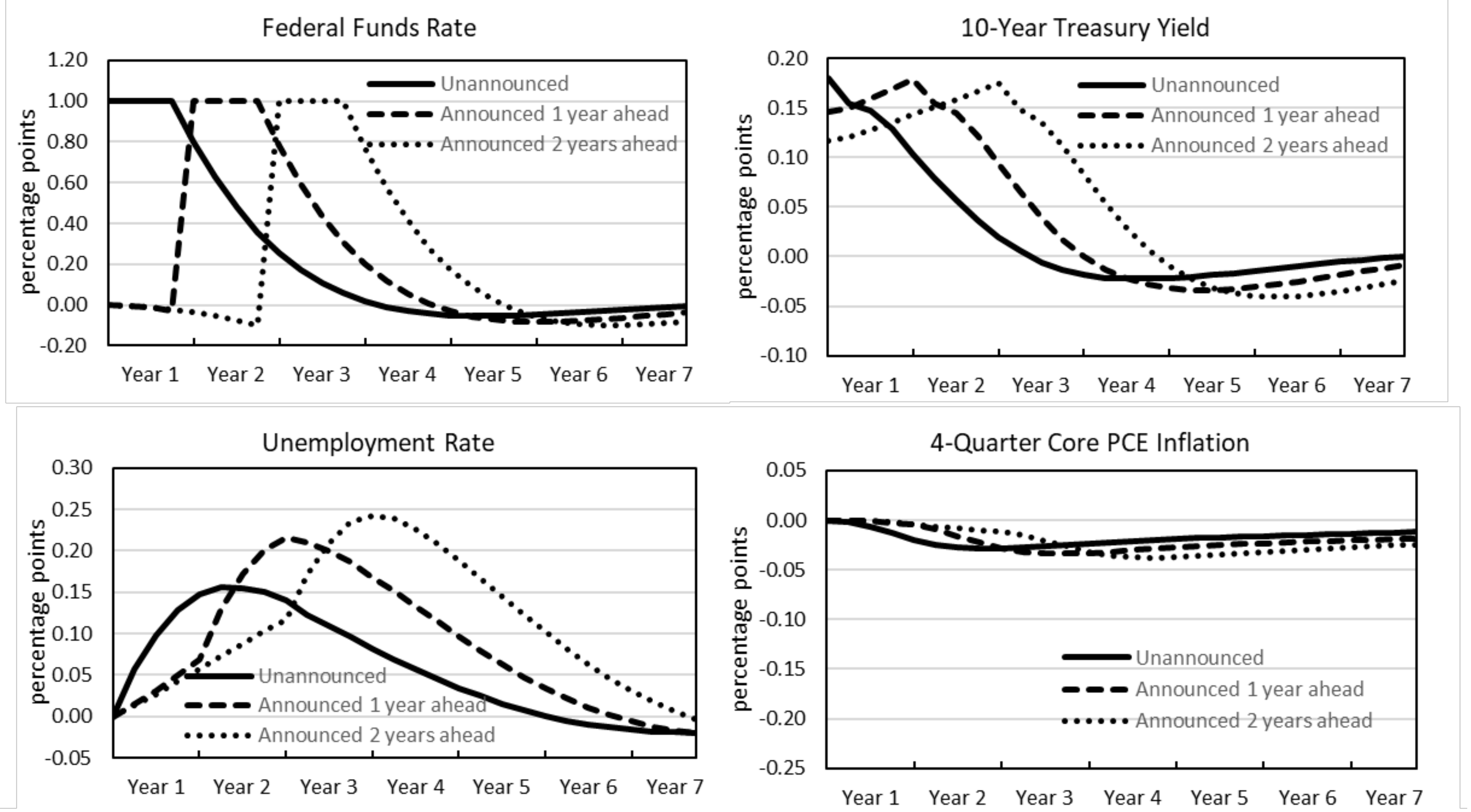
Figure 10. Effect of a 4-Quarter Hike in the Federal Funds Rate in the FRB/US Model, Modified to Incorporate Different Specifications of the Phillips Curve (PC), with Results Expressed as Differences from Baseline



Source: Federal Reserve Board and author's calculations.

For details on the specifications of the different Phillips curves, see the appendix. Baseline economic conditions are consistent with being in the steep portion of the nonlinear inflation equations estimated by Cecchetti and others and Gagnon and Collins. In the simulations, well-informed financial market participants are assumed to have model-consistent expectations; in contrast, less-informed households and other agents revise their expectations in line with the predictions of a small VAR model. The federal funds rate follows the prescriptions of the balanced approach rule after Year 1.

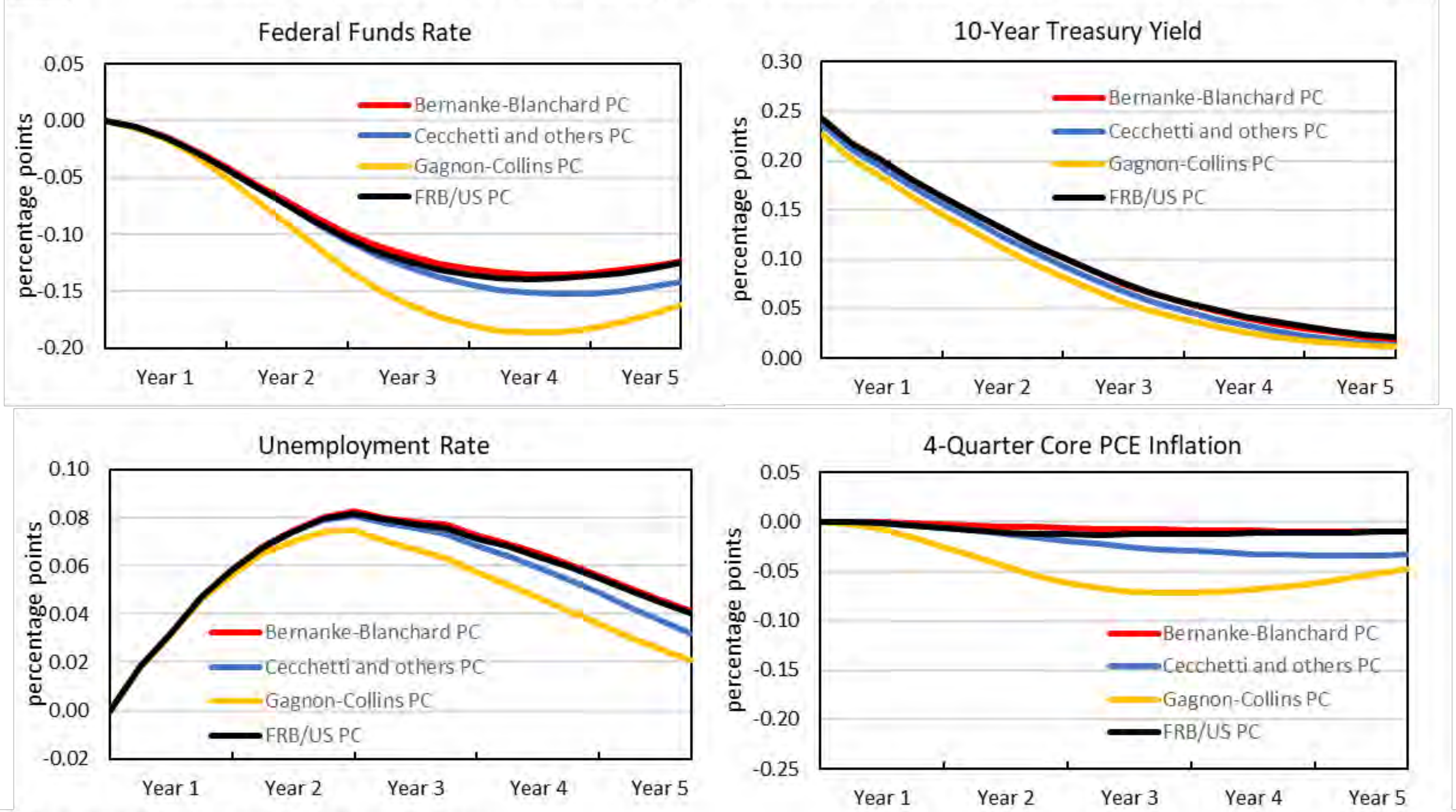
Figure 11. Effect of Unannounced and Pre-Announced Hikes in the Federal Funds Rate in the Standard Version of the FRB/US Model, with Results Expressed as Differences from Baseline



Source: Federal Reserve Board and author's calculations.

In the simulations, well-infomed financial market participants fully understand the economic implications of the hikes in the federal funds rate and regard the pre-announced ones as credible. In contrast, less-informed households and other agents revise their expectations in response to events only as they occur based on the predictions of a small VAR model. Outside of the hike period, the federal funds rate follows the prescriptions of the balanced approach rule.

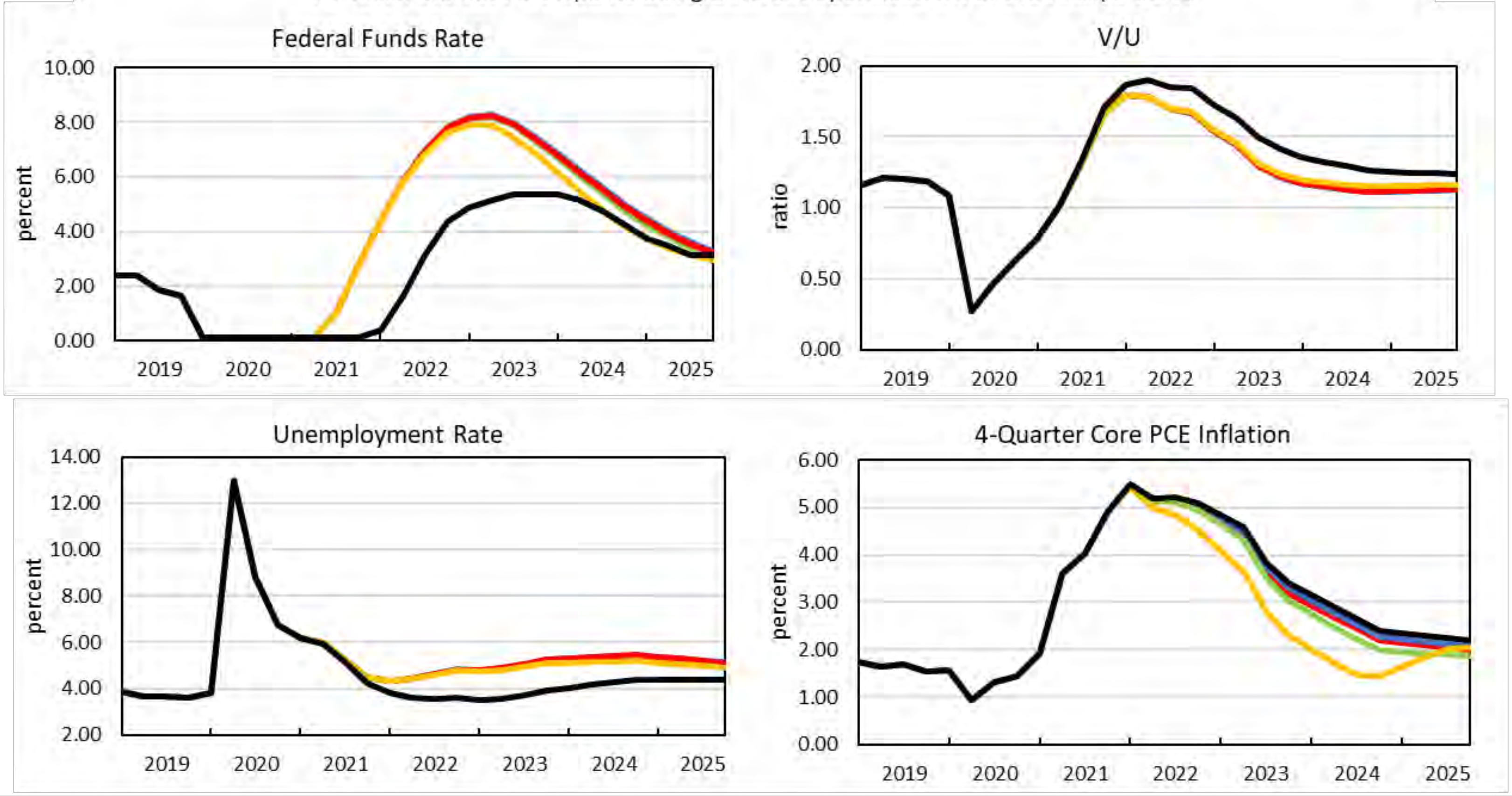
Figure 12. Effect of Transitory Increases in Term Premiums in the FRB/US Model, Modified to Incorporate Different Specifications of the Phillips Curve (PC), with Results Expressed as Differences from Baseline



Source: Federal Reserve Board and author's calculations.

For details on the specifications of the different Phillips curves, see the appendix. Baseline economic conditions are consistent with being in the steep portion of the nonlinear inflation equations estimated by Cecchetti and others and Gagnon and Collins. In the simulations, well-informed financial market participants have model-consistent expectations while less-informed households and other agents revise their expectations in line with the predictions of a small VAR model. The federal funds rate follows the prescriptions of the balanced approach rule. In quarter 1, 5-year, 10-year, and 30-year Treasury term premiums jump 25, 35, and 11 basis points, respectively, and thereafter fade away linearly over the next 24 quarters.

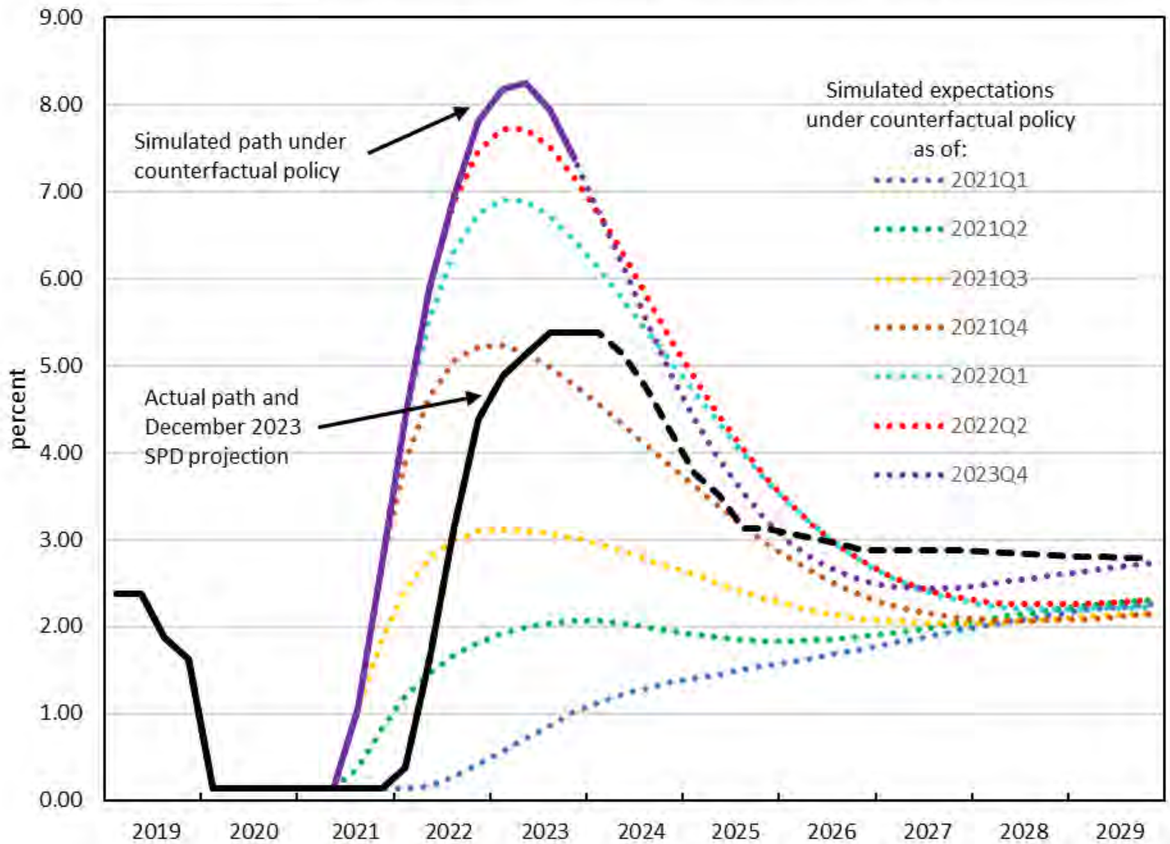
Figure 13. Economic Effects of the Counterfactual Monetary Policy: FRB/US Simulations Assuming Well-Informed Financial Market Participants Using Different Specifications of the Phillips Curve



Source: Bureau of Labor Statistics, Bureau of Economic Analysis, Federal Reserve Bank of New York, Federal Reserve Board, and author's calculations.

The black lines are actual and SPD projected results. The other lines are simulation results derived using wage and price equations based on the standard FRB/US model (red), the Bernanke and Blanchard specification (blue), the Cecchetti and others hot/cold model (green), and the Gagnon and Collins low inflation bend model (yellow). Under the counterfactual policy, in early 2021 the FOMC announces that it will follow the prescriptions of the V/U version of the BA rule and will begin normalizing the size of the SOMA portfolio. In response, financial markets revise their expectations as predicted by the model but do not have perfect foresight about future shocks to real activity and inflation. Other agents are less informed and revise their expectations in line with the predictions of a small VAR model.

Figure 14. Simulated Evolution of Financial Market Expectations for the Federal Funds Rate under the Counterfactual Policy

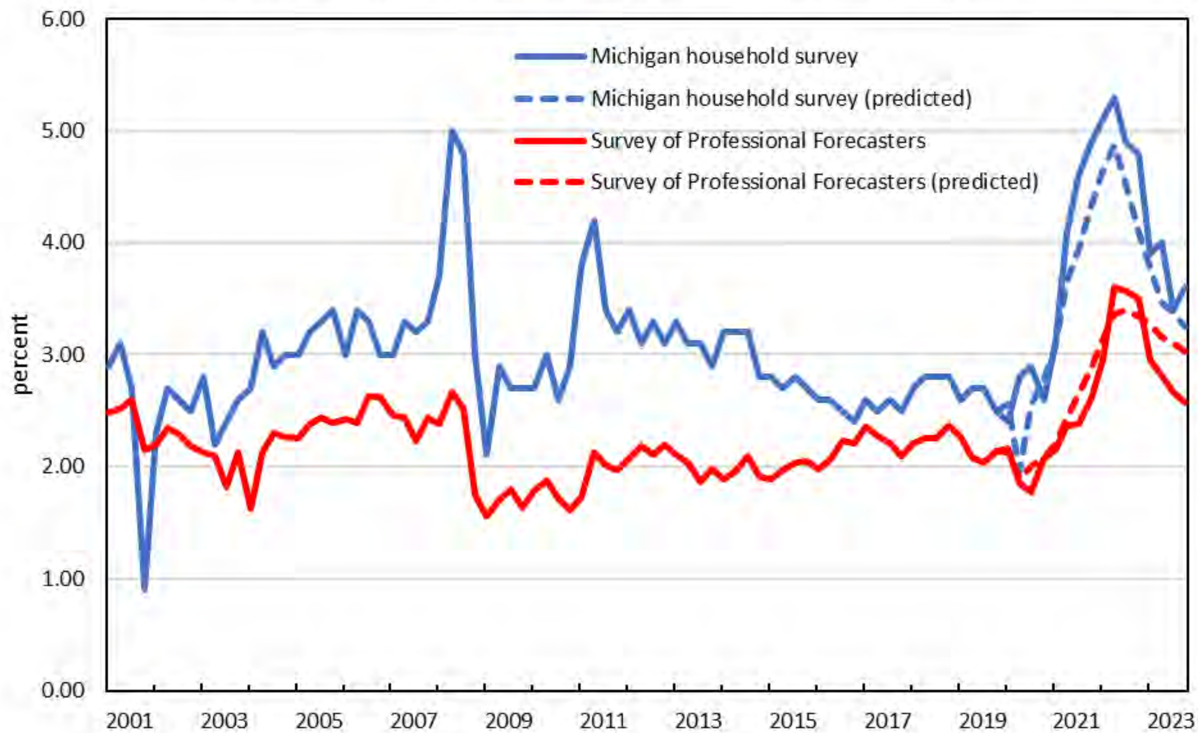


Source: Federal Reserve Bank of New York, Federal Reserve Board, and author's calculations.

The expected paths are generated using the standard version of the FRB/US model and a sequence of baselines, where each baseline replicates the median projections for the federal funds rate, real activity, and inflation reported in the Survey of Primary Dealers (SPD) released in the last month of each quarter. Under the counterfactual policy, the FOMC announces in early 2021 both the start of balance-sheet normalization and that it will follow the V/U version of the BA rule. In the simulations, financial market participants fully understand the implications of the change in policy for future economic conditions but do not have perfect foresight about future shocks to real activity and inflation; instead, they only learn about these shocks over time as implicit in the evolution of their projections. Outside of financial markets, households and other agents have only limited information about the effects of the change in monetary policy.

The figure illustrates that the counterfactual monetary policy (if deemed credible) would likely have had a large effect on financial market expectations over time, but these effects would have been modest to start because these agents did not initially anticipate the shocks that would cause inflation to persistently surge later in 2021 and in 2022.

Figure 15. Survey Measures of Short-Run Inflation Expectations:
Actual and Predicted Based on Current and Lagged Headline CPI Inflation

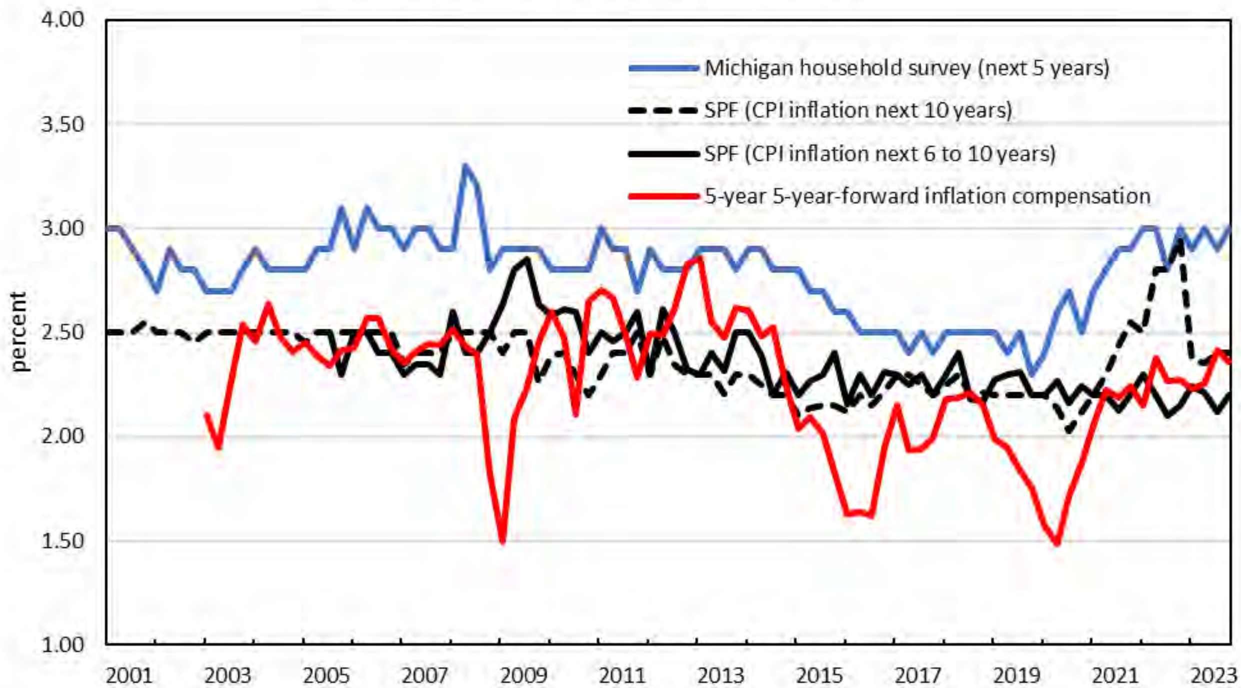


Source: University of Michigan, Federal Reserve Bank of Philadelphia, and author's calculations.

Predicted short-run inflation expectations are out-of-sample forecasts derived from regressions of each survey measure on a constant, the lagged survey measure, and current and lagged CPI inflation using quarterly data from 1990 to 2019. The out-of-sample predictions are dynamic and use the lag of the predicted value of each measure.

The figure illustrates that, post-Covid, measures of short-run inflation expectations have evolved about as would have been expected given the actual movements in inflation.

Figure 16. Measures of Expected Long-Run Inflation



Source: University of Michigan, Federal Reserve Bank of Philadelphia, and Federal Reserve Bank of St. Louis.

The SPF measure of expected inflation 6 to 10 years ahead is constructed using the median SPF projections of CPI inflation over the next five years and over the next 10 years. Note that the inflation compensation is not a pure measure of expected inflation but includes the effects of differential movements in liquidity and risk premiums between inflation-indexed and non-indexed Treasury securities.

The figure illustrates that survey-based measures of expected long-run inflation have moved in a fairly narrow range post-Covid despite the huge surge in actual inflation. Forward inflation compensation derived from yields has been more variable but this measure is strongly influenced by movements in liquidity and inflation-risk premiums on the yields of indexed Treasury securities relative to non-indexed yields.

PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

POLICY BRIEF

24-11 Was Something Structurally Wrong at the FOMC?

Alan S. Blinder

October 2024

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INTRODUCTION

There is little doubt that the Federal Reserve was late to start raising interest rates as inflation rose in 2021–22. Even Chair Jerome Powell admitted that not starting until March 2022 was too late.[1] Some critics have even accused the Federal Open Market Committee (FOMC) of being as much as a full year late in pulling the rate trigger,[2] though that seems exaggerated to me. In fact, as late as January 2022, private forecasters were more or less where the Fed was: forecasting that core personal consumption expenditures (PCE) inflation, then over 5 percent, would decline to about 2¼ percent in 2023.[3] In that case, why raise rates? All the inflation optimists were wrong, of course. But if misery loves company, the Fed had plenty of both.

THE FORECASTING ERROR

I begin this Policy Brief with the forecasting error because mistakes in monetary policy often emanate from poor forecasts rather than from any structural problem at the central bank. This one surely did. But why was the inflation forecast so important? And why was it so wrong?

Alan S. Blinder was a distinguished visiting fellow at the Peterson Institute for International Economics from September 2023 to January 2024. He has been on the Princeton faculty since 1971, taking time off from January 1993 through January 1996 for service in the US government, first as a member of President Bill Clinton's original Council of Economic Advisers and then as vice chair of the Board of Governors of the Federal Reserve System. He is grateful for helpful comments from Karen Dynan, Peter Fisher, Heidi Shierholz, and David Wilcox and for fine research assistance from Daniel Sozanski.

1 Rachel Siegel, "Fed Chair says Interest Rates Should Have Gone Up Sooner," *Washington Post*, May 12, 2022.

2 John B. Taylor, "The Fed's State of Exception," *Project Syndicate*, August 13, August 2021.

3 David Wilcox, "If the Fed Is Wrong on Inflation, It's Not Alone," *Bloomberg Terminal*, January 23, 2022 (subscription required).

Regarding the first question, it is well known that the effects of monetary policy on inflation arrive only after "long and variable lags." As a hypothetical example, but one that is highly relevant to the present context, imagine that inflation is running at 3 percent, and the central bank's forecast under current policy is that it will either (1) recede to 2 percent in one or two years; or (2) rise to 4 percent in one or two years. The monetary policies suggested by these two alternative forecasts are radically different, and many forecasts in early 2022 looked more like the former rather than the latter. The Fed's forecasts in its Summaries of Economic Projections (SEPs) certainly did.

Except when the inflation rate is going nowhere (as was true in the pre-pandemic years), forecasting inflation is fraught with risk. And the task becomes next to impossible when there are large supply shocks and when you lack a usable Phillips curve. As a classic example of the former, the Congressional Budget Office's retrospective on its own forecasting errors since 1976 concluded the following: "Some of the largest errors in forecasting Consumer Price Index (CPI) inflation can be attributed to forecasters' inability to predict major changes in crude oil prices. For example,…oil prices increased rapidly in 2022 [due to] Russia's invasion of Ukraine."[4] In the early 2020s, the FOMC was handicapped by both supply shocks and only a dim memory of a reliable Phillips curve.

So why not eschew the so-called preemptive strategy, which requires acting on a forecast, and adopt instead what I have called the Bunker Hill strategy? *Don't fire your interest rate bullets until you see the whites of inflation's eyes*.

The traditional answer is that, because of lags, the Bunker Hill strategy will always leave the central bank behind the curve, whether inflation is rising or falling. Although the FOMC didn't say so in August 2020, many observers interpreted the Fed's new framework as favoring Bunker Hill over preemption despite the inflation risk. *Let's not tighten just because unemployment is low*. Remember, after years of watching inflation run below its 2 percent target, allowing a modest overshoot of inflation seemed welcome.

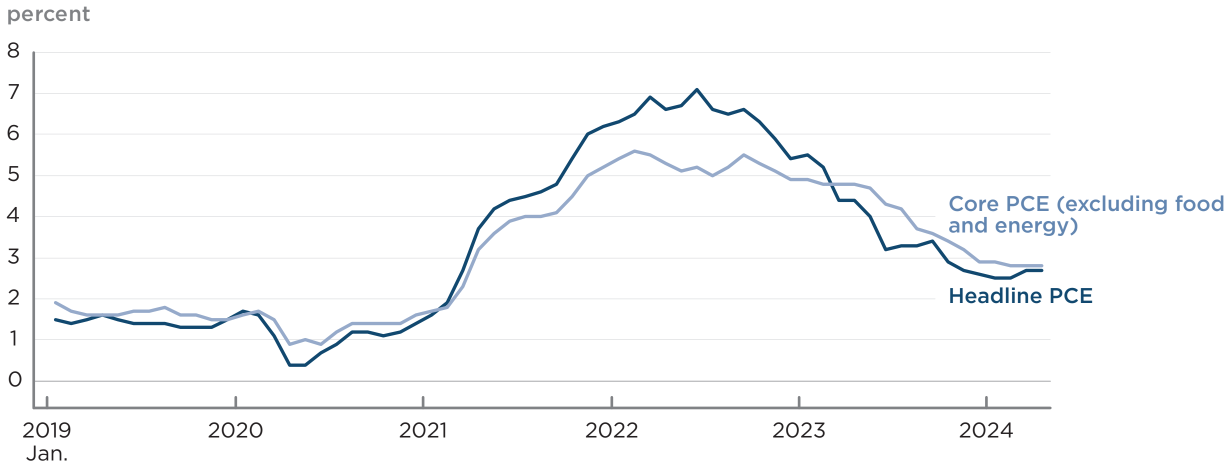
Several other bits of data—many of them now forgotten—were relevant to what seems in retrospect to have been excessive complacency at the FOMC. Perhaps foremost among these were residual worries about the strength of the economy. Real GDP growth was reported contemporaneously to be slightly *negative* in both 2022Q1 and 2022Q2—thereby meeting the media's definition of a recession—although domestic private demand was much stronger.[5] (The National Bureau of Economic Research's dating committee was not tempted to declare a recession.) Lacking a crystal ball, the Fed had no idea that growth would speed up to nearly 4 percent in the second half of 2023.[6] In fact, between the March 2022 and June 2022 SEPs, the FOMC's median forecasts for growth in 2022 and 2023 were *reduced* from 2.8 percent and 2.2 percent, respectively,

4 Grace Berry and Edward Gamber, CBO's Economic Forecasting Record: 2023 Update, Congressional Budget Office, June 2023.

5 In the 2024 revisions of the NIPA accounts, 2022Q2 turned slightly positive (at 0.3 percent), and 2022Q1 remained negative (at –1.0 percent).

6 The FOMC's March 2022 forecast of growth over the four quarters of 2023 was just 2.2 percent. (The actual number was almost 3.1 percent.) Its June 2022 forecast for 2023 was even lower—1.7 percent. These and other FOMC forecasts come from various issues of the FOMC's SEP.

Figure 1
Core and headline PCE inflation, January 2019–April 2024



Source: Bureau of Economic Analysis via Federal Reserve Bank of St. Louis, Federal Reserve Economic Data.

to 1.7 percent in both years—evidence of greater pessimism. Commensurate with that revision, the committee also marked up its unemployment forecasts for the ends of 2022 and 2023.

Yet inflation was high and rising alarmingly at the time, so the Fed finally started tightening in March 2022, albeit cautiously at first. It must, however, have had some residual worries about the strength of the economy.

Lest you think I am bending over backwards to support a revisionist history designed to cover up an egregious policy error, as late as August 31, 2022, the blog of the Federal Reserve Bank of St. Louis, an institution not known as a hotbed of dovish sentiment and certainly not controlled by Washington, concluded the following:

> According to the August Blue Chip Consensus, real GDP growth will average less than 1% annualized over the second half of this year and into the first half of 2023.... While the expected return to positive GDP growth is heartening, heightened uncertainty about the outlook for medium-term inflation and the likelihood of further tightening actions by the FOMC suggests that *risks to the macroeconomy remain tilted to the downside*. (Italics added)[7]

Beyond growth worries, there were also some oddities in the various measures of inflation—perhaps enough to sow confusion. Regardless of whether you focus on the consumer price index (CPI) (as the media does) or the PCE measure (as the Fed does), the gap between headline and core measures widened spectacularly—a sure sign that major food and energy shocks were afoot. Figure 1 illustrates this phenomenon using 12-month percent changes in the headline and core PCE price indexes. You can see that the gap between core and headline PCE inflation was negligible early in 2021, rose to almost a percentage point in 2021, and then soared to a peak of nearly 2 percentage points in June

7 Kevin Kliesen, "GDP Growth, Decelerating Inflation in U.S. Economic Outlook," Federal Reserve Bank of St. Louis. August 31, 2022.

2022. By March 2023, the gap was all the way back down to zero. Notably, these supply shocks began before the Russian invasion of Ukraine in February 2022. But they got a substantial boost from that war.

Since the 1980s, the Fed and other central banks have learned to "look through" food and energy shocks for two main reasons: Central banks can't do anything about them, and they generally disappear or even reverse on their own.[8] This thinking was one driving force behind the optimistic predictions made in 2021 and 2022 by "Team Transitory," of which I admit to being a member (and which the FOMC also joined). We were wrong, though only on the timing. The "transitory" inflation lasted too long to merit that diminutive adjective. But figure 1 shows that inflation eventually fell dramatically and the gap between core and headline reversed.

One reason for the longer-than-expected delay in disinflation is that much more than food and energy shocks was occurring in the COVID and post-COVID periods. That's why (and when) the traditional term "supply shock" gave way to a new and different term: "supply disruptions." These disruptions extended well beyond the food and energy sectors; indeed, they mostly affected items included in core inflation. They also lasted longer than many economists thought likely.

The supply disruptions were so ubiquitous and varied that—unlike, say, oil prices—they defied measurement. How do you combine soaring shipping costs with strains on container and port capacity, shortages of trucks and truckers, and even (for a while) of cardboard boxes? The Federal Reserve Bank of New York now maintains a Global Supply Chain Pressure Index (GSCPI) that attempts to summarize most of that. They describe it as follows on their website:

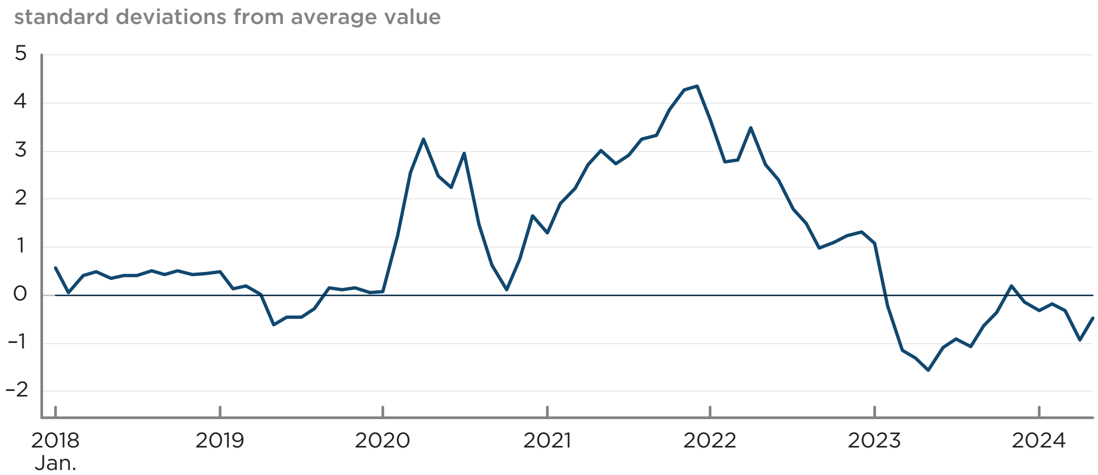
> The GSCPI integrates a number of commonly used metrics with the aim of providing a comprehensive summary of potential supply chain disruptions. Global transportation costs are measured by employing data from the Baltic Dry Index (BDI) and the Harpex index, as well as airfreight cost indices from the U.S. Bureau of Labor Statistics. The GSCPI also uses several supply chain-related components from Purchasing Managers' Index (PMI) surveys, focusing on manufacturing firms across seven interconnected economies: China, the euro area, Japan, South Korea, Taiwan, the United Kingdom, and the United States.[9]

Figure 2, which shows the behavior of this index since 2018, tells the following story. There were basically no unusual supply pressures before the pandemic, a notable climb to about three standard deviations above the mean when the pandemic struck, a surprising drop later in 2020, and then a huge and prolonged climb to a peak more than four standard deviations above the mean from late 2020 to late 2021. The supply pressures disappear only in early 2023. Little if any of this action is captured by the standard distinction between core and headline inflation. It basically happened in the core, reflecting the inability of supply to keep pace with soaring demand for many types of goods.

8 Lael Brainard, "What Can We Learn from the Pandemic and the War about Supply Shocks, Inflation, and Monetary Policy," speech at the 21st BIS Annual Conference: Central banking after the pandemic: challenges ahead, Bank for International Settlements, Basel, Switzerland, June 24, 2022.

9 Federal Reserve Bank of New York, Global Supply Chain Pressure Index (accessed June 20, 2024).

Figure 2
Federal Reserve Bank of New York Global Supply Chain Pressure Index, January 2018–May 2024



Source: Federal Reserve Bank of New York.

These unusual supply-demand imbalances go a long way toward explaining why Team Transitory got the timing so wrong. And they don't suggest any structural problem with FOMC procedures, just incorrect guesses about what an unprecedented set of circumstances would bring.

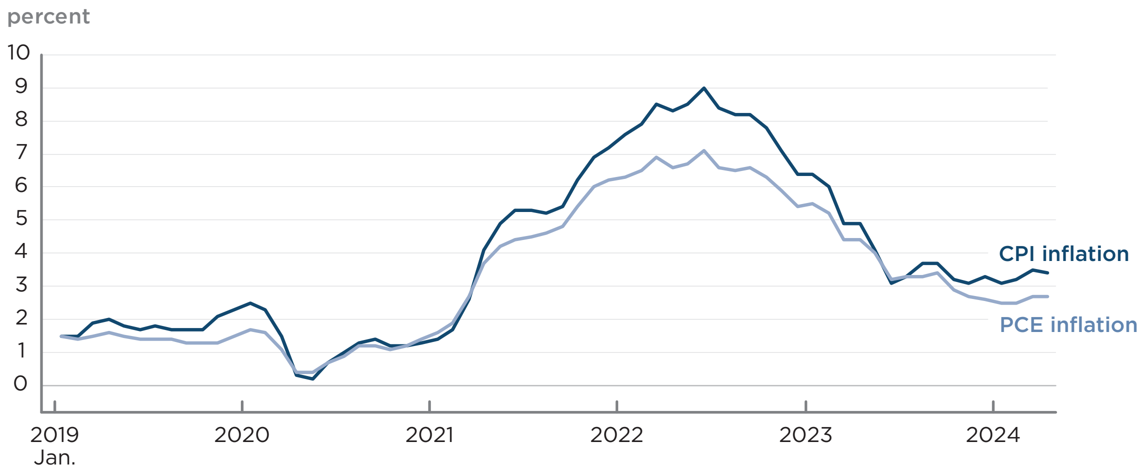
Some, but certainly not all, of the supply chain disruptions may underlie another unusual aspect of the inflationary outburst of 2022: CPI inflation ran far above PCE inflation, especially in 2022, when the gap between the two rose as high as 1.9 percentage points (see figure 3). The difference from normal is quantitative, not qualitative, as CPI inflation runs above PCE inflation most of the time—the average gap between 1990 and 2019 was about 50 basis points.[10] By comparison, the CPI-PCE gap shown in figure 3 is huge.

Now try to put yourself in the shoes of a Federal Reserve inflation forecaster circa 2022. Inflation has been rising for months, but:

- You adopted flexible *average* inflation targeting in August 2020—a framework that now calls for some overshooting of the 2 percent target. (More on this later.)
- The US economy actually looked to have *shrunk* in the first half of 2022.
- Headline inflation is running well above core inflation, and you know that gaps like that normally close on their own.
- CPI inflation is running well above PCE inflation, which is your target. The gap is far larger than the historic norm.
- Mainstream forecasts of inflation over the next year or two are relatively benign.

10 Thus the Fed's 2 percent PCE target translates to a 2.5 percent CPI target—a point that is often forgotten.

Figure 3
PCE and CPI inflation, January 2019–April 2024



Source: Bureau of Economic Analysis and Bureau of Labor Statistics via Federal Reserve Bank of St. Louis, Federal Reserve Economic Data.

Is it any wonder that the Fed let itself fall behind the curve?

None of this is meant to exonerate the FOMC. It was slow to start raising rates even after inflation began to rise. By March 2022, the 12-month CPI inflation rate was already up to 8.5 percent, near its eventual peak. FOMC members also heard many voices complaining that they were "behind the curve." An error is an error, and this was a large one. I'm only arguing that the error was understandable, not an episode of contagious stupidity within a committee nor a reflection of some structural problem in the way monetary policy decisions are reached, such as overreliance on groupthink.[11]

The rest of this Policy Brief focuses on possible reasons for the policy error, quickly eliminating several and then focusing on the Fed's August 2020 framework—and how it might share the blame. The central question is: Did something structural make the FOMC susceptible to this error? To anticipate what may be a surprising conclusion, I will argue that something as simple as having a point target (2 percent), rather than a range (say, 1.5 to 2.5 percent), may have been more problematic than is commonly understood. Call that problem "structural" if you like. I call it easily fixable.

A DOVISH FOMC?

The Fed's dual mandate allows some leeway for FOMC members to disagree over the relative weights on low inflation versus high employment, and also where the natural rate of unemployment is. While every committee member seeks a 2 percent PCE inflation rate, more dovish members may place a higher weight on employment than more hawkish ones during the adjustment to 2 percent. They may also have a lower estimate of the natural rate of unemployment. In a close

11 On the debate over groupthink on the FOMC, see Peter Coy, "Is the Fed Falling Prey to Groupthink?" *New York Times*, January 15, 2024.

call, such disparate views may matter even though everyone agrees on the same inflation target.

Was the FOMC of 2021 unusually dovish? I don't think so. It's hard for me to think of a committee that included Esther George, James Bullard, Loretta Mester, Michelle Bowman, and Christopher Waller as packed with doves who are soft on inflation.[12] Financial media often rank FOMC members on a dovish-hawkish scale. While such rankings are far from scientific, in July 2021, the *Financial Times* rated six members as hawkish, six as dovish, and six, including the chair, as "centrists."[13] Sounds evenly divided. But the centrists in the ranking included Mester and Waller, which seem like clear misclassifications to me.[14]

Even if the FOMC had been loaded with doves at the time, that would not have signaled a *structural* design flaw. After all, it is US presidents who get to select Fed governors over time (subject to Senate confirmation). If those choices are deemed "too dovish," you know whom to blame. The 12 Reserve Bank presidents, on the other hand, are *not* presidential appointees. But they tend to be more hawkish on average than the governors,[15] whom they outnumber around the FOMC table though not in the vote.[16] So you might, if anything, argue that the FOMC's legal composition tilts structurally hawkish.[17]

IS A COMMITTEE JUST SLOW TO MOVE?

Another possibility is that committee decisions are just hard to change, especially if committee members value consensus and seek unanimity—both of which generally characterize the FOMC and definitely characterize Chair Powell.[18] If consensus-seeking members who are watching the same data change their minds only gradually, and not synchronously, it may take a while before the whole committee is prepared to act. As evidence for such inertia, we know that econometrically estimated Taylor rules that allow last quarter's funds rate to enter the equation always find it to be significant.[19]

The FOMCs of late 2021 and early 2022 had been living at the Fed's version of zero (a range of 0 to 25 basis points) since March 2020. Perhaps the strong attraction of the status quo overwhelmed good judgment. Maybe—but I doubt it. In times of crisis, such as 2008 and 2020, the FOMC has shown itself capable of moving dramatically and quickly.

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12 Official Fed jargon distinguishes between FOMC "members" (the 12 who get to vote) and FOMC "participants" (the entire 19). For the most part, this distinction is unimportant, and I don't make it.

13 There was one vacancy on the Board at the time.

14 Colby Smith and James Politi, "Hawks vs. Doves: US Federal Reserve Divided Over When To Dial Back Economic Support," *Financial Times*, July 25, 2021.

15 Among many possible sources, see Federal Reserve Bank of St. Louis, "A History of FOMC Dissents," September 16, 2014, updated September 2024.

16 Only five Reserve Bank presidents get to vote at any meeting.

17 Faust (1996) makes this claim and provides a rationale.

18 Not all monetary policy committees seek unanimity. Some prominent counterexamples are the monetary policy committees of the Bank of England and the Sveriges Riksbank, which I have called *individualistic* committees (Blinder 2004).

19 See Clarida, Gali, and Gertler (2000, pp. 157–158) and Sack (1998, pp. 2–4). For further debate and discussion on policy inertia, see Rudebusch (2002, 2006).

Besides, experimental evidence suggests that committees react to incoming data about as quickly as individual decision makers do. Since Blinder and Morgan (2005) first discovered this surprising finding in an experiment with Princeton University students, it has been replicated with different subjects in different countries. The first, I believe, was by a team of Bank of England economists using students from the London School of Economics (Lombardelli, Proudman, and Talbot 2005). A questionnaire study of monetary policy committee (MPC) members at Norges Bank and the Sveriges Riksbank found that members believe that group decisions on monetary policy are better than individual ones (Apel et al. 2015). That would imply, among other things, that they are not inertia bound.

THE AUGUST 2020 FRAMEWORK

If central bankers believe that raising interest rates will slow economic growth and job creation, as most do, that belief alone should make banks with a dual mandate slower on the trigger than what Mervyn King (1997, p. 89) memorably called "inflation nutters," meaning banks that care only about inflation. The Fed, of course, has long had a dual mandate, given to it by Congress that has not changed for decades, and the Fed speaks of it often. However, in August 2020 the FOMC announced several meaningful changes in the way it was going to interpret that unchanged mandate.

To understand these changes, it is useful to compare them with what came before. Theoretical models of central bank behavior are typically built around a periodic loss function that looks something like this:

$$L = (\pi - \pi^*)^2 + \lambda(y - y^*)^2.$$

Here π^* is the inflation target, the Fed's rendering of "stable prices," which is now 2 percent; and y^* is full-employment GDP, the operational version of "maximum employment."[20]

Notice two aspects of this loss function. First, the quadratic functional form embodies a strong symmetry. Too much employment (represented by $y > y^*$) is modeled as being just as bad as too little (represented by $y < y^*$). This is a dubious proposition, to say the least, especially when inflation is already penalized in the loss function. Why fret about high employment except for its possible effect on inflation?[21]

Second, the period-by-period inflation target is always 2 percent. It does not depend, e.g., on recent history. Rather, bygones are bygones. An inflation miss on the low side does not mean that the central bank will try to engineer an equal and opposite miss on the high side. Both of these symmetrical aspects were altered in August 2020.

The employment target was changed from gaps to shortfalls: "The Committee seeks over time to mitigate shortfalls of employment from the Committee's

20 $y - y^*$ could easily be changed to $u - u^*$ for unemployment or $E - E^*$ for employment.

21 In pure economic theory, the answer might be that y^* is the first-best equilibrium level of GDP, so that any deviation yields lower utility. Actual policymakers are not detained by such thoughts.

assessment of its maximum level."[22] Given the moribund Phillips curve, the FOMC would no longer raise rates only because employment was thought to be overshooting its natural rate. This change was meaningful, important, and possibly germane to the policy error of 2021–22. After all, previous FOMCs might have been spooked by the persistently low unemployment rates that began late in 2021, and therefore might have been inclined to raise interest rates sooner.

In fact, I was on the FOMC that achieved the perfect soft landing in 1994–95, and that is precisely what we did. With inflation steady around 3 percent, not rising, our principal rationale for raising the funds rate was fear that very low unemployment would trigger higher inflation. We were lauded for that "preemptive" approach at the time. But maybe we were wrong—after all, unemployment fell further in the 1990s without higher inflation.

Whether or not the asymmetry implied by concentrating on shortfalls rather than deviations from the natural rate contributed much to the policy error of 2021–22 depends on whether you believe that an overheated economy contributed much to the burst of inflation. The *ex post* evidence seems to say "not much." (More on this shortly.) But that was not obvious *ex ante*. The various rounds of fiscal stimulus alone were enormous and the pent-up demand to spend was palpable as Americans emerged from their COVID shelters.

The other notable change in August 2020 was in the inflation target. It remained at 2 percent for the PCE index but was modified to what came to be called flexible average inflation targeting (FAIT). As the FOMC put it then: "The Committee seeks to achieve inflation that averages 2 percent over time, and therefore judges that, following periods when inflation has been running persistently below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time."[23] Of course, by August 2020 inflation had indeed run "persistently below 2 percent" for some time, so the new framework implied that the FOMC would target inflation modestly *above* 2 percent (how much above?) for a while (how long?).

The revised policy framework was criticized for its vagueness and asymmetry. Notably, the FOMC's statement did not state that following periods when inflation has been running persistently *above* 2 percent, appropriate monetary policy would likely aim to achieve inflation moderately *below* 2 percent for a while. And nowadays, despite the burst of inflation far above 2 percent in 2021–24, nobody expects that, once the Fed reaches its 2 percent target, it will try to push inflation even lower for a time. The asymmetry was presumably intended, as the big perceived threat then was getting constrained by the effective lower bound on nominal interest rates. Bygones on the upside were to remain bygones.

Obviously, both of these August 2020 changes pushed the FOMC in the dovish direction. Blaming the new framework, which could certainly be considered "structural," for the high inflation that soon followed therefore

22 Board of Governors of the Federal Reserve System, Federal Open Market Committee announces approval of updates to its Statement on Longer-Run Goals and Monetary Policy Strategy, press release, August 27, 2020.

23 Federal Reserve Board, 2020 Statement on Longer-Run Goals and Monetary Policy Strategy, January 14, 2021.

seemed natural—and many have done so.[24] My guess is that 2025 will see changes to the framework.

WAS THE AUGUST 2020 FRAMEWORK REALLY TO BLAME?

The case that dovish asymmetries in the new framework played a role in the policy error seems obvious, and there is no doubt some truth to it. But I think the blame has been exaggerated. Remember, the case against the new framework would have to be that (1) it led the FOMC to stick with easy money for too long; (2) maintaining near-zero interest rates both stimulated excessive aggregate demand and permitted expansionary fiscal policy to do so; and (3) the resulting overheated economy fueled inflation.

At least two major pieces of evidence undermine points (2) and (3). One has already been alluded to: The econometric modeling evidence developed by Reifschneider (2024) and Mark Zandi implies that sticking with excessively loose monetary (and, in Zandi's case, also fiscal) policy for too long added only a minor amount to the 2021–22 inflationary surge.[25] Far bigger contributions came from supply shocks and supply constraints. Tightening monetary policy earlier would have helped, but not much. As Reifschneider (2024, p. 1) concluded, "a more restrictive strategy on the part of the FOMC would have done little to check inflation in 2021 and 2022," and "the modest reductions in inflation suggested by these simulations would have come at a cost of higher unemployment and lower real wages," making "the net social benefit of a more restrictive policy response on the part of the FOMC seem doubtful."

The second piece of evidence is the remarkable behavior of inflationary expectations during this episode. Figure 4 displays the five-year breakeven inflation rate implied by the Treasury Inflation-Protected Securities (TIPS) market from 2019 into 2024. The left-hand side of the graph starts by showing one measure of what was worrying the FOMC prior to the pandemic recession: The expected inflation rate implied by the TIPS market was stubbornly hanging around 1.5 percent when, because TIPS inflation compensation is based on the CPI, the Fed wanted it closer to 2.5 percent.

Expected inflation then briefly plummeted to near zero during the COVID-19 recession before beginning a slow but steady climb to 2.5 percent by March 2021—where it remained for about six months. Notice that this is exactly the number the Fed wanted.

Then came the bad news: Expected inflation by this measure rose in late 2021 and early 2022, briefly reaching a peak of around 3.5 percent before receding into the 2 to 2.5 percent range again. That brief episode must have caused some consternation at the Fed and elsewhere. But when you remember that actual CPI inflation soared from around 5 percent in mid-2021 to about 9 percent in June 2022, and then remained above 6 percent for the next eight months, that rise in expected inflation seems both modest and short-lived. The main impression that should be taken from figure 4 is that long-term inflationary expectations were remarkably well anchored near the Fed's target throughout this period. Despite

24 For some examples, see Levy and Plosser (2024) or Eggertsson and Kohn (2023).

25 Mark Zandi, "U.S. Outlook: The Inflation Story," Moody's Analytics, April 15, 2024 (subscription required).

Figure 4
Five-year breakeven inflation rate implied by the TIPS market, June 2019–June 2024

TIPS = Treasury Inflation-Protected Securities
Source: US Treasury Department via Federal Reserve Bank of St. Louis, Federal Reserve Economic Data.

plenty of bad inflation news that might have spooked traders, markets did not believe the Fed would lose control of an overheating economy.

A RANGE RATHER THAN A NUMBER

My main suggestions for the 2025 framework discussions are that the FOMC should drop FAIT—which it has not followed in any case (no one would call the 2022 inflation overshoot "moderate")—and change its inflation target from 2 percent to a range between 1.5 and 2.5 percent. The midpoint of that range, which naturally attracts most of the attention, would still be 2 percent; so this small change would not be deemed a retreat in the war against inflation. Rather, it would be seen—and should be explained—as an admission that no central bank can control inflation to the first decimal place. Getting within ½ percent of target is good enough.

Let's now rerun the history of 2016–24 on the ahistorical assumption that the FOMC's target had been 1.5 to 2.5 percent, rather than 2 percent, all the time. During the four full years 2016–19, both PCE inflation and core PCE inflation averaged 1.7 percent—with only minor deviations from year to year.[26] With inflation both low and stable, the Fed should have been happy with that outcome. And it would have been happy had it been shooting for a 1.5 to 2.5 percent target range, a range that was almost never breached.

Instead, however, the Fed was distressed that it was constantly falling short of its 2 percent target—by a mere 30 basis points on average! That attitude was silly on its face. Yes, 1.7 is not 2.0, but no human being can detect a 30 basis point difference in the annual rate of inflation. Nor can a central bank be expected to control inflation that tightly. But the FOMC viewed the chronic

26 For headline, annual inflation rates varied between 1.5 and 1.9 percent. For core, the range was 1.5 to 2.0 percent.

undershoot as a failure and felt it necessary to express a desire to push inflation above 2 percent "for some time," presumably to avoid another collision with the effective lower bound.

As inflation subsequently soared to heights not seen in the United States since the 1980s, the difference between a point target (2 percent) and a range (1.5 to 2.5 percent) became totally unimportant: 2.5 percent inflation was in the distant rearview mirror. But as tight money and normalization of supply conditions brought inflation under control, it once again became meaningful.

By April 2024—the last observation available when this Policy Brief was composed—12-month PCE inflation had come down to 2.7 percent. If the FOMC had a 1.5 to 2.5 percent target range today, its disinflation job would be basically over—subject to some wariness that inflation not stage another uprising. Instead, we see a lot of hand wringing about how hard it is to travel "the last mile" to 2.0 percent. In its June 12, 2024 statement, for example, the FOMC said that it "does not expect it will be appropriate to reduce the target range [for the funds rate] until it has gained greater confidence that inflation is moving sustainably toward 2 percent."[27] All this while the real funds rate was pushing 3 percent—clearly implying "tight money."

Looking forward rather than backward, how might changing from a point target to a range alter the FOMC's behavior? Most obviously, it would get the central bank to ignore small deviations from 2 percent as unimportant—which they are. Markets would quickly catch on to that and read nothing into inflation rates of, say, 1.8 or 2.2 percent. More important, a range would reduce (not eliminate) the need for great subtlety in forward guidance, which has tripped up many central banks many times. I say this because the inflation numbers would in some sense speak for themselves. Seeing inflation rise to say, 2.3 percent or 2.4 percent would automatically trigger what we used to call a "tightening bias" as markets focused on inflation approaching its upper bound. Similarly, as inflation approached the lower bound of 1.5 percent, markets would start building in an "easing bias." In principle, this process should be smooth and modestly predictable. While having a range would not be a perfect substitute for forward guidance, it would partly reinforce and partly supplant it.

Notice also that the range would be inherently symmetric, unlike flexible average inflation targeting in practice. When the FOMC announced FAIT in August 2020, it explained—vaguely and presumably intentionally—how it would work only in the case of an undershoot, not in the case of an overshoot. And as mentioned, no one thinks the FOMC will react to the large overshoot since 2021 by trying to create a long period of inflation under 2 percent. So switching to a range in 2025 would be a step back toward symmetry, which hawks may like but doves may not.

Finally, lest anyone think that moving from a point target to a range would put the Federal Reserve out of step with central banking norms, readers should know that it is just the opposite: Central banks with point targets constitute a small minority group. Yes, several of the most prominent central banks—including the European Central Bank, the Bank of England, and the Bank of Japan—do post

27 Board of Governors of the Federal Reserve System, Federal Reserve Issues FOMC Statement, press release, June 12, 2024.

point targets (2 percent) like the Fed. But they are in the clear minority. Most central banks post target ranges. In Canada and New Zealand, where inflation targeting started, it is 1 to 3 percent, which is twice as wide as the range that I am suggesting. In Australia, it's 2 to 3 percent.[28]

The other aspect of asymmetry is the output/employment target, which the FOMC changed to "shortfalls" in August 2020. For reasons already stated, I don't see a strong case for abandoning that language, though others do. The issue is debatable, and I may be showing my own dovish feathers here, but frankly, I'm not convinced it's all that important. I have touched on the main reasons already. For one thing, falling short of "full employment" seems to me like a more serious problem than overshooting full employment. For another, the "Phillips curve," to the extent that one exists, looks pretty flat, meaning that modest overshoots will lead to only small increases in inflation.

CONCLUSION

The FOMC made a substantial, though perhaps understandable error in failing to raise interest rates until March 2022. Much of that policy error can be attributed to faulty forecasts of inflation, which the Fed shared with many other forecasters. It was not an outlier. But the error was not quite as consequential as the Fed's sharpest critics allege. Even if the FOMC had started to hike rates earlier (how much earlier?), the econometric evidence suggests that the effects on peak inflation would likely have been small. Supply constraints, not excess demand, ruled the roost. They came, driving inflation higher; and then they went, pulling inflation down.

The FOMC's August 2020 framework shoulders more of the blame for the inflationary surge than it should—probably because the new wording revised both of the Fed's goals, low inflation and high employment, in dovish directions. For that reason alone, the framework will almost certainly be changed in 2025, given the high inflation since. But how?

I suggest that the August 2020 change in the employment goal, from symmetry to "shortfalls," is sensible and probably not too important anyway. But the change in the inflation goal, from a 2 percent point target to FAIT, was probably consequential. It may have made the FOMC slow on the draw as inflation gathered steam, and I worry a bit that it may have kept monetary policy too tight for too long in 2024. In both directions, I argue, a 1.5 to 2.5 percent target range would be a better choice. In answer to the question at the top of this Policy Brief, that may be the structural flaw the Fed should fix.

28 For a long list of over 50 central banks, see http://www.centralbanknews.info/p/inflation-targets.html?m=1. The data in that list apply to 2022.

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24-3 The Influence of Gasoline and Food Prices on Consumer Expectations and Attitudes in the COVID Era

Joanne Hsu

May 2024

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INTRODUCTION

Food and gasoline are high-frequency consumption items that compose a substantial share of budgets for most families. On average, consumers spend over 10 percent of their disposable personal income on food, with lower-income consumers spending as much as one-third of their budgets (USDA ERS 2022). Aggregate gasoline expenditure shares vary across time, typically ranging between 1.5 and 5.5 percent of disposable personal income since 1974 (EIA 2022). Like food, household expenditure shares for gasoline fall with income.[1]

Food and gasoline prices are extremely salient to consumers; they regularly purchase these goods, and their prices are highly visible. In particular, gasoline prices are visible outdoors even to those who do not pump gasoline or drive cars. Over the past two years, numerous media stories have explored the influence of gasoline prices on consumer attitudes. One 2022 piece in the *New York Times* noted that "gasoline, distinct from other things we buy, wields real power over how Americans think about their personal circumstances, the wider economy and even the state of the nation."[2] The shared experience of purchasing food and gasoline makes it no surprise that those prices have been blamed for the relatively dismal consumer views of the economy in 2023 amid strong economic indicators,

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1 See, for example, Glaeser et al. (2023) and Chernick and Reschovsky (1997).

2 Emily Badger and Eve Washington, "Why the Price of Gas Has Such Power over Us," *New York Times*, October 25, 2022.

including slowing inflation, low unemployment, and robust growth. At the same time, consumer inflation expectations have eased during this past year.

This Policy Brief investigates the role food and gasoline prices play in influencing consumer inflation expectations and economic sentiment, as measured on the University of Michigan Surveys of Consumers, and focuses on the COVID inflationary episode. Understanding how realized inflation from gasoline, food, and core goods drives consumer attitudes is important for several reasons. First, the determinants of inflation expectations are of interest to policymakers focused on controlling inflation and ensuring the anchoring of expectations. Furthermore, economic sentiment factors into consumer behavior, including spending decisions, which affect the trajectory of the macroeconomy. Finally, survey data reveal the costs of realized inflation on consumers, or at least how consumers experience those costs, even in an environment where other economic indicators appear relatively strong.

Ultimately, although consumer sentiment now appears to be more sensitive to inflation than prior to the pandemic, inflation expectations do not. Even as inflation has waned, consumers continue to spontaneously comment on the negative impact of high prices on their lives. That said, these persistently negative perceptions about inflation have not translated into persistently high inflation expectations. Even as high prices, particularly gasoline and food, continue to weigh on consumers' experiences in the economy in a way that appears unique, inflation expectations have eased through the end of 2023 in ways that are consistent with the slowdown in realized inflation.

GASOLINE AND FOOD PRICES, EXPECTATIONS, AND SENTIMENT BEFORE AND AFTER 2020

Founded in 1946, the Surveys of Consumers at the University of Michigan have collected a rich set of data on the economic attitudes and expectations of Americans and are used widely by economic researchers, policymakers, and forecasters. Monthly data releases began in 1978 and are based on representative samples of consumers in the coterminous United States.[3]

The most-cited measures on the Surveys of Consumers include the Index of Consumer Sentiment and inflation expectations. The sentiment index is based on five questions on current assessments and expectations of personal finances; buying conditions for large durable goods; and business conditions. Inflation expectations are elicited for both short- and long-run horizons using the following questions:

1. "During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?"
2. "By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?"
3. "What about the outlook for prices over the next 5 to 10 years? Do you think prices will be higher, about the same, or lower, 5 to 10 years from now?"
4. "By about what percent per year do you expect prices to go (up/down) on the average, during the next 5 to 10 years?"

3 More information about the Surveys of Consumers can be found at https://data.sca.isr.umich.edu/.

In figure 1, the left panels plot the historical time series of inflation expectations and sentiment over the last 45 years, and the right panels zoom in on the 3 years before and following the start of the COVID pandemic in March 2020.

Similarly, the left panels of figure 2 display the evolution of core, food, and gasoline inflation over the last several decades, expressed as year-over-year percentage changes in monthly readings. The right panels of figure 2 focus on 2017–23.

Even at its peak during this period, at 6.6 percent year over year in September 2022, core inflation did not come close to the double-digit inflation of the 1970s and 1980s. In contrast, the more highly volatile prices of food and gasoline reached inflation rates comparable to the early 1980s.

Gasoline prices are unique on one key dimension: They frequently decline. Since 1960 about one-third of monthly gasoline consumer price index (CPI) readings exhibit year-over-year deflation. In contrast, food CPI exhibits deflation in about 2 percent of months, and core CPI never declines. As such, the two highly volatile categories of food and gasoline may play separate roles in informing the views of consumers.

When the pandemic began in the United States in March 2020, food inflation rose while core and gasoline inflation dipped. Inflation expectations bumped up at that time (see figure 1, top and middle right panels). Consumers appeared to perceive this initial rise in inflation to be a temporary result of extenuating circumstances; short- and long-run inflation expectations both eased by the end of 2020.

Starting in early 2021, however, year-ahead inflation expectations began a precipitous climb that peaked in the late spring and early summer of 2022. Long-run expectations rose modestly but remained remarkably stable through much of the COVID era. Long-run expectations fell between the narrow range of 2.9 to 3.1 percent for all but four months between August 2021 and December 2023 and ultimately remained elevated relative to the 2.2 to 2.6 percent range seen during the two years prepandemic.

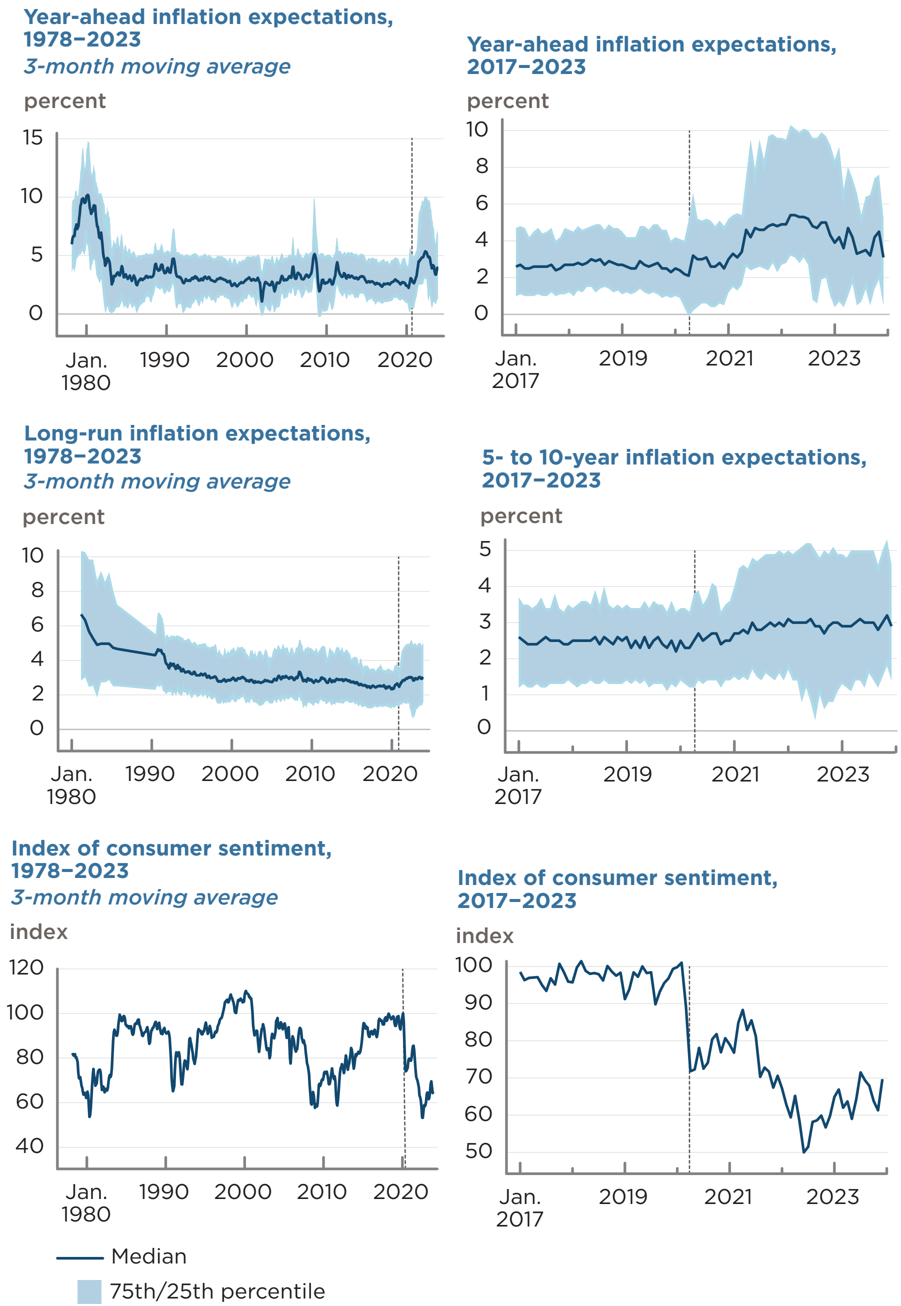
For both short- and long-run expectations, the interquartile range (visible on the top and middle panels of figure 1 as the blue shaded areas), which measures the dispersion of inflation expectations and is often taken as a proxy for inflation uncertainty, grew sharply through 2022 and reached levels not seen since the early 1980s. For short-run expectations, this was primarily driven by an increase in the share of consumers expecting high inflation. In contrast, a growing share of consumers began expecting very low inflation, or even perhaps deflation in the long run. The rise in uncertainty is unsurprising given the robust debates over the past two years among economists, policymakers, and pundits on the nature and expected duration of the inflationary episode. Increased uncertainty could reflect (or cause) greater unease about inflation or the economy.

Did inflation expectations co-move with core, food, or gasoline inflation in the COVID era?

Past research suggests that food and gasoline prices could be highly influential for consumers' inflation expectations. For example, Coibion and Gorodnichenko (2015) find that the increase in consumer inflation expectations, as measured

Figure 1

Evolution of short- and long-run inflation expectations and consumer sentiment



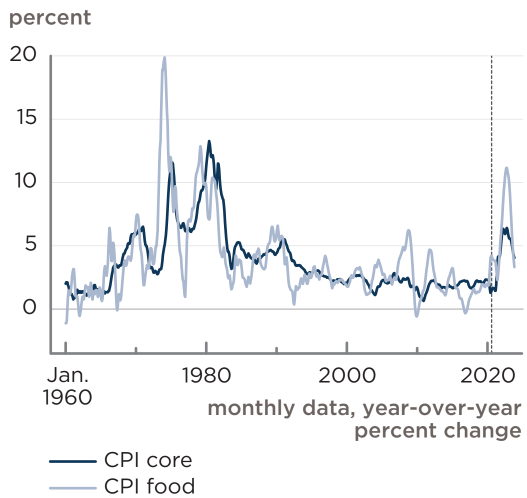
Source: Data are from University of Michigan, Survey Research Center, Surveys of Consumers.

by the University of Michigan Surveys of Consumers, relative to expectations of professional forecasters between 2009 and 2011, can be explained by the concurrent increase in oil prices. In a set of survey experiments conducted in 2012 and 2013, Cavallo, Cruces, and Perez-Truglia (2017) find that "even when information about inflation statistics is available, individuals still place a significant weight on inaccurate sources of information, such as their memories

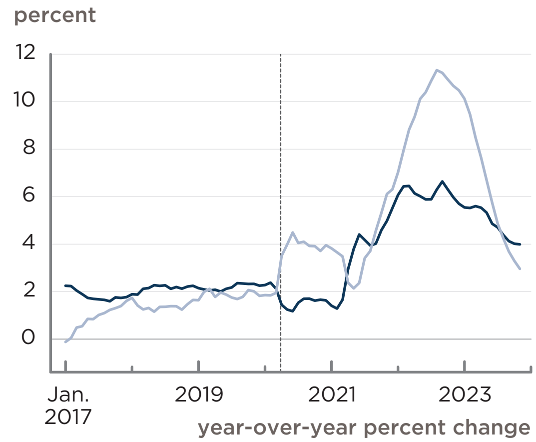
Figure 2
Evolution of core, food, and gasoline CPI prices

Evolution of core and food inflation, 1960–2023

3-month moving average

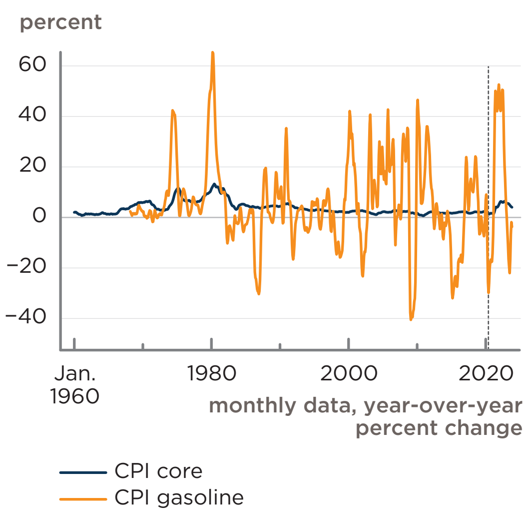


Evolution of core and food inflation, 2017–2023

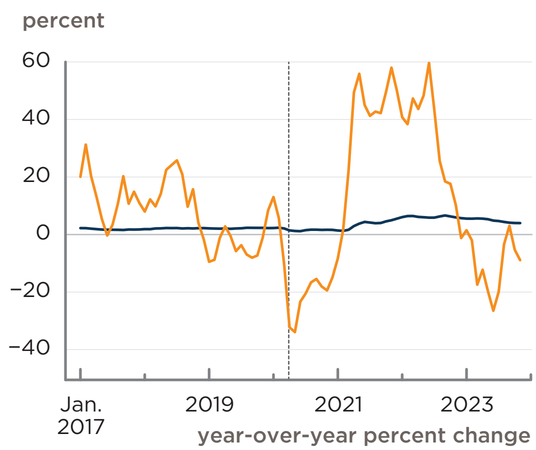


Evolution of core and gasoline inflation, 1960–2023

3-month moving average



Evolution of core and gasoline inflation, 2017–2023



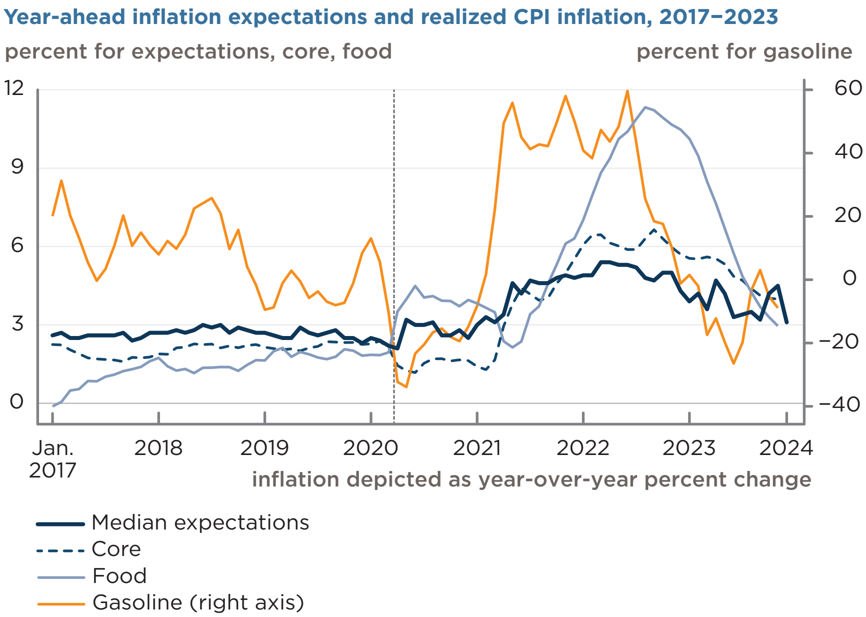
CPI = consumer price index

Sources: Data are from University of Michigan, Survey Research Center, Surveys of Consumers; US Bureau of Labor Statistics.

of the price changes of the supermarket products they purchase." Bruine de Bruin, van der Klaauw, and Topa (2011) compared the inflation expectations of individuals who were first prompted to recall specific price changes to the expectations to those who were not. For individuals who recalled specific prices, inflation expectations were "more extreme and more disagreeing . . . because they were biased towards various items associated with more extreme perceived price changes." In general, studies such as these have analyzed low-inflation periods that differ greatly from the COVID era.

Figure 3

Short-run inflation expectations and realized inflation both rose sharply in late 2021



CPI = consumer price index.

Sources: Data are from University of Michigan, Survey Research Center, Surveys of Consumers; US Bureau of Labor Statistics.

The Surveys of Consumers elicit inflation expectations without providing any statistics about current inflation or prompting participants to consider specific price changes. Still, during high-inflation episodes, consumers may be particularly sensitive to price changes of familiar goods like gasoline and food when forming their expectations.

Figure 3 plots year-ahead inflation expectations and realized inflation—core, food, and gasoline prices—before and after the onset of the pandemic. Throughout this period, expectations closely matched core inflation patterns, with little of the volatility seen in gasoline prices. This can also be seen in a simple regression comparing the relationships between core, food, and gasoline inflation and short-run inflation expectations, shown in table 1. Between 1978 and 2023, a 1 percentage point increase in year-over-year gasoline inflation is associated with only a 0.02 percentage point increase in short-run inflation expectations. A 1 percentage point increase in food inflation is associated with a 0.19 percentage point rise in inflation expectations. In contrast, a 1 percentage point increase in core inflation is associated with a much larger 0.38 percentage point rise in short-run expectations and, interestingly, a 0.49 percentage point increase in long-run expectations. When restricting the analysis to the COVID era, expectations became even less sensitive to food and gasoline prices, with a more modest reduction in the still sizable influence of core inflation.

Although inflation expectations are relatively insensitive to food or gasoline prices, these patterns do not imply that consumers are completely unmoved by those prices. In fact, the sentiment index, which encompasses views of business conditions and personal finances (incorporating the impact of high prices or

Table 1

Regressions show that inflation expectations are more highly influenced by core inflation than by gasoline and food inflation, particularly in recent years

A 1 percentage point increase in...	Is associated with a change in year-ahead inflation expectations of:		Is associated with a change in long-term inflation expectations of:		Is associated with a change in sentiment index of:	
	1978–2023	*2020–2023*	*1978–2023*	*2020–2023*	*1978–2023*	*2020–2023*
Gas inflation	0.02 pp	0.01 pp	–0.00 pp	–0.00 pp	–0.06	0.08
Food inflation	0.19 pp	0.06 pp	–0.10 pp	–0.02 pp	–1.82	–2.06
Core inflation	0.38 pp	0.27 pp	0.49 pp	0.12 pp	–0.73	–2.47

pp = percentage point

Sources: Data are from University of Michigan, Survey Research Center, Surveys of Consumers; US Bureau of Labor Statistics.

inflation) but does not include a direct measure of inflation expectations, is highly influenced by both food and core inflation. These patterns are visible in the last two columns of table 1.[4] These relationships strengthened even further since 2020, suggesting that the relatively dismal views of consumers in 2023 partly reflect greater sensitivity to and frustration with each incremental unit of inflation than the historical averages across previous periods. One possible reason for this sensitivity could be the fact that American consumers had become accustomed to the extended period of very low inflation preceding the COVID pandemic.

Consumers expressed specific concerns over food and gasoline prices without prompting

The Surveys of Consumers began tracking spontaneous mentions of food and gasoline prices in January 2021, displayed in figure 4. These mentions suggest that food or gasoline are prominent in the minds of those consumers. In early 2021 less than 10 percent of consumers mentioned food or gasoline, but rates began climbing soon thereafter. These mentions were overwhelmingly negative comments on the high prices of either good. Gasoline mentions peaked in June 2022 at nearly 50 percent of consumers, and food mentions reached their apex of 26 percent the next month.

As seen in the bottom panel of figure 5, the rise in spontaneous food comments climbed between January 2021 and July 2022 and mirrored the increase in both food prices and inflation. Although food inflation slowed since then to rates seen at the beginning of the period, food price mentions remain quite elevated. In contrast, gasoline mentions (top panel of figure 5) were quite stable for much of 2021, then rose and fell closely with gasoline prices. Year-over-year gasoline inflation increased sharply in early 2021, but it was not until prices climbed sharply in early 2022 that gasoline mentions began to escalate in earnest. Given that gasoline prices exhibit both inflation and deflation, it is unsurprising that consumers appear to be more affected by gasoline price levels than inflation rates.

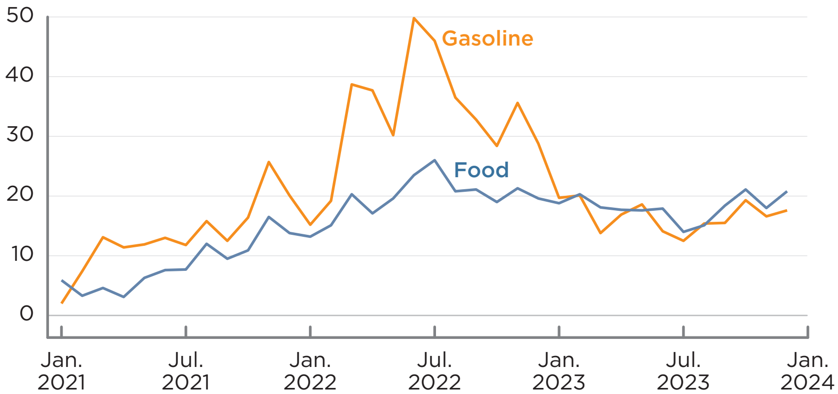
4 The relationships do vary over time and across different inflationary or recessionary episodes, and the 1978–2023 regression averages across these episodes.

Figure 4

Spontaneous mentions of food and gasoline prices escalated in 2021 and peaked in mid-2022

Gasoline/food mentions, 2021–2023

percent of consumers mentioning



Source: Data are from University of Michigan, Survey Research Center, Surveys of Consumers.

Consumers expressing concerns about food or gasoline prices reported higher inflation expectations than other consumers (figure 6, top panels). On average each month between 2021 and 2023, consumers who mentioned food prices had year-ahead inflation expectations that were about 1.4 percentage points higher than those who did not. Those who mentioned gasoline prices had expectations that were 1.2 percentage points higher. For long-run inflation expectations, the wedges were 0.5 and 0.3 percentage points, respectively. Likewise, those who mentioned gasoline or food exhibited lower sentiment than those who did not (figure 6, bottom panels), showing that the views of those with gasoline and food price concerns have generally less favorable views toward the economy. As gasoline and food prices rise, a growing share of consumers report concerns as well as higher inflation expectations, worsening the population average or median.

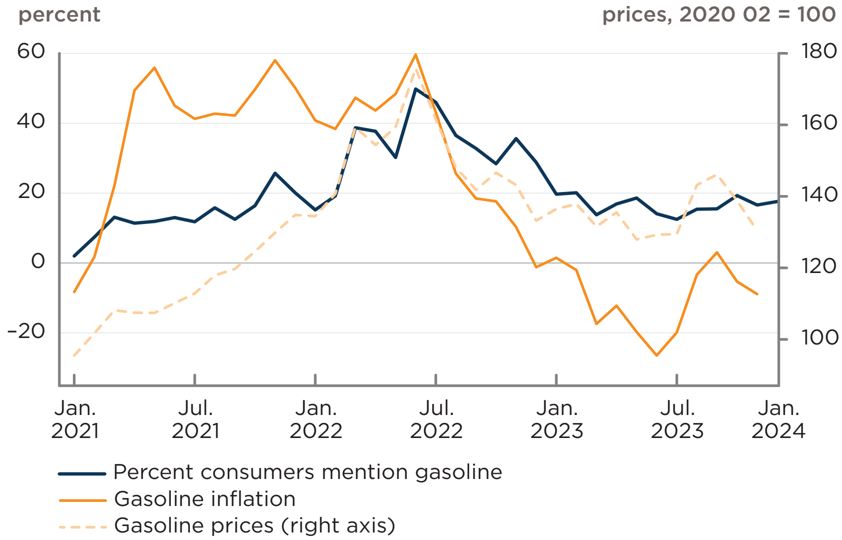
The frequency of food mentions varies across demographic groups; gasoline mentions are more balanced across groups

Figure 7 displays the shares of different demographic groups mentioning gasoline and food during the survey interview. Across all demographic groups, gasoline mentions are more common than food mentions. A possible reason is that within households with more than one adult, there may be a household division of labor in which one member may be responsible for most of the food shopping, whereas multiple members may drive or otherwise notice gasoline station prices in their daily lives. The patterns by gender—more women mentioning food than men, but both mentioning gasoline at similar rates—are also suggestive of this explanation. Consistent with established patterns of how lower-income consumers spend a larger share of their budgets on food than higher-income consumers, there is a strong negative income gradient for food mentions, from about 20 percent of those in the lowest income quintile

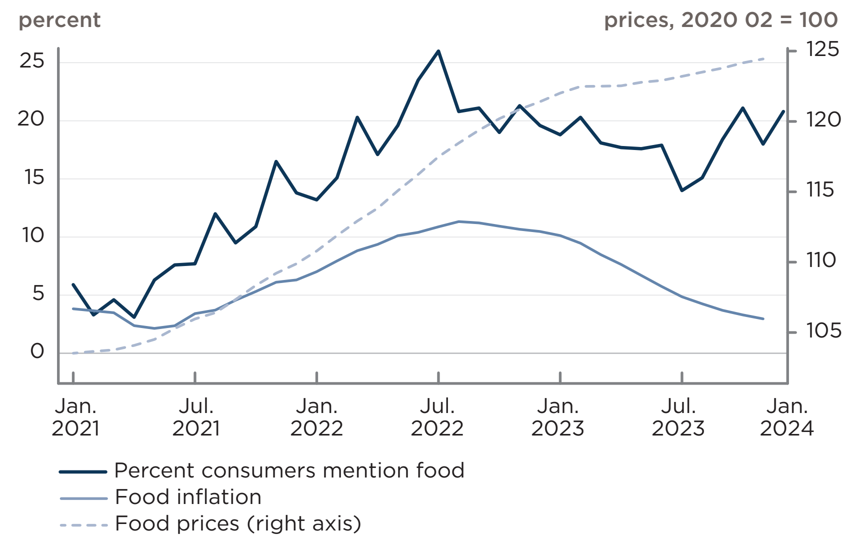
Figure 5

Gasoline mentions tracked the rise and fall of gasoline prices; food mentions followed food prices but leveled off as food inflation slowed

Gasoline mentions and realized prices, 2021–2023



Food mentions and realized prices, 2021–2023



Sources: Data are from University of Michigan, Survey Research Center, Surveys of Consumers; US Bureau of Labor Statistics.

mentioning food declining to less than 10 percent in the highest quintile. Rates of gasoline mentions are similar in the first, second, and third quintiles at about 22 percent; a slightly smaller share of the top quintile, 18 percent, mentioned gasoline as well. Similar patterns are visible by education. About 15 percent of consumers under the age of 35 commented on gasoline; these comments increase with age and peak between 55 and 64, declining slightly thereafter, likely an effect of reduced driving during retirement years. Food concerns also rise continuously with age, even beyond age 65.

Figure 6

Consumers mentioning food or gasoline report higher inflation expectations and sentiment

Source: Data are from University of Michigan, Survey Research Center, Surveys of Consumers.

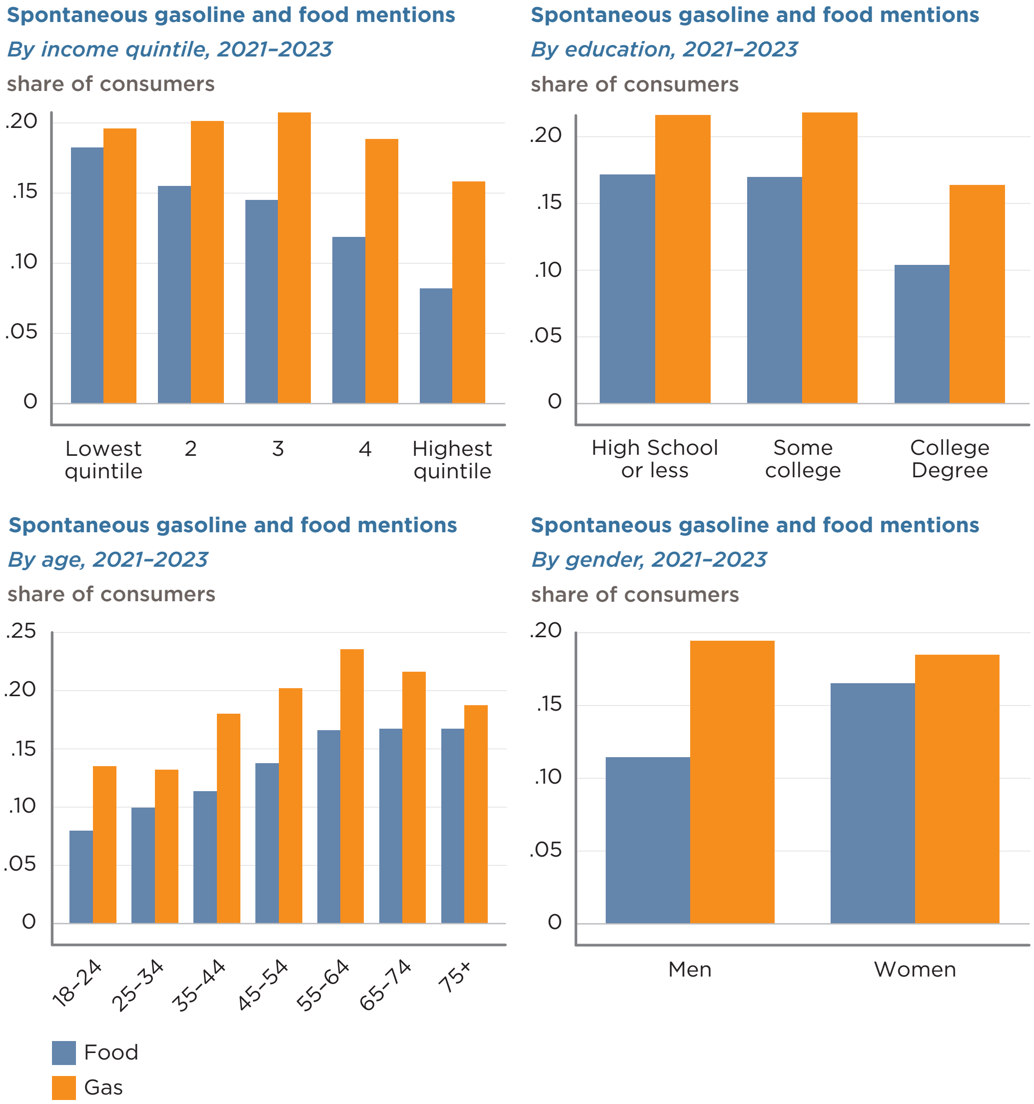
WHAT IS DIFFERENT ABOUT THE 2020S INFLATIONARY EPISODE?

High prices continued to weigh down consumers' perceptions of their personal finances and their sentiment even as inflation waned

CPI inflation fell from a peak of 8.9 percent year over year in June 2022 to 3.1 percent in November 2023, compared with 2.3 percent in February 2020 prior to the pandemic. Consumer sentiment, which reached a historic low in June 2022, lifted 39 percent by December 2023, supported by a slowdown in inflation. However, sentiment remained 37 percent below its February 2020 prepandemic reading. Concerns over high prices continued to weigh on consumers; as seen in the top panel of figure 8, food and gasoline comments were highly (negatively) correlated with sentiment (displayed on the reversed right axis). Sentiment has a very strong –0.92 correlation with gasoline mentions and a –0.76 correlation with food mentions. As such, these spontaneous comments show that food

Figure 7

Gasoline mentions are relatively balanced across demographic groups, but food mentions are more common among older consumers, lower-income consumers, less-educated consumers, and women



Source: Data are from University of Michigan, Survey Research Center, Surveys of Consumers.

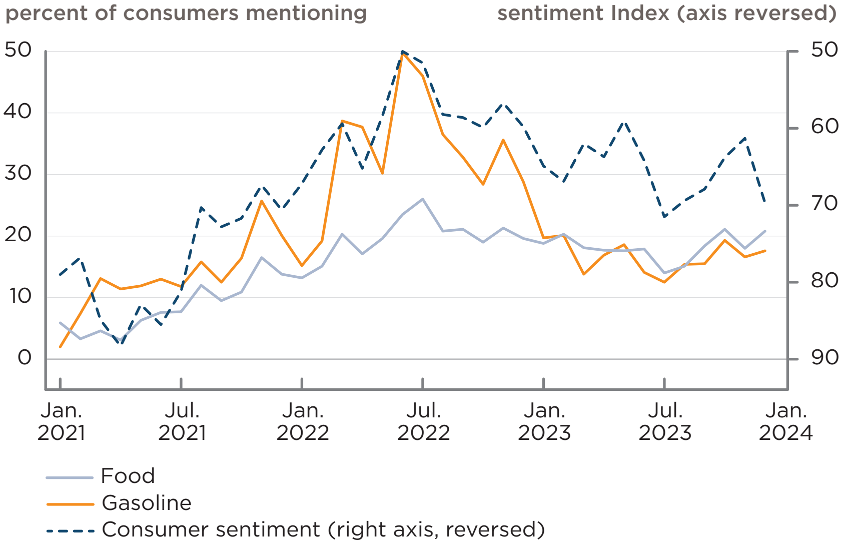
or gasoline prices weigh on those consumers in ways that affect their overall economic attitudes.

One key component of the Index of Consumer Sentiment is the current assessment of personal finances. Consumers are asked for reasons why they answered favorably or unfavorably about their personal finances; high price reasons have been tracked since 1947. Historically, high price reasons (which may include references to specific prices such as food or gasoline) for poor personal finances have broadly followed a similar path as year-ahead inflation expectations and realized CPI inflation (figure 9). But the inflationary episode of the 2020s differs from the historical averages: Concerns about high prices are at rates similar to the much more severe inflationary episodes of the late 1970s

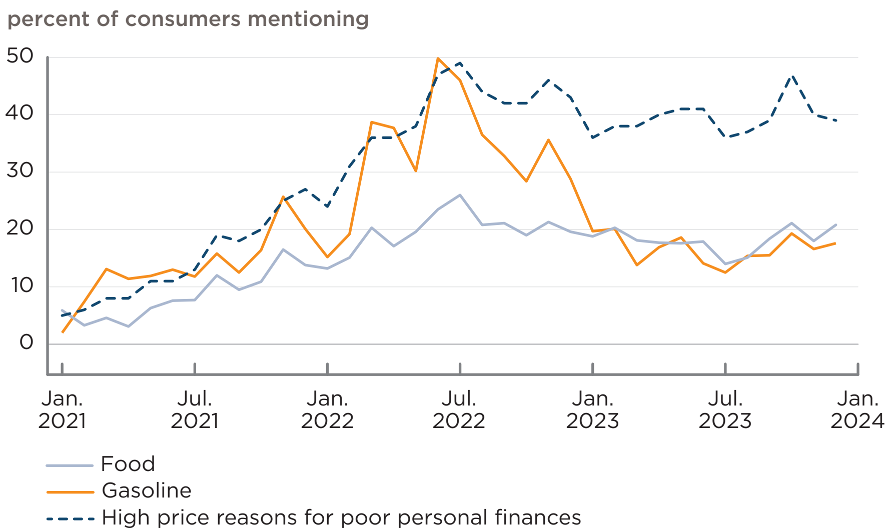
Figure 8

Sentiment and negative effects of prices on personal finances improved little, even as food and gasoline mentions declined

Gasoline/food mentions and sentiment, 2021–2023



Gasoline/food mentions and high price reasons for poor personal finances, 2021–2023



Source: Data are from University of Michigan, Survey Research Center, Surveys of Consumers.

and early 1980s, and they have remained elevated in spite of inflation easing. The bottom panel of figure 9 shows that high price reasons for poor finances grew in frequency from 2021, reaching a peak in summer of 2022, coinciding with the peak of gasoline and food mentions.

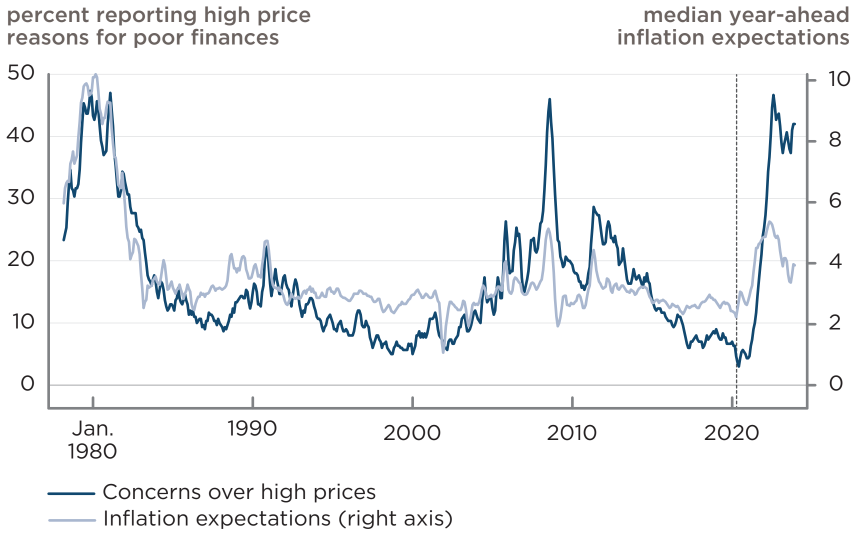
Despite the reduction in gasoline and food mentions—as well the softening of realized gasoline, food, and core inflation since mid-2022—the share of consumers blaming high prices for poor finances has remained steady, as seen in figure 10. This pattern suggests that for a substantial part of the population, persistent high prices continue to weigh on their minds. In contrast, year-ahead

Figure 9

High price concerns continued rising in 2022 even as inflation expectations and realized CPI inflation both eased

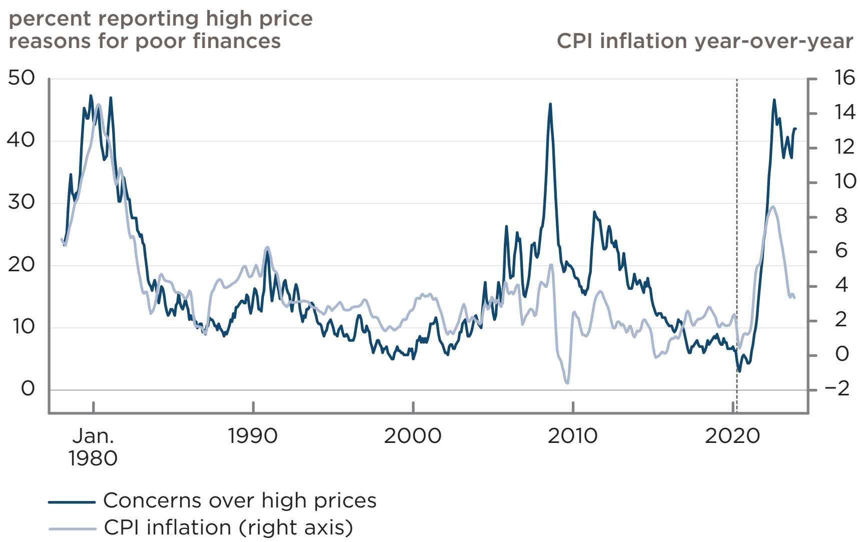
High price concerns and expectations 1978–2023

3-month moving average



High price concerns and CPI inflation 1978–2023

3-month moving average



CPI = consumer price index.

Sources: Data are from University of Michigan, Survey Research Center, Surveys of Consumers; US Bureau of Labor Statistics.

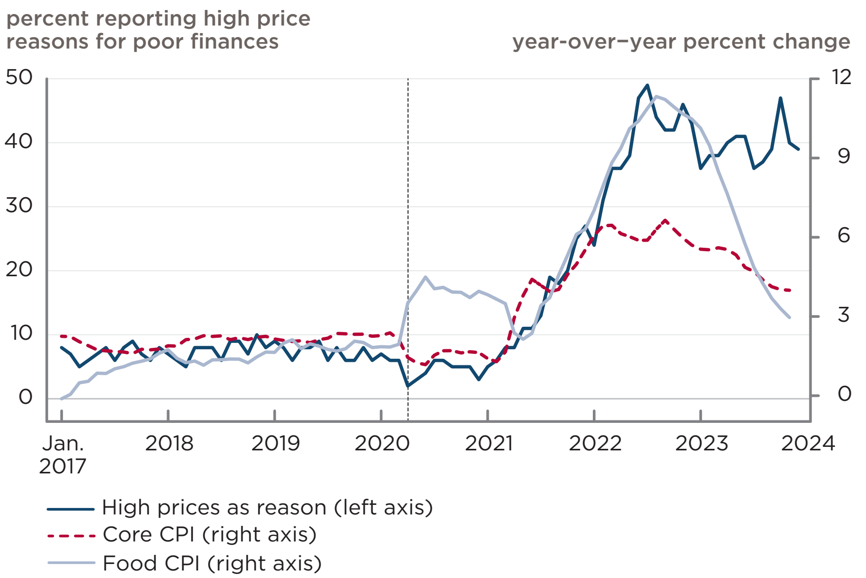
inflation expectations fell from 5.4 percent for March through June 2022 down to 3.5 percent for October through December 2023, modestly above the 2.5 to 3.0 percent range seen in the two years prior to the pandemic. The fact that high price complaints have remained high in 2023, even as consumers' inflation expectations have eased, shows that they are able to separate their own feelings about the impact of high prices on their lives from expectations about the future path of inflation.

Figure 10

High price concerns rose in step with gasoline prices, food inflation, and core inflation; concerns remained high, even as gasoline and core inflation softened

High price reasons for poor personal finances and gas inflation, 2017–2023

High price reasons for poor personal finances and inflation, 2017–2023



CPI = consumer price index.

Sources: Data are from University of Michigan, Survey Research Center, Surveys of Consumers; US Bureau of Labor Statistics.

Why do consumers feel so dismal about the economy even when they recognize that inflation has slowed and expect the slowdown to continue?

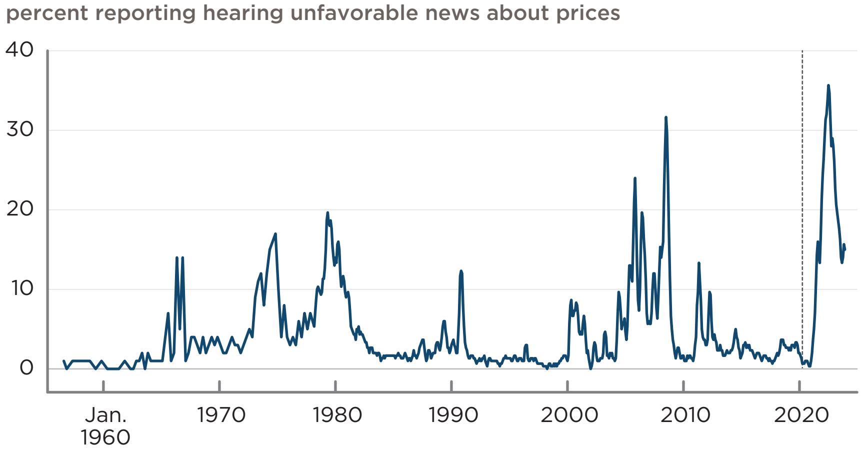
Consumers have been aware that inflation has slowed, which bears out in their responses to survey questions about inflation expectations as well as about current buying conditions for large purchases such as cars, durable goods, or homes. However, high prices continue to be salient for consumers, and they appear to exert a stronger relationship on sentiment now than during earlier periods. Further

Figure 11

Negative news about inflation during 2021–23 exceeds levels seen in the late 1970s and early 1980s

Unfavorable news heard about prices

3-month moving average



Source: Data are from University of Michigan, Survey Research Center, Surveys of Consumers.

research will be needed to understand the reasons for any shifts in consumer attitudes, but two factors stand out as potential candidates.

According to the American Psychological Association (APA), stress levels among Americans increased in 2023 relative to 2019 despite the official end of the pandemic and a strong recovery from the pandemic recession: "A superficial characterization of day-to-day life being more normal is obscuring the posttraumatic effects that have altered our mental and physical health. . . . Widespread trauma has not been limited to the pandemic. Global conflict, racism and racial injustice, inflation, and climate-related disasters are all weighing on the collective consciousness of Americans" (APA 2023). An undercurrent of stress or anxiety stemming from the collective experience of the pandemic period could very well amplify the effects of high prices and inflation on Americans' sense of financial well-being and their outlook for the economy as a whole. The APA notes that stress is associated with worse physical well-being, and further research can shed light on the extent to which stress or worsened psychological well-being could influence their economic views or their perceptions of their economic experiences.

A second societal factor that has shifted over the past several years is how Americans consume and share news. The media landscape has changed dramatically over the years. Daily print newspapers have evolved into constantly updated online news websites, and the role of social media has grown. The speed of the news cycle accelerated with the spread of internet access and later with the proliferation of smartphones. Political polarization has also been accompanied by divisions across the population, along with the types of news sources they trust.

Each month, the Surveys of Consumers ask respondents, "During the last few months, have you heard of any favorable or unfavorable changes in business conditions?" and "What did you hear?" Figure 11 plots the share of consumers reporting hearing negative news about inflation. In 1979, a high of 21 percent of consumers reported hearing negative news about inflation. In June 2023, almost twice as many consumers reported the same, in spite of the fact that inflation rates were lower than the earlier period. Although the relationship between negative news and unfavorable sentiment is not necessarily causal—after all, individuals are likely to gravitate to news stories that confirm their experiences or their priors—the proliferation of negative news could certainly exacerbate already tense feelings about inflation or the economy more generally.

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PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

25-1 Why Did Inflation Rise and Fall So Rapidly? Lessons from the Korean War

Joseph E. Gagnon and Asher Rose

January 2025

ABSTRACT

The speed of both the rise and fall of US inflation in 2021–23 took many economists by surprise. This paper shows that the rise of COVID era inflation reflects three independent shocks: a plethora of pandemic-related shifts in demand patterns and supply disruptions; the largest commodity price surge in 40 years caused by the Ukraine war; and strong monetary and fiscal responses to the pandemic, which kept labor markets tight. This paper documents the transmission of these shocks through the main components of private consumption: durable goods, nondurable goods, and services. The rapid fall of inflation reflects the credibility of the Federal Reserve's commitment to low inflation, something that was not apparent during the inflationary shocks of the 1970s but that was important during the Korean War inflation of 1950–51. Another similarity with the Korean War episode is the temporary surge in demand for durable goods.

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JEL codes: E30, E31

Keywords: durable goods, nondurable goods, services, pandemic inflation

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INTRODUCTION

US inflation surged to a 40-year high in 2021–22. Many observers argued that it would take years for inflation to return to its 2 percent target unless the economy endured a recession with a sharp rise in unemployment (Domash and Summers 2022; Verbrugge and Zaman 2023; Cecchetti et al. 2023). Others were more optimistic that inflation would fall rapidly even if the economy avoided a hard landing (Gagnon 2021; Reifschneider and Wilcox 2022; Krugman 2022).[1]

As of mid-2024, US inflation had fallen most of the way toward its 2 percent target without a sharp rise in unemployment. This paper shows that a rapid reversal of a sudden burst of inflation is the expected outcome in monetary regimes that actively target low inflation. Notable episodes of inflation under such a regime include the Korean War inflation of 1950–51 and the COVID era inflation. The more pessimistic predictions likely were unduly influenced by inflation behavior between the late 1960s and early 1990s, when the Federal Reserve did not actively target a constant low rate of inflation.

This paper estimates models of inflation on US data back to 1949 for the three main components of consumption: durable goods, nondurable goods, and services. The regressions find remarkably stable underlying effects of commodity prices, import prices, and labor market conditions on inflation after controlling for differences in monetary regime. The burst of inflation in 2021–22 was driven by the confluence of three developments: (1) a plethora of pandemic-related demand and supply disruptions that pushed up prices of durable goods, (2) the global commodity price shock caused by Russia’s invasion of Ukraine, which was especially important for nondurable goods, and (3) tight labor markets, which mainly operate through prices of services. Similar developments occurred in other advanced economies (Gagnon and Rose 2024).

The COVID era inflation bears striking similarities to the inflation surge during the Korean War in 1950–51, which was also associated with a temporary large increase in demand for durable goods and which receded quickly without any increase in unemployment. COVID era inflation, however, was amplified by a large commodity price shock and supply chain disruptions that did not occur during the Korean War.

OVERVIEW OF US POSTWAR INFLATION

The United States has a rich trove of macroeconomic data dating back to the late 1940s, creating a unique opportunity to search for lessons from earlier surges in inflation. Figure 1 displays contributions to inflation going back to 1949. The 2021–22 inflation surge is one of four notable inflation episodes. The others are 1950–51, 1973–75, and 1979–81.

The solid black line displays the four-quarter rate of change of the price index for personal consumption expenditures (PCE) from 1949 through 2023. The colored bar segments display the contributions to inflation from the three major categories of consumption: durable goods (blue), nondurable goods (green), and services (pink). When all components contribute positively to inflation, the

1 The size of the inflation surge seems to have caught nearly everyone, both optimist and pessimist, by surprise.

solid line is at the top of the stacked bars. When inflation is positive but some components are negative, the solid line is below the top of the bars.

Three broad patterns are apparent. First, services prices are typically the largest contributor to overall inflation, reflecting both the high share of services in total consumption and the fact that services prices tend to grow faster than goods prices. Second, large bursts of inflation tend to be associated with large increases in the contributions of both durable and nondurable goods prices, whereas the services contribution is much less volatile. Third, durable goods prices often make a negative contribution to inflation, especially during periods of low overall inflation.

THE KOREAN WAR ANALOGY

There are strong parallels between the inflation surges of 1950–51 and 2021–22.

Both surges were immediately preceded and quickly followed by inflation rates of around 2 percent.[2] In contrast, in the 1970s, inflation surges began and ended with inflation rates of around 4 percent or more.

In 1950–51 and 2021–22, unemployment rates fell as inflation rose and unemployment remained low as inflation receded. In contrast, in 1973–75 and 1979–81, the rise in inflation was quickly followed by a recession and a sustained rise in unemployment that was widely viewed as necessary to bring down inflation.

In 1950–51 and 2021–22, consumers rushed to buy durable goods either because they feared a return of wartime rationing (1950–51) or because they feared getting ill from going to restaurants and traveling (2021–22). In contrast, changes in durable goods spending in the 1970s were less pronounced and appear to reflect a standard cyclical pattern in which durable goods spending declines more during recessions than other categories of consumer spending.

Figure 2 displays the growth rate of US real durables consumption since 1949. Note that the two largest spikes are in 1950 and 2021, coinciding with two of the four inflation spikes in figure 1. There is also a spike in 1971–73, but that was before the 1973–75 inflation surge and it was reversed during the 1974–75 recession. Durables consumption growth was especially low during the 1979–81 burst of inflation, unlike during inflation in the 1950s and 2020s.

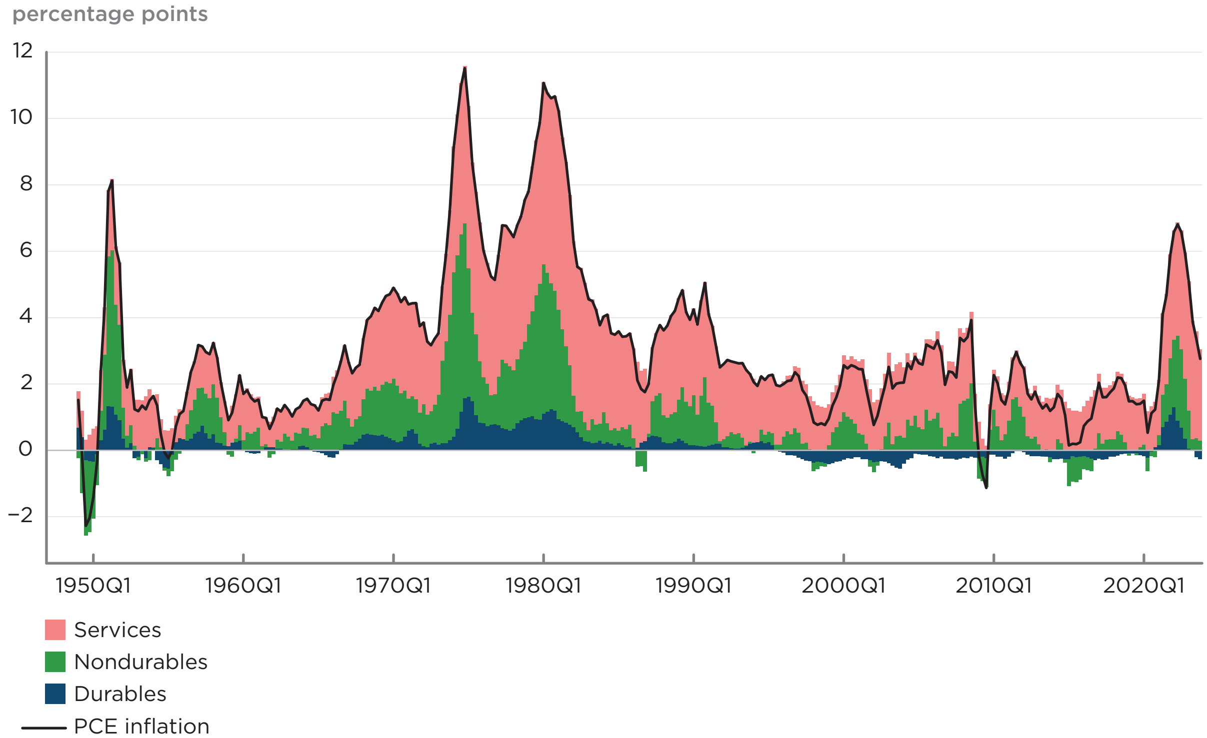
Bert Hickman (1955, 2–3) discusses the importance of the shift in spending on consumer durables to the 1950–51 surge in inflation:

> The outbreak of the Korean War in June 1950 was followed by eight months of strong inflationary pressure, due largely to abnormally heavy buying by consumers in anticipation of possible future shortages.... Memories of wartime shortages were still fresh in 1950, and the beginning of hostilities in Korea touched off a wave of forward buying in July and August.

Hickman notes that the bulk of the consumer boom of 1950 was in durable goods, reflecting fears that shortages would last for years rather than just weeks or months. Panic buying stopped almost as quickly as it started after the feared shortages did not materialize. By 1951Q2, real spending on consumer durables

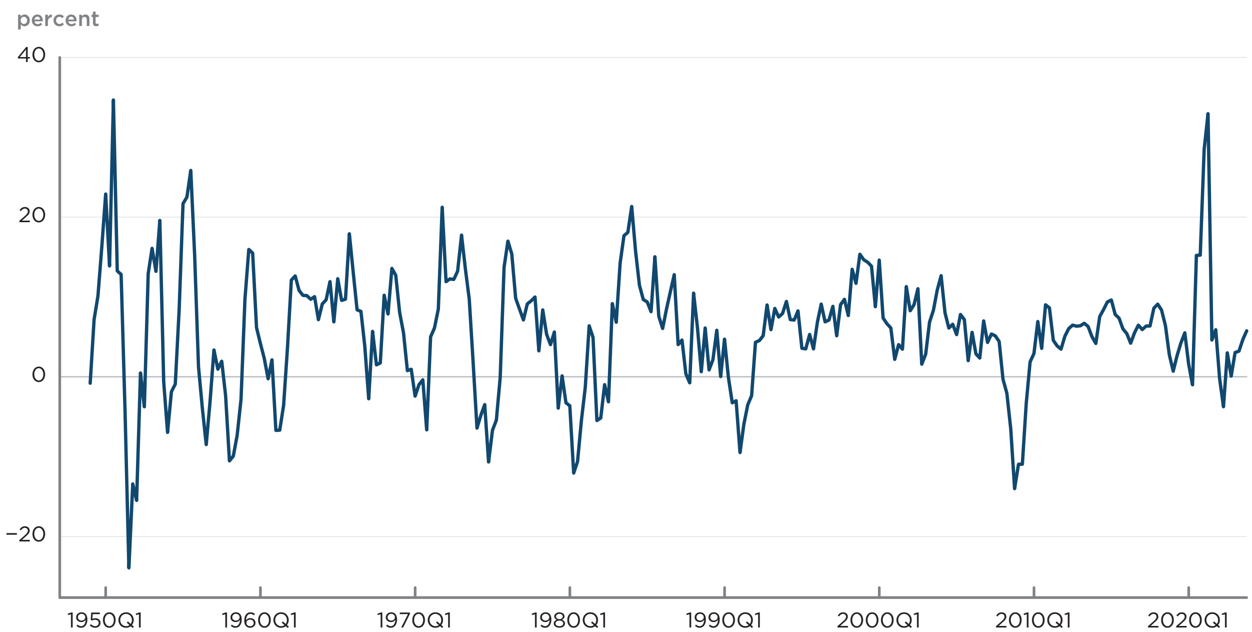
2 As of May 2024, the 12-month PCE inflation rate was 2.6 percent See https://www.bea.gov/news/2024/personal-income-and-outlays-may-2024.

Figure 1
Contributions to PCE inflation in the United States, 1949Q1–2023Q4 (4-quarter changes)



PCE = personal consumption expenditures
Source: Authors' calculations using data described in the appendix.

Figure 2
Real (inflation-adjusted) growth in US consumption of durable goods, 1949Q1–2023Q4 (4-quarter changes)



Source: Authors' calculations using data described in the appendix.

had fallen below the level of 1950Q1 before the war started. By 1952Q1, the PCE inflation rate (four-quarter change) was only 2.7 percent and by 1952Q4 it was only 1.2 percent.

Two notable differences between the inflation episodes of 1950–51 and 2021–22 are that the durable goods boom of 1950 was much shorter-lived and there were few supply disruptions like those in 2021–22. The main reason for these differences appears to be tighter fiscal and monetary policies in the 1950s.

Taxes were raised immediately. In his first *Economic Report of the President* after the start of the war, President Harry Truman (1951, 17) stated

> We should make it the first principle of economic and fiscal policy in these times to maintain a balanced budget, and to finance the cost of national defense on a "pay-as-we-go" basis. The Congress is to be commended upon the successful completion of two vitally important pieces of tax legislation since the middle of calendar year 1950.

Current federal expenditures rose from $46 billion in 1949 to $58 billion in 1951, while current federal tax receipts rose from $33 billion to $56 billion over the same period, resulting in a *narrowing* of the federal deficit from 5.0 percent of GDP to 0.7 percent of GDP.[3] Only part of this surge in revenues owes to recovery from the 1948–49 recession. Higher income taxes reduced disposable income available for consumption.

At the request of the Truman administration, the Federal Reserve tightened credit by raising down payments and shortening repayment terms on housing and consumer loans (Truman 1951, 18). Housing starts fell from 1.4 million units in 1950 to 1.1 million in 1951 (Truman 1952, 11). Moreover, the Treasury Department used moral suasion and more attractive terms on savings bonds to encourage a large increase in private saving (Truman 1952, 22).

In March 1951, the Federal Reserve and the Treasury reached an Accord that ratified the Federal Reserve's switch from targeting interest rates at a low level to stabilizing the economy and prices.[4] Despite this renewed freedom, the Federal Reserve raised interest rates only a small amount during the war, reflecting the fact that other measures were effective in keeping household spending low enough to bring inflation down and avoid overheating the economy.

The Korean War was not associated with the workplace lockdowns, school closures, and mobility restrictions of the COVID-19 pandemic. There was no analog to the shortage of semiconductor chips for automobiles that characterized 2021–22. Although wage and price controls were revived during the Korean War, Hickman (1955) argues that they were generally not binding, pointing to the large runup in business inventories in 1951 as consumers became less concerned about possible future shortages and the spending binge subsided. When price controls were completely removed in 1953, inflation actually fell, providing further evidence that the controls were not binding.

3 Data are from the Bureau of Economic Analysis at https://www.bea.gov/data/economic-accounts/national.

4 The Federal Reserve maintained low caps on short-term and long-term bond yields between 1941 and 1951 to help in wartime finance and to protect banks from sharp declines in bond prices (Eichengreen and Garber 1991).

DIFFERENCES WITH THE 1970s INFLATION EPISODES[5]

Perhaps the most important contrast between the 1950–51 and 2021–22 episodes on the one hand and the 1973–75 and 1979–81 episodes on the other hand concerns the credibility of monetary policy in maintaining a low level of inflation. Prior to the 1960s, bouts of high inflation were always brief and associated with unusual circumstances, especially wars. Households and businesses generally expected prices to be relatively stable over long periods of time, as reflected in long-term bond yields of around 2 to 3 percent in the early 1950s.[6]

In the late 1960s and 1970s, the Federal Reserve did not have any stated inflation goal nor did it act resolutely to achieve any stable unstated inflation goal. When the Kennedy tax cuts, the Vietnam War, and President Johnson's Great Society programs fostered a prolonged period of growing fiscal deficits in the mid- and late 1960s, the unemployment rate fell to a record low and inflation began to rise. The Federal Reserve made only sporadic and half-hearted attempts to fight inflation, leading to a long period in which each bout of inflation reached a higher peak and was followed by a higher trough.[7]

Expectations of long-term inflation (and long-term bond yields) drifted up with each inflationary shock and became entrenched into workers' pay demands. A notable difference between the 1970s inflationary surges and the other surges is that the dollar fell sharply at the beginning of each 1970s surge as investors expected inflation to persist, and import prices contributed to inflationary pressure. The dollar and import prices were relatively stable during the 1950–51 and 2021–22 surges, reflecting investor confidence that inflation would not persist. During the 1970s period of unanchored inflationary expectations, it took large increases in the unemployment rate to reduce inflation even part way back to earlier levels.

The appointment in 1979 of an aggressively anti-inflationary Federal Reserve chairman, Paul Volcker, started the process of returning to a low and stable inflation rate. After two recessions in 1980 and 1982, inflation settled at around 4 percent. Volcker's successor, Alan Greenspan, took advantage of the 1990 recession to push inflation down further to 2 percent and it remained near that level until the post-pandemic inflation of 2021–22.

The 30-year US experience of low and stable inflation combined with the Federal Reserve's public adoption of a 2 percent inflation target in 2012 kept long-run expectations of inflation at low levels and enabled the 2021–22 inflation surge to recede without any substantial runup in unemployment, just as in the inflation surge of 1950–51.

5 A similarity between the 1970s episodes and the COVID era inflation is the importance of higher commodity prices, which did not characterize the 1950–51 episode to a significant extent.

6 As discussed above, the Federal Reserve exited its wartime policy of capping bond yields at 2.5 percent in early 1951. Yields rose only modestly above the previous cap despite reductions in Federal Reserve bond purchases, suggesting that private buyers were not worried about future high inflation eroding the value of their bond holdings.

7 President Nixon imposed wage and price controls in 1971 but these had only modest and temporary effects (Gordon 1982).

STATISTICAL MODELING OF US POSTWAR INFLATION

A key issue in modeling inflation from 1949 through 2023 is that the US monetary policy regime shifted substantially, as discussed above. These shifts have important effects on the lag coefficients of the inflation models. From 1949 to 1968, inflation was generally low (average value of 1.8 percent) and shocks to inflation died away quickly. From 1968 to 1992, inflation was generally high (average value of 5.4 percent) and shocks were highly persistent. In this regime, the Federal Reserve did not act systematically to return inflation to a low and stable level. From 1992 to 2023, inflation was generally low (average value of 1.8 percent) and shocks to inflation died away quickly, as in the 1950s and early 1960s. In this regime, the Federal Reserve did respond systematically to return inflation to a low and stable level.

We follow the analysis of Gagnon and Collins (2019) and model the components of inflation using separate intercepts and lag coefficients for each of the three monetary regimes (1949–68, 1968–92, 1992–2023).[8] As in Gagnon and Collins, the regressions allow eight quarters of lagged inflation but restrict the coefficients to be equal for the first four lags and also for the second four lags.[9]

For nondurable goods and services, we model inflation as a function of commodity and import prices as well as labor market conditions. Following recent studies (Ball, Leigh, and Mishra 2022; Blanchard and Bernanke 2023) labor market conditions are measured by the vacancy/unemployment ratio, *V/U*, which allows for a nonlinear effect of unemployment on inflation because it increases proportionally more for each percentage point decline in the unemployment rate when unemployment approaches zero.

$$\Delta PN_t = \alpha^R + \sum_{i=1}^{8} \rho_i^R \Delta PN_{t-i} + \sum_{i=0}^{1} (\beta_i \Delta PE_{t-i} + \gamma_i \Delta PF_{t-i} + \delta_i \Delta PIM_{t-i})$$

$$+ \mu_0 (V/U)_t + \mu_1 \Delta (V/U)_t$$

$$\Delta PS_t = \alpha^R + \sum_{i=1}^{8} \rho_i^R \Delta PS_{t-i} + \sum_{i=0}^{1} (\beta_i \Delta PE_{t-i} + \gamma_i \Delta PF_{t-i} + \delta_i \Delta PIM_{t-i})$$

$$+ \mu_0 (V/U)_t + \mu_1 \Delta (V/U)_t$$

Δ denotes annualized percent change. Note that these are one-quarter changes, unlike the four-quarter changes displayed in figure 1. *PN* is the price index for nondurable goods. *PS* is the price index for services. *PE* is the price index for energy. *PF* is the price index for food. *PIM* is the price index for imports of goods and services. *PE*, *PF*, and *PIM* are expressed relative to the GDP deflator.

8 These dates differ slightly from those in Gagnon and Collins because that paper was focused on consumer price index (CPI) inflation and this paper focuses on PCE inflation. The transition to the third regime is estimated to occur roughly two years earlier with PCE inflation than with CPI inflation. Results would be only minimally affected using the original Gagnon and Collins regime dates.

9 Note that the coefficients on lagged inflation are allowed to shift immediately with the transition to a new regime, even if the lagged observations are in the preceding regime. Gagnon and Collins find that their results are not sensitive to moderate changes in the break dates.

Import price inflation is also scaled by the ratio of nominal imports to nominal GDP. The superscripts R refer to the three monetary regimes. Within each regime the following constraints are imposed: $\rho_1=\rho_2=\rho_3=\rho_4$ and $\rho_5=\rho_6=\rho_7=\rho_8$.

For durable goods, *V/U* is not statistically significant. Instead we take the approach in Gagnon and Rose (2024) and include the growth rate of real durables spending and a measure of the COVID era semiconductor shortage based on Google searches for the term "chip shortage" from Google Trends.[10]

The semiconductor shortage was obviously not an important driver of inflation before 2020. We devoted considerable efforts to finding an alternate measure that might capture unusual supply restrictions in earlier years, but these efforts ultimately were not successful.[11] As discussed above, macroeconomic policies to restrain demand appear to have been successful in avoiding shortages and significant rationing of consumer goods in the Korean War. The Vietnam War was not associated with any significant government restrictions on US manufacturing production.

$$\Delta PD_t = \alpha^R + \sum_{i=1}^{8} \rho_i^R \Delta PD_{t-i} + \sum_{i=0}^{1} (\beta_i \Delta PE_{t-i} + \gamma_i \Delta PF_{t-i} + \delta_i \Delta PIM_{t-i})$$

$$+ \theta\, CHIPSHORT_t + \sum_{i=0}^{3} \sigma_i \Delta CD_{t-i}$$

PD is the price index for durable goods. *CHIPSHORT* is the frequency of Google searches for "chip shortage." *CD* is real consumption of durable goods. Other variables are the same as above.

Table 1 presents results of regressions of nondurable goods, services, and durable goods inflation over the period 1949Q2 through 2023Q4 in the United States.[12] For simplicity, the table displays only the sums of the coefficients on variables with multiple lags.

The first column of table 1 displays a regression of nondurable goods inflation over all three monetary regimes. Column 2 displays a regression limited to the final regime. The coefficients in column 2 are notably similar to those for the United States in Gagnon and Rose (2024, table 3), despite a moderately different sample period and lag structure. Perhaps more interesting is the remarkable similarity of the coefficients in the first two columns, despite a sample in column

10 This measure is set equal to zero before 2004.

11 One approach involved keyword analysis through the archives of the *New York Times*, searching for terms relating to supply or manufacturing shortages. Results appeared to be inconsistent over time owing to changes in writing style and editorial focus. The coefficient on these search results had the wrong sign and was not statistically significant. Similar efforts using Google Books N-gram Viewer and the Federal Reserve Bank of St. Louis FRASER searchable archive of Federal Reserve documents did not yield useful results. Another approach was motivated by possible effects of controls under the Defense Production Act in the Korean War. We created a shortage measure based on the shortfall of automobile production from its peak in 1950 until the end of the Korean War, when it surpassed its previous peak. We set this variable to zero until the peak of automobile production in 2020Q1, after which it was set equal to the shortfall through 2023. The coefficient on this measure was not significant and had the wrong sign.

12 As in Gagnon and Collins (2019), the regressions include the Gordon (1982) dummy variable for wage and price controls that were imposed in 1971 and fully removed by 1975.

Table 1
US inflation components, 1949Q2–2023Q4

	Nondurable goods		Services		Durable goods		
	1	**2**	**3**	**4**	**5**	**6**	**7**
	Full sample	*Post-1992*	*Full sample*	*Post-1992*	*Full sample*	*Excluding 1968–92*	*Post-1992*
1949Q2–68Q1 lags	−0.33 (0.20)		0.36 (0.19)		0.14 (0.27)	0.20 (0.28)	
1968Q2–92Q2 lags	0.51** (0.09)		0.94** (0.06)		0.77** (0.09)		
1992Q3–2023Q4 lags	0.15 (0.09)	0.23* (0.09)	0.52** (0.11)	0.64** (0.10)	0.28 (0.16)	0.27 (0.17)	0.39** (0.13)
ΔPIM	1.28** (0.26)	1.58* (0.31)	0.45** (0.09)	0.44** (0.11)	1.08** (0.26)	0.48 (0.25)	0.60** (0.21)
ΔPE	0.13** (0.02)	0.12** (0.02)	0.01 (0.01)	0.00 (0.01)	−0.03** (0.01)	−0.02 (0.01)	−0.02* (0.01)
ΔPF	0.32** (0.04)	0.20* (0.09)	0.05* (0.02)	0.00 (0.03)	0.00 (0.05)	0.09 (0.09)	−0.02 (0.07)
V/U	1.79** (0.37)	1.54** (0.47)	1.05** (0.19)	0.64** (0.21)			
ΔV/U	5.54** (1.53)	5.87* (2.32)	1.33 (0.77)	2.16** (0.71)			
CHIPSHORT					0.11** (0.03)	0.10** (0.03)	0.08** (0.02)
ΔCD					0.04 (0.03)	0.08 (0.04)	0.09** (0.03)
Observations	299	126	299	126	299	202	126
R^2	0.87	0.86	0.96	0.95	0.65	0.47	0.76

*p < 0.05, **p < 0.01. Robust standard errors in parentheses.
Source: Authors' calculations using data described in the appendix.

1 that is roughly 2.5 times greater than that in column 2. This suggests that our empirical results in the post-1992 period are not unduly influenced by the large movements of inflation in the years from 2020 through 2023.

Inflation of nondurable goods responds positively to commodity and import price inflation as well as to both the level and change of the vacancy/unemployment ratio, *V/U*. The coefficient on the level of *V/U* represents a permanent effect of labor market tightness on inflation. The coefficient on the change of *V/U* represents a temporary effect sometimes referred to as a "speed limit" effect, reflecting the possibility that a rapidly growing economy may put upward pressure on inflation even when the level of activity or employment is not especially high.

The sums of the lag coefficients differ sharply across monetary regime, with small and statistically insignificant lags in the first and third regimes but moderate and statistically significant lags in the middle regime (1968–92). Lags close to zero imply that any shock to inflation dies out immediately, whereas a sum of lags around 0.5 (as in the middle regime) implies that shocks to inflation persist for about two or three quarters.[13]

The next two columns of table 1 display regressions of services inflation over the full sample and the final monetary regime. Again, the results for the final regime are close to those for the United States in Gagnon and Rose (2024, table 4). Moreover, the results for the full sample are broadly similar to those for the final regime, despite the far larger number of observations.

Services inflation responds significantly to import prices and labor market conditions, with coefficients that are moderately lower than those for nondurable goods inflation. However, the coefficients on lagged services inflation in columns 3 and 4 are notably higher than those on lagged nondurables inflation in columns 1 and 2. Thus, the long-run effects of import prices and labor market conditions on services inflation are rather similar to their long-run effects on nondurable goods inflation.[14]

Again, the lag coefficients differ sharply across regimes. A cumulative lag coefficient of 0.5 or 0.6 in the final regime reflects moderately rapid adjustment of inflation, with a large majority of the effects of shocks to inflation dissipating after two or three quarters. However, the cumulative lag coefficient of 0.94 in the middle regime implies much more persistent shocks to inflation, with half of the effects remaining after three years. Moreover, the coefficient is not statistically different from 1.0, which would imply that shocks to inflation last forever. It may be this property of the middle monetary regime that led some observers to predict that COVID era inflation would be highly persistent unless a recession introduced an opposing disinflationary shock. Table 1 shows that the pessimistic view of COVID era inflation ignores the regime shift that occurred in the early 1990s. Column 3 shows that services inflation was much less persistent in the first and third monetary regimes, enabling shocks to inflation to dissipate relatively quickly.

The final column of table 1 displays a regression of durable goods inflation over the final monetary regime. The coefficients are broadly similar to those for the United States in Gagnon and Rose (2024, table 2), except that the effect of the growth of real durables consumption (*ΔCD*) is notably higher (0.09 vs. 0.05) and the *CHIPSHORT* coefficient is a bit lower (0.08 vs. 0.11).

13 Almost all of the lagged effects occur in the first four quarters. The coefficients on lags 5 through 8 are close to zero.

14 For example, the long-run effect of import price inflation on services inflation is $(\delta_0+\delta_1)/(1-\Sigma\rho_i)$, which increases as the sum of lag coefficients approaches 1.

The regression in column 5 extends the sample to all three regimes. Many coefficients are similar to those in column 7, but the coefficient on real durables consumption is considerably smaller and not significant. Another notable difference in the full sample is the larger impact of import prices. The chip shortage coefficient is slightly higher but not significantly so.

A possible explanation for the small and insignificant effect of the growth of real durables spending on durables inflation in the full sample lies in the different sources of spikes in durables consumption. In both 1950 and 2021, consumer demand drove the shift. In 1950, the outbreak of the Korean War caused consumers to fear a return of wartime rationing, which had ended only a few years earlier. In 2021, consumers feared spending on services that might expose them to the virus that causes COVID-19 and switched to durable goods such as exercise bicycles and recreational vehicles. Shifts in consumer spending on durable goods in the 1970s and 1980s may have been driven more by endogenous responses to cyclical fluctuations in household income rather than from exogenous shocks to consumer preferences.

To test this hypothesis, column 6 displays a regression that drops the second monetary regime and includes only the first and third regimes. Most of the coefficients, and the coefficient on the growth of real spending on durables in particular, are similar to those in the regression on the third regime only (column 7). This coefficient is almost statistically significant, with a p-value of 0.06. A regression limited to the first regime (1949–68, not shown) yields a coefficient on durables spending only slightly smaller, but it is not statistically significant, probably because the sample is too short to obtain precise estimates. A regression limited to the second regime (1968–92, not shown) yields a coefficient on durables spending that is negative and not significant. These results suggest that the spikes in durable goods spending in the Korean War and the COVID-19 pandemic may have had similar effects on inflation, whereas shifts in durables goods spending in the 1970s had different causes and the opposite relationship to durable goods inflation.

As is the case for nondurable goods and services inflation, the sums of the lag coefficients on durable goods inflation differ strongly across monetary regimes, with much greater persistence of inflationary shocks in the middle regime. The sharp decline in the persistence of inflationary shocks after 1992 in all three components of inflation explains why COVID era inflation was able to decline relatively quickly without a recession.

CONCLUSION

In 2021–22, an unusual confluence of shocks caused the largest surge of inflation experienced by the United States and many other economies in roughly 40 years. The shocks include (1) a plethora of pandemic-related demand and supply disruptions, (2) the global commodity price shock caused by Russia's invasion of Ukraine, and (3) tight labor markets. This paper traces out the working of these shocks through inflation rates in the major categories of consumption: durable goods, nondurable goods, and services.

There is a striking similarity between COVID era inflation and the Korean War inflation. Both inflation surges had a strong impetus from purchases of consumer durable goods, and both surges receded quickly without any noticeable increase in the unemployment rate. Key differences are that unique pandemic-related supply disruptions and a global commodity price shock contributed to COVID era inflation but not Korean War inflation.

A number of observers expected COVID era inflation to persist for years unless the economy experienced a sharp rise in unemployment. Yet inflation has returned most of the way to its target without a recession. This paper shows that pessimism about disinflation may reflect an inappropriate focus on the experience of the 1970s, when the Federal Reserve did not try to achieve a constant low rate of inflation. Since the early 1990s, the Federal Reserve has aimed at a constant low rate of inflation, and the dynamics of inflation in the COVID era more nearly resemble those of the 1950s.

After allowing for shifts in the monetary regime, the inflation process is remarkably stable. In particular, the effects of commodity and import prices and labor market conditions are similar when estimated over the entire postwar period or the much shorter period since the early 1990s. This stability provides assurance that the coefficient estimates in the latter period are not unduly affected by the COVID era inflation surge.

The pandemic-related demand and supply disruptions have largely reversed and commodity prices are back in historical ranges, allowing a substantial decline of inflation in 2023. The labor market, however, is only gradually returning toward normal and kept inflation slightly above its pre-pandemic levels in 2024.

APPENDIX: DATA SOURCES AND DEFINITIONS

Sources

Data on nominal consumption, goods and services imports, GDP, and related price indexes are from the Bureau of Economic Analysis National Accounts database via https://fred.stlouisfed.org/. All data are seasonally adjusted.

Food and energy inflation data come from the World Bank Global Database of Inflation at https://www.worldbank.org/en/research/brief/inflation-database.

Unemployment rates are obtained from the Bureau of Labor Statistics (BLS) via https://fred.stlouisfed.org/.

The job vacancy rate was obtained from the BLS Job Openings and Labor Turnover Survey database via https://fred.stlouisfed.org/. The vacancy rate was extrapolated backwards using data from Petrosky-Nadeau and Zhang (2021) available at https://drive.google.com/file/d/1NcuUMRR4_fOwJW6qHb-XxitVSXXONBHW/view.

Our proxy for semiconductor supply shortages is constructed using data from Google Trends on frequency of search results in the United States for the term "chip shortage." Results are available from 2004 to present at a monthly frequency, with the peak month indexed at 100. We converted the data to a quarterly frequency using averages within each quarter. We extrapolated data before 2004 at 0.

Definitions

PN	price index for nondurable goods in personal consumption expenditures (PCE)
PD	price index for durable goods in PCE
PS	price index for services in PCE
PE	energy component of consumer price index, ratio to GDP price index
PF	food component of consumer price index, ratio to GDP price index
PIM	price index for imports of goods and services, ratio to GDP price index (the *PIM* inflation rate is scaled by the ratio of imports to GDP)
V/U	ratio of job vacancies to unemployment
CD	real consumption of durable goods
CHIPSHORT	Google Trends search frequency for the term "chip shortage"
WPC	dummy variable for wage and price controls equal to 0.8 in each quarter from 1971Q3 through 1972Q3, –0.4 in 1974Q2 and 1975Q1, –1.6 in 1974Q3 and 1974Q4, and 0 otherwise, based on Gordon (1982)

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PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

25-7 The Role of Long Histories of "Lived Experience" in the COVID-Era Inflationary Surge

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ABSTRACT

A rough consensus has evolved around the causes of the COVID-era inflationary spike: the disruption in supply chains; the shift in demand from services to goods; the surge in commodity prices that followed Russia's invasion of Ukraine; and the pandemic fiscal stimulus programs. In this paper, we highlight an additional factor influencing the incidence of pandemic inflation across countries—their long histories of "lived experience" with inflation. We show that more than half of the variation in inflation across countries during the 2020–23 period can be explained by their earlier levels of inflation. Even controlling for inflation in the 2016–19 period, countries with higher inflation in the 2000–2015 period had higher COVID-era inflation, and the effect of long-lagged inflation is both economically and statistically significant. These long histories of lived experience dominated other policy measures to control inflation, including inflation targets and central bank independence. The influence of long-lagged inflation history appears to be greatest during periods of heightened volatility; it was less important in explaining the cross-country pattern of inflation during the more tranquil period immediately preceding the pandemic.

JEL Codes: E30, E31
Keywords: inflation, expectations, pandemic

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The further back I look, the further forward I can see.
—Winston Churchill

INTRODUCTION

This paper shows how long histories of "lived experience" with inflation influenced the cross-country incidence of the COVID-era inflationary surge. That surge was the most important monetary event since the 2007-09 global financial crisis. Inflation soared around the world, reaching a 40-year high in advanced economies, challenging financial markets, fiscal authorities, and central banks that had largely failed to foresee this development. Out of an extremely large and growing body of research, a rough consensus has evolved around the causes of the inflationary spike: the disruption in global and domestic supply chains triggered by COVID; the shift in demand from services to goods also caused by the pandemic; the surge in commodity prices that followed Russia's invasion of Ukraine; and the support to aggregate demand stemming from COVID-era fiscal stimulus programs.[1]

Despite the pivotal role of expectations in our theories of inflation, studies generally find that widely used measures of inflation expectations were not a factor propelling COVID-era inflation higher. Surveys of long-term inflation expectations remained stable in the face of the spike in prices, militating against the emergence of a wage-price spiral that many had feared during the initial stages of the inflationary surge.[2] And once the supply-side disruptions had eased, the subsequent disinflation was credited in part to well-anchored inflation expectations. As Fed

[1] See Gagnon and Rose (2024) for a summary of the voluminous research on the sources of COVID-era inflation as of early 2024. Additional studies not covered in their article include Aguilar, Guerra, and Martinez (2024), Bloesch (2024), di Giovanni et al. (2024), Dynan and Elmendorf (2024), Fatás (2024), Giannone and Primiceri (2024), Hsu (2024), IMF (2022, 2024), Kamin, Kearns, and Strain (2022), Kamin and Kearns (2022), Kamin and Roberts (2024), and Reifschneider (2024).
[2] Measures of short-term inflation expectations did rise after inflation took off, but they did not anticipate inflation to any notable extent.

Chairman Jerome Powell noted in 2024, "All told, the healing from pandemic distortions, our efforts to moderate aggregate demand, and the anchoring of expectations have worked together to put inflation on what increasingly appears to be a sustainable path to our 2 percent objective."[3]

But there is more to this story than just that inflation expectations remained anchored, helping to bring inflation down. Differences in inflation expectations across countries, rooted in their differing historical experiences, were a critical factor explaining why some countries experienced greater price pressures than others. Figure 1 plots average consumer price index (CPI) inflation rates during 2020-23 (the Y axes) against average inflation rates during the years 2000-2009 (the X axes), more than a decade earlier.[4] It shows a wide range of inflation outcomes across countries in the 2020-23 period, and perhaps surprisingly, much of that variation is explained by differences in those countries' long past inflation rates.

Moreover, not only does long-ago inflation explain much of the cross-country variation in the levels of COVID-era inflation, but it also helps to explain why inflation rose more from pre-pandemic levels in some countries than in others. In figure 2, the Y axes plot the change in average inflation between the four years before COVID and the four years after. As before, the X axes plot the average level of inflation from 2000 through 2009. Inflation increased almost everywhere after 2020, evidenced by the fact that more than 85 percent of the observations are above the zero lines of the Y axes. But the increases generally were larger in economies that had higher inflation a long time ago.

The effect of long past inflation illustrated above has not been emphasized in earlier studies of COVID inflation, and it sheds important light on the inflationary process. Figures 1 and 2, of

[3] Speech presented at the 2024 Jackson Hole Symposium. Available at https://www.federalreserve.gov/newsevents/speech/powell20240823a.htm.

[4] Data are described in appendix B. These figures and the regression results below exclude economies in which average inflation in 2020-23 or 2000-19 exceeds 25 percent. The excluded economies are Angola, Argentina, Belarus, Democratic Republic of the Congo, Eritrea, Ethiopia, Haiti, Iran, Kuwait, Lebanon, Sierra Leone, Somalia, South Sudan, Sudan, Suriname, Turkey, Venezuela, and Zimbabwe.

course, merely show simple bilateral correlations. The rest of this paper uses regression analysis to explore the impact of long past inflation in models that allow for other forces on inflation. We find that even controlling for 2016-19 inflation and other factors, inflation in the preceding 2000-2015 period retains a strong and statistically significant correlation with 2020-23 inflation. This suggests that inflation expectations are deeply rooted in the "lived experience" of households, workers, and firms. In consequence, when the pandemic shocks hit, countries with long histories of low inflation (e.g., Japan, Switzerland) showed more muted responses than countries with histories of much higher inflation (Ghana, Latvia, Pakistan).

These long histories of lived experience are so important that they dominate other policy measures to control inflation. Adding inflation targets and measures of central bank independence to our regression equations adds little explanatory power, and the lags of inflation remain highly significant. It is apparent that central banks influence inflation expectations through the cumulative effect of their policies on inflation history rather than through any fast-acting effects of central bank communications, governance, or targets.

The influence of long-lagged inflation history appears to be greatest during periods of heightened volatility. During the tumultuous environment of the COVID era, as global shocks pushed inflation well above inflation targets, central banks appear to have (at least temporarily) lost their ability to control inflation behavior and expectations—they were supplanted by the ingrained psychology of households, workers, and firms stemming from decades of their inflationary experience. Conversely, when we reestimate our models of inflation in the immediate pre-COVID era (2016-19), we find that the effect of the longest-lagged inflation (1996-2011) is diminished relative to that of more recent inflation (2012-2015), though it often remains statistically significant.

We also examine long-term inflation expectations embodied in bond yields and in surveys of professional economists. Like actual inflation, bond yields were strongly correlated with long past inflation in 2020-23 and more weakly correlated in 2016-19. The effect of long past inflation is weakest in surveys of long-term inflation projections by professional forecasters. Moreover, survey measures of inflation expectations had no ability to explain differences in pandemic inflation across countries, controlling for inflation histories. We surmise that the inflation expectations of professional economists may deviate from those of actual price-setters and investors to a noticeable extent, particularly during times of heightened uncertainty. This may be because professional economists are more reliant on central bank guidance, or, as a related matter, because they are producing modal forecasts that ignore upside risks to inflation such as have materialized in the distant past.

This paper adds to a very small body of earlier research showing that inflation expectations may be influenced by inflation experiences going back many years, and even generations (Gagnon 2008; Malmendier and Nagel 2016; Braggion et al. 2023). It is also one of very few papers to identify a linkage across countries between initial pre-pandemic levels of inflation and their subsequent rise (Kamin, Kearns, and Strain 2022; Fatás 2024). Finally, it is the only paper we are aware of to show the effect of long past inflation experiences on the global incidence of the COVID-era inflationary surge.

METHODOLOGY

To assess the influence of inflation history on inflation during the COVID era, we estimate the following cross-country regression:

$$INF(2020-23)_i = \alpha + \beta\, INF(2016-19)_i + \gamma INF(2000-15)_i + \delta GAP(2020-23)_i + e_i \quad (1)$$

Average CPI inflation in country *i* during 2020-23 is regressed on a constant, average inflation over the four years before COVID-19, average inflation over 16 years from 2000 through 2015, and the output gap during 2020-23.[5] This is a simple cross-sectional version of an expectations-augmented Philips curve, with the lagged inflation rates intended to capture the influence of inflation history on inflation expectations. As COVID was a global shock hitting all countries, we expect its effects on inflation to be captured by a positive intercept α; of course, the shock hit different countries to varying degrees, reflecting differences in consumption baskets and energy dependence, and those differences will be reflected in the error term e_i.

The coefficients on the lagged inflation variables will test our hypothesis regarding the dependence of inflation expectations on prior history. To the extent that those expectations adjust quickly in response to changes in actual inflation performance, γ should be close to 0. On the other hand, if credibility takes a long time to build up, γ should be greater than 0. In the latter case, even if an economy had experienced low inflation for four years before the pandemic, the inflationary impact of COVID-19 would be larger for economies that had experienced high inflation in the more distant past.

We also consider whether our econometric results are specific to the COVID era or apply with greater generality. Accordingly, we estimate a lagged version of equation (1) on data for the pre-pandemic era:

$$INF(2016-19)_i = \alpha + \beta\, INF(2012-15)_i + \gamma INF(1996-2011)_i + \delta GAP(2016-19)_i + e_i \quad (2)$$

[5] We use four-year averages to capture the overall effect of the pandemic on prices while allowing for moderate differences in the exact timing across countries.

To shed further light on the behavior of inflation expectations, and the ability of central banks to mold those expectations, we add two additional independent variables to both the COVID-era and pre-COVID-era equations, one at a time: (1) each central bank's inflation target as of 2022, and (2) a measure of each country's central bank independence averaged over 2020-23.

Finally, we considered two alternative proxies for inflation expectations: (1) projections of far-forward CPI inflation (6 to 10 years ahead) from Consensus Forecasts' survey of professional forecasters, and (2) 10-year bond yields. These were employed in different ways. First, we added the far-forward survey as a separate explanatory variable to equations (1) and (2), above. Second, we estimated separate equations to explain the far-forward survey and 10-year bond yield during the COVID era as a function of lagged inflation rates, as shown in equations (3) and (4), below:

$$Survey(2020-23)_i = \alpha + \beta\, INF(2016-19)_i + \gamma INF(2000-15)_i + \delta GAP(2020-23)_i + e_i \quad (3)$$

$$Yield(2020-23)_i = \alpha + \beta\, INF(2016-19)_i + \gamma INF(2000-15)_i + \delta GAP(2020-23)_i + e_i \quad (4)$$

RESULTS

Baseline results for COVID-era inflation

Table 1 below presents the results from estimating equation (1). The coefficients on lags of inflation are highly statistically significant, both on more recent lags (2016-19) and, strikingly, on much older lags (2000-2015). These findings are robust to whether prices are measured by CPIs or GDP deflators, as well as to advanced economies or developing economies.[6] These variables, along with

[6] Neither the standard deviation nor the variance of inflation over the previous 20 years is significant when added to any of the regressions in table 1.

the output gap, explain about 60 percent of the variation in inflation across countries during the COVID era. Most of this explanation comes from the lagged inflation variables; in estimations that exclude the output gap (not shown), the coefficients on the inflation terms are similar and the R^2s are nearly as high.

Finally, the intercept terms are highly significant, reflecting the effect of the pandemic shocks themselves. The intercepts are larger in developing economies but the sums of the coefficients on lagged inflation in advanced economies are greater than one—which also helps to explain higher COVID inflation. The average increase in inflation from 2016-19 to 2020-23 was 2.9 percent in advanced economies and 2.3 percent in developing economies (after excluding outliers as described in figure 1).

All told, these results are strong evidence that inflation and inflation expectations depend on much longer histories of inflation than we would have expected. Moreover, as shown in table 2 below, these long lags of inflation remain important even after accounting for inflation targets and the extent of central bank independence. (Table 2 displays results for CPI inflation; results for GDP deflator inflation, not shown, are essentially similar.) The signs and significance of the coefficients on the inflation target are mixed, while those on central bank independence are all positive, the opposite of the expected sign; neither variable adds much explanatory power to the equation. In all three of the samples, the coefficient on long-lagged inflation history (2000-2015) remains statistically significant.

Robustness of the baseline results

It is possible that the statistical significance of the coefficients on long-lagged inflation shown in table 1 reflects the correlation of long-lagged inflation with some other influence on inflation in the pandemic era that has been omitted from the equation. To assess the robustness of our results, we added a long list of additional explanatory variables, one at a time, to the baseline CPI equations in table 1. They include:

- The difference between headline CPI inflation and core inflation; this is intended to control for any correlations between pandemic era non-core inflation (food and energy price rises) and lagged inflation;
- The log of constant-price PPP GDP per capita on average during 2020-23;
- Population growth during 2020-23;
- The change in population growth from 2016-19 to 2020-23;
- The share of the population aged 65+ in 2020-23;
- The government fiscal balance/GDP in 2020-23;
- The change in the government fiscal balance/GDP from 2016-19 to 2020-23;
- The current account balance/GDP in 2020-23;
- The change in the current account balance/GDP from 2016-19 to 2020-23;
- The measure of central bank independence in 2020-23 multiplied by long-lagged inflation; this is intended to test the possibility that when central banks are highly independent, inflation is better-anchored and less influenced by long-lagged inflation.

The results of these estimations are shown in appendix tables A1 (advanced economies) and A2 (developing economies). In every case except the last one listed above, addition of the extra explanatory variable leaves the coefficient on long-lagged inflation to be sizeable. All but one of these sizeable coefficients are statistically significant. In the last case above, the coefficient on long-lagged inflation becomes insignificant, but the coefficient on the interaction term is positive and highly significant for advanced economies. For developing economies, the long lag coefficient is sizeable, and this coefficient and the interaction term are jointly significant at the 1 percent level. These results are inconsistent with the view that central bank independence leaves inflation expectations better anchored, and, again, affirms the importance of long-lagged inflation in influencing pandemic inflation.

Baseline results for the pre-COVID era

To what extent are our findings specific to the COVID era? To address that question, we reestimated the equations in tables 1 and 2, but specifying inflation in the 2016-19 period as the dependent variable. Table 3 replicates table 1, using only lags of inflation and the output gap as explanatory variables. As would be expected, given the absence of a global inflationary shock during this period, the intercept terms are now much smaller and generally not significantly different from zero. The coefficients on the output gap are also smaller, insignificant, or of the incorrect sign; that likely reflects the smaller variation in output gaps across countries compared with the COVID era.[7] Finally, the coefficients on long-lagged inflation (1996-2011) are smaller than estimated for the COVID era (2000-15).[8] The long history of lived experience with inflation appears to weigh more on expectations and pricing decisions during periods of elevated volatility and uncertainty (2020-23) than it does in more tranquil periods (2016-19). In any event, however, the coefficients on both shorter and longer lags of inflation history generally remain highly significant.

Table 4 below replicates the specification in table 2, applied to the pre-COVID era. The coefficients on central bank independence now have the expected negative sign but are not significantly different from zero. The coefficient on the inflation target, however, is now significant and about one for the all-economies and developing-economies samples. For these samples, the addition of the inflation target leads the coefficients on both the near-term and long past lags of

[7] It is also possible that measurement error in the GDP deflator used to construct real GDP introduces a spurious negative correlation between the output gap and GDP inflation. For a given value of nominal GDP, a higher estimate of the GDP deflator raises inflation and reduces real GDP and hence the output gap.
[8] The changes in the long-lagged inflation coefficients from those in table 1 are statistically significant except for GDP inflation in developing economies. Tests are based on joint regressions over both the COVID era and the pre-COVID period allowing all coefficients to change.

inflation to become very small and insignificant. (The lack of significance of the inflation target for the advanced economies likely reflects the lack of variation across countries; the addition of the inflation target has little impact on the other coefficients in the model for this sample.)

The results of tables 3 and 4 suggest that during the tranquil pre-COVID period, central banks were successful in meeting their inflation targets, and those targets reduced the importance of past history as a determinant of inflation and inflation expectations. By comparison, in the tumultuous environment of the COVID era, as global shocks pushed inflation well above inflation targets, these targets lost their traction in guiding inflation behavior and expectations—they were supplanted by the ingrained psychology of households, workers, and firms stemming from decades of their inflationary experience.

Adding survey measures of inflation expectations

Table 5 below adds to the baseline regressions for CPI inflation projections of CPI inflation 6 to 10 years ahead from Consensus Forecasts' survey of professional forecasters (the far-forward survey). Because of the small sample size, we show results only for the all-economies sample; and because of the large difference in sample sizes, which depend on data availability, we show results both with and without inclusion of the survey measure within the same samples. Inclusion of the far-forward survey has little impact on the other coefficients or on the equation R^2. The table shows that neither in the COVID era nor the pre-COVID era did the far-forward surveys have much predictive power for actual inflation.[9] This could be because inflation history is acting on actual inflation through some mechanism other than inflation expectation. However, the more likely explanation is that the

[9] There is a potential endogeneity of the explanatory variable to the extent that higher inflation raises survey expectations of future inflation. Endogeneity would bias the coefficient upward, but since the effect of survey expectations on inflation is also assumed to be positive and the estimated coefficient is not statistically significant, we conclude that neither the hypothesized effect nor the bias is significant.

inflation expectations of professional forecasters are not the same thing as the expectations held by households, workers, and firms, a hypothesis we explore further below.

How inflation history affects surveys of inflation expectations

In table 6 below, we switch the survey measure of inflation expectations from being the explanatory variable to the dependent variable—that is, we seek to explore the determinants of the far-forward survey. We find that surveyed expectations were less sensitive to lagged inflation and more sensitive to inflation targets than actual inflation in the COVID era. Focusing first on columns (1) and (3), the far-forward survey in the COVID era is less affected by short and long lagged inflation than is actual inflation (using the same sample to facilitate comparison), but there are statistically significant small positive impacts of lagged inflation on far-forward surveys. When inflation targets are added (column 2), the effects of lagged inflation fall even closer to zero, though they remain statistically significant. Adding inflation targets to the inflation regression (column 4), on the other hand, yields a negative but insignificant coefficient on the target and little effect on the other coefficients.[10] Appendix table A3 shows that in the pre-COVID period, long-lagged inflation has even smaller (and insignificant) effects on surveys of inflation expectations.

How inflation history affects bond yields

An alternative means of gauging the effect of inflation history on expectations is based on the behavior of long-term bond yields.[11] Table 7 regresses averages of 10-year government bond yields over 2020-23 on recent and long-lagged averages of actual inflation, as well as the auxiliary variables

[10] Note that the output gap coefficients, which are positive in the inflation regressions, are small and negative in the survey regressions, suggesting that the economists surveyed did not expect the existing gaps to have a long-run effect on inflation.

[11] In addition to expectations about future inflation into the distant future, bond yields reflect expectations of future real short-term rates set by monetary policy and a term premium. Yields are highly responsive to current inflation and other macroeconomic developments, making them unsuitable as an explanatory variable in our inflation regressions.

we've reviewed above. Starting with the base case in column (1), as in the case of COVID-era CPI inflation, both recent (2016-19) and earlier (2000-15) lags of inflation are positive and significant, suggesting that the expectations process influencing inflation may be similar to that influencing bond yields.[12] Column (2) shows that average CPI inflation for 2020-23 has little correlation with bond yields, leaving the coefficients on lagged inflation little changed. In other words, bond investors did not expect COVID inflation to persist very long.[13] Column 3 adds central bank inflation targets, which are highly significant with the correct sign; however, the coefficient on the long backward lag of inflation remains sizeable and significant. Finally, the far-forward inflation survey coefficient in column 4 has the wrong sign and is not significant, suggesting that the bond market largely (and perhaps rightly!) ignored the inflation projections of professional economists.[14]

Appendix table A4 repeats the exercise for the pre-COVID era. Similar to what we've found for CPI inflation and far-forward inflation surveys in the 2016-19 period, the importance to bond yields of long-lagged inflation diminishes relative to more recent inflation, whereas all three additional variables—current (2016-19) inflation, inflation targets, and far-forward inflation projections—are statistically significant. These findings reinforce our conclusion that in the more tranquil period of the late 2010s, current inflation, recent inflation, inflation targets, and far-forward surveys of inflation were highly correlated with each other and with long-term inflation expectations in each country. Conversely, in the more volatile and uncertain COVID era, these indicators of inflation expectations moved in different ways, and people looked more to their lived experience of long past inflation as a guide to what the future might hold.

[12] Gagnon (1996) shows that bond yields in the 1980s and early 1990s are correlated across countries with long lags of inflation.
[13] Professional forecasters also did not expect COVID inflation to persist. Adding contemporaneous inflation to the far-forward survey regression of table 6 column 1 yields a coefficient near zero.
[14] The large effects of adding either inflation targets or far-forward surveys on the coefficient on recent inflation suggests some collinearity among these three variables.

CONCLUSION

In normal or tranquil times, central banks generally keep inflation close to its target, and expectations of future inflation are also close to target. The impact of long past inflation on expected inflation is positive but small, though sometimes statistically significant. During turbulent times, people attach less (but not zero) weight to central bank inflation targets but considerably more weight to their experiences of inflation in the distant past. Notably, inflation from 5 to 20 years earlier is a strongly significant predictor of differences in COVID-era inflation across 166 countries.

These conclusions are apparent in estimated statistical models of inflation that are based on measures of inflation history and other factors. They are also apparent in models of bond yields, which are strongly influenced by long-term inflation expectations. Surveys of professional economists' projections of inflation in the distant future offer less (but not zero) support for the role of long past inflation. Professional economists appear more swayed by inflation targets and/or recent inflation than by long past inflation, even in turbulent times. This divergence between the expectations of professional forecasters and economic actors may not be all that surprising: Gagnon (2008) shows that in 2007 long-term inflation projections of professional forecasters were typically close to central bank inflation targets and well below inflation compensation in long-term bond yields. Binder and Kamdar (2022) document that during 2011-2021, inflation forecasts from the Federal Reserve Bank of Philadelphia Survey of Professional Forecasters were negatively correlated with the University of Michigan Survey of Consumer Expectations. Coibion and Gorodnichenko (2015) and Pfajfar and Roberts (2022) also document significant differences between household inflation expectations and professional forecasts, with the former exerting a greater influence on actual inflation than the latter.

Perhaps central bank promises are more convincing to economists than to investors, workers, and firms. A related possibility is that economists are projecting the most likely, or modal, future path of inflation, which may well be close to the central bank's inflation target. However, if the current inflation target is well below the mean of lifetime inflation, a period of heightened uncertainty is likely to be viewed by folks with less "buy in" to central bank guidance as raising more upside risks than downside risks to inflation. In that case, the mean of future inflation (which matters for actual price-setters and investors) will exceed the mode, leading to a greater dependence of actual inflation and bond yields on long past inflation histories.

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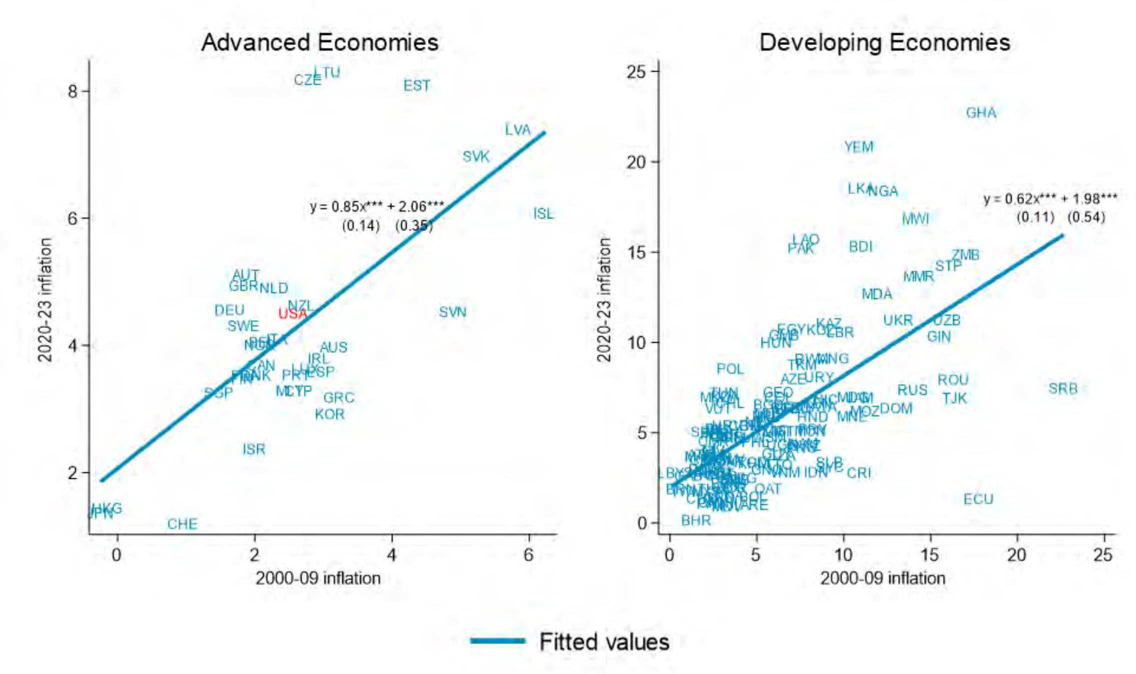
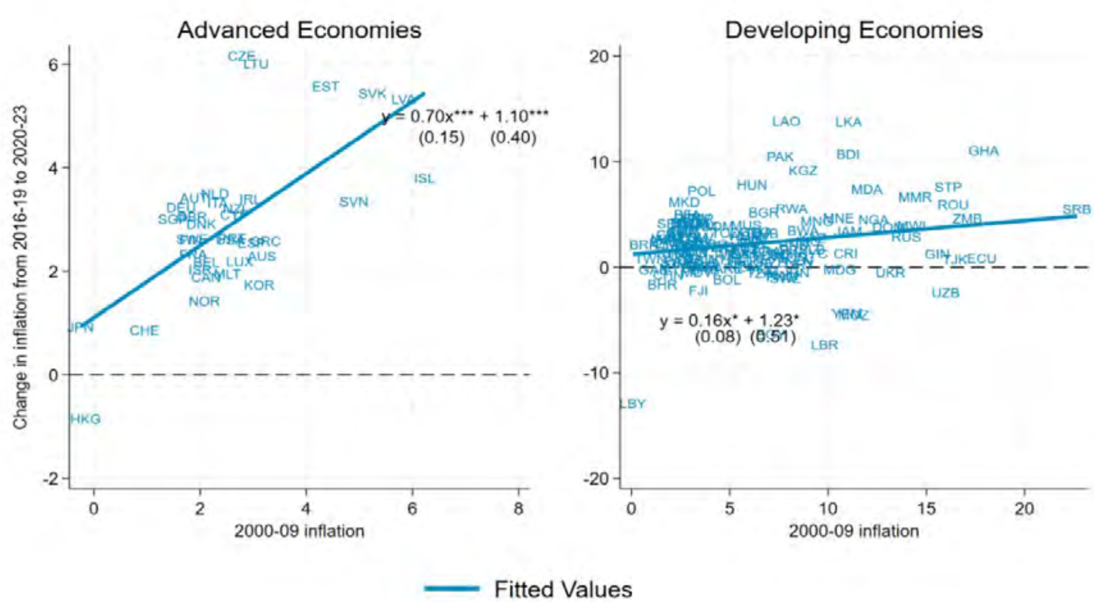
FIGURES AND TABLES

Figure 1. The correlation of COVID inflation with long past inflation



Note: *, **, and *** denote statistical significance at the 10, 5, and 1 percent levels, respectively, based on robust standard errors.
Source: Authors' calculations using data described in appendix B.

Figure 2. The effect of long past inflation on the COVID inflation surge



Note: *, **, and *** denote statistical significance at the 10, 5, and 1 percent levels, respectively, based on robust standard errors.
Source: Authors' calculations using data described in appendix B.

Table 1. Cross-country regressions of COVID-era inflation

	CPI Inflation (20-23)			GDP Inflation (20-23)		
	All	**Advanced**	**Developing**	**All**	**Advanced**	**Developing**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Intercept	2.58***	1.06**	2.31***	2.36***	1.16***	2.12***
$(\boldsymbol{\alpha})$	(0.35)	(0.42)	(0.50)	(0.45)	(0.41)	(0.66)
INF(16-19)	0.40***	1.06**	0.40***	0.48***	0.84**	0.47***
$(\boldsymbol{\beta})$	(0.09)	(0.41)	(0.09)	(0.17)	(0.34)	(0.18)
INF(00-15)	0.47***	0.90***	0.49***	0.41***	0.72***	0.43***
$(\boldsymbol{\gamma})$	(0.10)	(0.28)	(0.11)	(0.11)	(0.26)	(0.12)
Output Gap (20-23)	0.53***	0.49**	0.48***	0.54***	-0.14	0.52***
$(\boldsymbol{\delta})$	(0.14)	(0.21)	(0.16)	(0.16)	(0.29)	(0.18)
No. Obs.	166	35	131	165	35	130
R^2	0.59	0.60	0.59	0.58	0.65	0.57

Note: The dependent variable is average inflation over the years 2020 through 2023. The independent variables are average inflation over the years 2016 through 2019, average inflation over the years 2000 through 2015, and the percent deviation of real PPP GDP per capita from a Hodrick-Prescott (HP) filtered trend. Outliers are excluded for INF(20-23)>25% or INF(00-19)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table 2: Adding inflation targets and central bank independence for COVID-era inflation

	All		Advanced		Developing	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Intercept	2.06***	0.36	8.48***	-0.01	1.18	-0.01
$(\boldsymbol{\alpha})$	(0.71)	(1.14)	(1.59)	(0.72)	(1.12)	(1.74)
INF(16-19)	0.29*	0.39***	1.44***	1.37***	0.22	0.39***
$(\boldsymbol{\beta})$	(0.16)	(0.10)	(0.42)	(0.41)	(0.17)	(0.10)
INF(00-15)	0.37***	0.55***	0.92***	0.63**	0.38***	0.57***
$(\boldsymbol{\gamma})$	(0.11)	(0.13)	(0.20)	(0.24)	(0.12)	(0.14)
Output Gap (20-23)	0.58	0.51***	0.27**	0.38**	0.63	0.46**
$(\boldsymbol{\delta})$	(0.35)	(0.18)	(0.13)	(0.16)	(0.57)	(0.22)
Inflation Target	0.53		-3.94***		0.78*	
(2022)	(0.37)		(0.84)		(0.40)	
Central Bank		2.85**		1.67*		3.00
Independence (20-23)		(1.39)		(0.86)		(2.23)
No. Obs.	93	136	31	33	62	103
R^2	0.60	0.62	0.71	0.67	0.57	0.61

Note: The dependent variable is average CPI inflation over the years 2020 through 2023. The independent variables are average CPI inflation over the years 2016 through 2019, average CPI inflation over the years 2000 through 2015, the percent deviation of real PPP GDP per capita from an HP filtered trend, inflation targets, and an index of central bank independence. Outliers are excluded for INF(20-23)>25% or INF(00-19)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table 3. Cross-country regressions of pre-COVID inflation

	CPI Inflation (16-19)			GDP Inflation (16-19)		
	All	**Advanced**	**Developing**	**All**	**Advanced**	**Developing**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Intercept	-0.19	0.37	-0.33	0.49	0.66**	0.45
(α)	(0.40)	(0.23)	(0.50)	(0.37)	(0.28)	(0.54)
INF(12-15)	0.66***	0.48***	0.67***	0.27***	0.33**	0.27***
(β)	(0.12)	(0.07)	(0.12)	(0.08)	(0.14)	(0.08)
INF(96-11)	0.15	0.17***	0.15	0.38***	0.24***	0.39***
(γ)	(0.10)	(0.05)	(0.10)	(0.07)	(0.07)	(0.08)
Output Gap (16-19)	0.22	-0.09	0.25	-0.29**	-0.11	-0.29**
(δ)	(0.28)	(0.14)	(0.30)	(0.12)	(0.18)	(0.14)
No. Obs.	161	35	126	162	34	128
R^2	0.55	0.46	0.51	0.61	0.45	0.58

Note: The dependent variable is average inflation over the years 2016 through 2019. The independent variables are average inflation over the years 2012 through 2015, average inflation over the years 1996 through 2011, and the percent deviation of real PPP GDP per capita from an HP filtered trend. Outliers are excluded for INF(16-19)>25% or INF(96-15)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table 4: Adding inflation targets and central bank independence for pre-COVID inflation

	All		Advanced		Developing	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Intercept	-0.47	0.53	-0.04	0.43	-0.32	1.06
$(\boldsymbol{\alpha})$	(0.53)	(1.10)	(1.59)	(0.40)	(0.76)	(1.67)
INF(12-15)	0.02	0.73***	0.53***	0.46***	-0.02	0.74***
$(\boldsymbol{\beta})$	(0.18)	(0.11)	(0.12)	(0.11)	(0.19)	(0.12)
INF(96-11)	0.07	0.06	0.14**	0.19***	0.08	0.06
$(\boldsymbol{\gamma})$	(0.05)	(0.07)	(0.06)	(0.06)	(0.05)	(0.07)
Output Gap (16-19)	-0.67**	0.14	-0.15	-0.13	-0.97**	0.15
$(\boldsymbol{\delta})$	(0.27)	(0.34)	(0.16)	(0.15)	(0.41)	(0.37)
Inflation Target	1.06***		0.28		1.09***	
(2016)	(0.28)		(0.82)		(0.28)	
Central Bank		-0.70		-0.01		-1.77
Independence (2016-19)		(1.28)		(0.49)		(2.11)
No. Obs.	86	133	31	33	55	100
R^2	0.80	0.63	0.51	0.46	0.77	0.60

Note: The dependent variable is average CPI inflation over the years 2016 through 2019. The independent variables are average CPI inflation over the years 2012 through 2015, average CPI inflation over the years 1996 through 2011, the percent deviation of real PPP GDP per capita from an HP filtered trend, inflation targets, and an index of central bank independence. Outliers are excluded for INF(16-19)>25% or INF(96-15)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table 5: Adding survey measures of inflation expectations

	INF(2020-23)		INF(16-19)	
	(1)	**(2)**	**(3)**	**(4)**
Intercept	3.61***	3.19**	0.70***	0.49
$(\boldsymbol{\alpha})$	(0.55)	(1.33)	(0.23)	(0.75)
INF (near lags)	0.35**	0.28	0.60***	0.56***
$(\boldsymbol{\beta})$	(0.14)	(0.30)	(0.08)	(0.18)
INF (long lags)	0.34**	0.30**	0.02	0.02
$(\boldsymbol{\gamma})$	(0.13)	(0.12)	(0.02)	(0.02)
Output Gap (contemporaneous)	0.87**	0.94*	-0.07	-0.10
$(\boldsymbol{\delta})$	(0.38)	(0.47)	(0.18)	(0.16)
Far-Forward Survey (contemporaneous)		0.33		0.15
		(0.96)		(0.48)
No. Obs.	43	43	41	41
R^2	0.39	0.40	0.84	0.84

Note: The dependent variables are average CPI inflation over the years 2020 through 2023 (columns 1 and 2) and over 2016 through 2019 (columns 3 and 4). The independent variables are average CPI inflation over the years 2016 through 2019 (columns 1 and 2) and over 2012 through 2015 (columns 3 and 4); average CPI inflation over the years 2000 through 2015 (columns 1 and 2) and over 1996 through 2012 (columns 3 and 4); the percent deviation of real PPP GDP per capita from an HP filtered trend; and Consensus Forecasts average of professional forecasters' inflation projections for 6-10 years ahead. Outliers are excluded for INF(2023)>25% or INF(0019)>25% (columns 1 and 2) and for INF(16-19)>25% or INF(96-15)>25% (columns 3 and 4).
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table 6: Cross-country regressions of COVID-era inflation expectations

	Far-Forward Survey (20-23)		INF (20-23)	
	(1)	**(2)**	**(3)**	**(4)**
Intercept	1.28***	0.32	3.98***	5.44***
($\boldsymbol{\alpha}$)	(0.12)	(0.33)	(0.60)	(1.61)
INF (16-19)	0.24***	0.11*	0.39***	0.60*
($\boldsymbol{\beta}$)	(0.07)	(0.06)	(0.13)	(0.32)
INF (00-15)	0.11**	0.05*	0.31**	0.39***
($\boldsymbol{\gamma}$)	(0.04)	(0.03)	(0.12)	(0.140
Output Gap (20-23)	-0.24*	-0.14*	1.00***	0.85*
($\boldsymbol{\delta}$)	(0.12)	(0.07)	(0.35)	(0.43)
Inflation Target (2022)		0.63***		-0.96
		(0.21)		(1.16)
No. Obs.	36	36	36	36
R^2	0.85	0.91	0.45	0.46

Note: The dependent variables are Consensus Forecasts professional forecasters' inflation projections for 6-10 years ahead, averaged over 2020 through 2023 (columns 1 and 2) and average CPI Inflation over 2020 through 2023 (columns 3 and 4). The independent variables are average CPI inflation over the years 2016 through 2019, average CPI inflation over the years 2000 through 2015, the percent deviation of real PPP GDP per capita from an HP filtered trend, and inflation targets. Outliers are excluded for INF(20-23)>25% or INF(00-19)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table 7. Cross-country regressions of COVID-era 10-year bond yields

	10-Year Bond Yields (20-23)			
	(1)	**(2)**	**(3)**	**(4)**
Intercept	-0.71*	-1.14*	-4.05***	-0.57
$(\boldsymbol{\alpha})$	(0.36)	(0.57)	(0.73)	(0.84)
INF (16-19)	0.88***	0.84***	0.19	1.60***
$(\boldsymbol{\beta})$	(0.11)	(0.11)	(0.16)	(0.43)
INF (00-15)	0.61***	0.54***	0.39***	0.30***
$(\boldsymbol{\gamma})$	(0.17)	(0.18)	(0.10)	(0.06)
Output Gap (20-23)	-0.62	-0.73*	-0.36	-0.49
$(\boldsymbol{\delta})$	(0.40)	(0.43)	(0.23)	(0.30)
INF (20-23)		0.14		
		(0.14)		
Inflation Target (2022)			2.33***	
			(0.48)	
Far-Forward Survey (20-23)				-0.37
				(0.77)
No. Obs.	53	53	47	38
R^2	0.78	0.79	0.92	0.79

Note: The dependent variable is the 10-year bond yield over the years 2020 through 2023. The independent variables are average CPI inflation over the years 2016 through 2019, average CPI inflation over the years 2000 through 2015, the percent deviation of real PPP GDP per capita from an HP filtered trend, average CPI inflation over the years 2020 through 2023, inflation targets, and Consensus Forecasts professional forecasters' inflation projections for 6-10 years ahead. Outliers are excluded for INF(20-23)>25% or INF(00-19)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

APPENDIX A: ADDITIONAL REGRESSIONS

Table A1. Auxiliary regressions, advanced economies

	Advanced Economies									
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Intercept	0.71**	20.28***	0.48	0.86**	-1.68	1.10**	1.17**	1.54***	1.63***	1.18***
	(0.27)	(7.05)	(0.46)	(0.40)	(1.13)	(0.45)	(0.43)	(0.41)	(0.51)	(0.33)
INF (16-19)	0.97**	1.11***	0.31	1.21***	0.93**	1.10**	1.09**	1.14***	1.35***	1.39***
	(0.36)	(0.38)	(0.28)	(0.39)	(0.40)	(0.46)	(0.40)	(0.38)	(0.36)	(0.41)
INF (00-15)	0.77***	0.75***	0.55	0.76***	1.10***	0.89***	0.88***	0.74***	0.55*	-0.11
	(0.24)	(0.21)	(0.36)	(0.23)	(0.27)	(0.29)	(0.27)	(0.24)	(0.29)	(0.40)
Output Gap (20-23)	0.50**	0.83***	0.26**	0.70***	0.72***	0.47**	0.43*	0.64**	0.90***	0.39**
	(0.18)	(0.25)	(0.13)	(0.22)	(0.25)	(0.23)	(0.22)	(0.24)	(0.32)	(0.16)
Headline minus Core Inflation (20-23)	0.83*** (0.20)									
Log of GDP PPP Per Capita, Constant Prices (20-23)		-1.71** (0.63)								
Population Growth Rate (20-23)			0.54* (0.28)							
Population Growth Rate (20-23 minus 16-19)				0.65*** (0.24)						
Share 65+ (20-23)					0.13** (0.05)					
Government Structural Balance/GDP (20-23)						0.03 (0.08)				
Government Structural Balance/GDP (20-23 minus 16-19)							0.06 (0.10)			
Current Account Balance/GDP (20-23)								-0.07* (0.04)		
Current Account/GDP (20-23 minus 16-19)									-0.18** (0.07)	
INF (00-15) X Central Bank Independence Index (20-23)										0.98** (0.38)
No. Obs.	35	35	35	35	35	35	35	35	35	33
R^2	0.70	0.67	0.71	0.68	0.65	0.60	0.60	0.64	0.67	0.69

Note: The dependent variable is average CPI inflation over the years 2020 through 2023. The independent variables are average CPI inflation over the years 2016 through 2019, average CPI inflation over the years 2000 through 2015, the percent deviation of real PPP GDP per capita from an HP filtered trend, and the list of auxiliary variables shown on the left. Outliers are excluded for INF(20-23)>25% or INF(00-19)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table A2. Auxiliary regressions, developing economies

	Developing Economies									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Intercept	2.10***	5.35**	1.36*	2.07***	1.93***	3.50***	2.47**	2.34***	2.28***	2.14***
	(0.68)	(2.20)	(0.69)	(0.45)	(0.59)	(1.00)	(0.95)	(0.50)	(0.51)	(0.59)
INF (16-19)	0.57***	0.38***	0.10	0.50***	0.42***	0.52***	0.54***	0.40***	0.40***	0.38***
	(0.11)	(0.09)	(0.10)	(0.11)	(0.09)	(0.15)	(0.14)	(0.08)	(0.08)	(0.10)
INF (00-15)	0.24**	0.48***	0.36**	0.30***	0.47***	0.23*	0.25**	0.47***	0.50***	0.46
	(0.10)	(0.11)	(0.15)	(0.10)	(0.12)	(0.12)	(0.11)	(0.11)	(0.11)	(0.39)
Output Gap (20-23)	-0.02	0.45***	0.45	0.29	0.53***	0.36	0.31	0.58***	0.48***	0.53**
	(0.37)	(0.16)	(0.31)	(0.20)	(0.17)	(0.27)	(0.27)	(0.17)	(0.17)	(0.21)
Headline minus Core Inflation	0.91**									
(20-23)	(0.37)									
Log of GDP PPP Per Capita, Constant		-0.32								
Prices (20-23)		(0.23)								
Population Growth Rate			0.46***							
(20-23)			(0.16)							
Population Growth Rate				1.05***						
(20-23 minus 16-19)				(0.20)						
Share 65+					0.07					
(20-23)					(0.04)					
Government Structural Balance/GDP						0.11				
(20-23)						(0.19)				
Government Structural Balance/GDP							-0.22			
(20-23 minus 16-19)							(0.22)			
Current Account Balance/GDP								-0.06**		
(20-23)								(0.03)		
Current Account/GDP									-0.08*	
(20-23 minus 16-19)									(0.04)	
INF (00-15) X Central Bank										0.16
Independence Index (20-23)										(0.49)
No. Obs.	53	131	131	131	130	43	43	130	130	103
R^2	0.47	0.59	0.73	0.72	0.59	0.55	0.56	0.60	0.60	0.61

Note: The dependent variable is average CPI inflation over the years 2020 through 2023. The independent variables are average CPI inflation over the years 2016 through 2019, average CPI inflation over the years 2000 through 2015, the percent deviation of real PPP GDP per capita from an HP filtered trend, and the list of auxiliary variables shown on the left. Outliers are excluded for INF(20-23)>25% or INF(00-19)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table A3: Cross-country regressions of pre-COVID inflation expectations

	Far Forward Survey (16-19)		INF (16-19)	
	(1)	(2)	(3)	(4)
Intercept	1.49***	1.76***	0.89***	0.27
(α)	(0.14)	(0.19)	(0.22)	(0.38)
INF (12-15)	0.26***	0.36***	0.61***	0.39***
(β)	(0.05)	(0.06)	(0.08)	(0.13)
INF (96-11)	0.02	0.02	0.01	0.01
(γ)	(0.01)	(0.01)	(0.02)	(0.02)
Output Gap (16-19)	0.19*	0.18**	-0.12	-0.09
(δ)	(0.10)	(0.09)	(0.20)	(0.17)
Inflation Target (2016)		-0.18*		0.41*
		(0.10)		(0.23)
No. Obs.	36	36	36	36
R^2	0.85	0.87	0.86	0.88

Note: The dependent variables are Consensus Forecasts professional forecasters' inflation projections for 6-10 years ahead, averaged over 2016 through 2019 (columns 1 and 2) and average CPI inflation over 2016 through 2019 (columns 3 and 4). The independent variables are average CPI inflation over the years 2012 through 2015, average CPI inflation over the years 1996 through 2011, the percent deviation of real PPP GDP per capita from an HP filtered trend, and inflation targets. Outliers are excluded for INF(16-19)>25% or INF(96-15)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

Table A4: Cross-country regressions of pre-COVID 10-year bond yields

	10-Year Bond Yields (16-19)			
	(1)	**(2)**	**(3)**	**(4)**
Intercept	-0.42	-0.76**	-1.95***	-2.96***
$(\boldsymbol{\alpha})$	(0.38)	(0.32)	(0.43)	(0.92)
INF (12-15)	1.25***	0.88***	0.75***	0.26
$(\boldsymbol{\beta})$	(0.19)	(0.22)	(0.20)	(0.22)
INF (96-11)	0.09	0.11**	0.11**	0.05**
$(\boldsymbol{\gamma})$	(0.06)	(0.05)	(0.05)	(0.03)
Output Gap (16-19)	0.33	0.49*	0.55*	-0.23
$(\boldsymbol{\delta})$	(0.36)	(0.28)	(0.29)	(0.29)
INF (16-19)		0.45***		
		(0.15)		
Inflation Target (2016)			0.89***	
			(0.20)	
Far-Forward Survey (16-19)				2.16***
				(0.59)
No. Obs.	52	52	47	36
R^2	0.75	0.80	0.84	0.85

Note: The dependent variable is the 10-year bond yield over the years 2016 through 2019. The independent variables are average CPI inflation over the years 2012 through 2015, average CPI inflation over the years 1996 through 2011, the percent deviation of real PPP GDP per capita from an HP filtered trend, average CPI inflation over the years 2016 through 2019, inflation targets, and Consensus Forecasts professional forecasters' inflation projections for 6-10 years ahead. Outliers are excluded for INF(16-19)>25% or INF(96-15)>25%.
***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors in parentheses.
Source: Authors' calculations using data described in appendix B.

APPENDIX B: DATA SOURCES

The primary source for data is the IMF's October 2024 *World Economic Outlook* (WEO) via https://www.imf.org/en/Publications/WEO. Data are at an annual frequency and cover 196 countries, including 38 advanced economies and 158 developing economies. However, regression samples are smaller than these totals owing to missing observations and excluded outliers. Data past 2023 are IMF projections. Data from the WEO include CPI inflation, GDP inflation, PPP real GDP per capita, population, general government structural balance, and the current account balance. The latter two variables are expressed in percent of GDP.

Output gaps are percent deviations of PPP real GDP per capita from a Hodrick-Prescott (HP) filtered trend, calculated separately for each country over the period 1981 to 2029. The HP parameter is 6.25, as recommended by Ravn and Uhlig (2002).

Core inflation data come from the World Bank, *A Global Database of Inflation*, available at https://www.worldbank.org/en/research/brief/inflation-database. Data for Italy were replaced with core inflation data from OECD *Main Economic Indicators*, accessed through FRED (https://fred.stlouisfed.org/series/CPGRLE01ITA659N), because the World Bank data for Italy were incorrect.

Central bank inflation targets come from CEIC, available at https://www.ceicdata.com/en.

The Central Bank Independence – Extended (CBIE) index, based on Romelli (2022, 2024), is available at https://cbidata.org/.

10-year government bond yields are from Macrobond.

Far-forward survey measures of inflation expectations are averages of professional forecasters' projections of inflation 6 to 10 years ahead from October issues of Consensus Forecasts, available at https://www.consensuseconomics.com/.

Population aged 65 and above as a percentage of total population come from the United Nations Population Division, *World Population Prospects*: *2024 Revision*, accessed through the World Bank, available at https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS.

The countries in both the COVID-era sample and the pre-COVID sample for CPI inflation are Albania, Algeria, Antigua and Barbuda, Armenia, Aruba, Australia[A], Austria[A], Azerbaijan, the Bahamas, Bahrain, Bangladesh, Barbados, Belgium[A], Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Brunei Darussalam, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada[A], Central African Republic, Chad, Chile, China, Colombia, Comoros, Republic of Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus[A], Czech Republic[A], Denmark[A], Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Estonia[A], Eswatini, Fiji, Finland[A], France[A], Gabon, The Gambia, Germany[A], Ghana, Greece[A], Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Honduras, Hong Kong SAR[A], Hungary, Iceland[A], India, Indonesia, Ireland[A], Israel[A], Italy[A], Jamaica, Japan[A], Jordan, Kazakhstan, Kenya, Kiribati, Korea[A], Kyrgyz Republic, Lao P.D.R., Latvia[A], Lesotho, Libya, Lithuania[A], Luxembourg[A], Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta[A], Mauritania, Mauritius, Mexico, Micronesia, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands[A], New Zealand[A], Nicaragua, Niger, Nigeria, Norway[A], Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, the Philippines, Poland, Portugal[A], Puerto Rico, Qatar, Romania, Russia, Rwanda, Samoa, São Tomé and Príncipe, Saudi Arabia, Senegal, Seychelles, Singapore[A], Slovak Republic[A], Slovenia[A], Solomon Islands, South Africa, Spain[A], Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sweden[A], Switzerland[A], Taiwan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Uganda, Ukraine, United Arab Emirates, United Kingdom[A], United States[A], Uruguay, Uzbekistan, Vanuatu, Vietnam, and Zambia.[15]

[15] Advanced economies have a superscript A.

Countries only in the COVID-era sample but not the pre-COVID sample are Bosnia and Herzegovina, Bulgaria, Georgia, Liberia, Montenegro, Myanmar, Serbia, Tajikistan, Turkmenistan, West Bank and Gaza, and Yemen.

Countries in the pre-COVID sample but not the COVID sample are Ethiopia, Eritrea, Haiti, Iran, Sierra Leone, and Suriname.

PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

25-3 Modernizing Price Measurement and Evaluating Recent Critiques of the Consumer Price Index

Daniel E. Sichel and Christopher Mackie

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ABSTRACT

The consumer price index (CPI) plays a critical role in measuring inflation. Recent inflation trends, however, have raised questions about its accuracy. This paper evaluates several of these critiques, including that the CPI fails to keep up with rapid changes in consumer expenditure patterns; that its methodology is out of date; that the CPI does not correctly track the cost of housing; and that it does not keep up with rapidly changing products being purchased in the market. We also discuss the concern that, while year-over-year inflation has slowed dramatically since reaching its peak in June 2022, consumers still face considerably higher prices than before the pandemic. Drawing on insights from the *2022 CPI Modernization Report* (NASEM 2022), we argue that the basic CPI methodology is sound and that it provides a robust and defensible measure of inflation. However, as consumer markets and data environments evolve, updates to CPI methodologies are necessary. We underscore the need for continued investment in economic statistics to ensure the CPI remains a reliable gauge, benefiting policymakers, businesses, and consumers.

JEL Codes: E30, E31

Keywords: Consumer Price Index, CPI, inflation, prices, price measurement

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1. Introduction

Inflation has been front and center in the news and for households, businesses, financial market participants, and policymakers since it began surging in mid-2021, with the 12-month change in the consumer price index (CPI) hitting a peak just over 9 percent in June 2022 (figure 1). This acceleration had several underlying causes, including pandemic-related supply chain and labor market disruptions, the Russian invasion of Ukraine, which put upward pressure on energy and food prices, and demand that was bolstered by COVID-related stimulus. Since mid-2022, inflation has retreated quickly as supply chain disruptions resolved and the effects of tighter monetary policy worked their way through the economy.[1] While the inflation rate has eased substantially, the overall price level remains well above its pre-pandemic level, a significant pain point for many consumers.

Figure 1 CPI for all urban consumers (percent change from year earlier)

Source: Bureau of Labor Statistics (BLS) data as processed by the Federal Reserve Bank of St Louis.

As a consequence of the recent salience of inflation, questions have been raised about whether official measures are providing reliable gauges of inflation. Indeed, some commentators have suggested that inflation and prices are higher than official measures, while others have argued that inflation has fallen more than has been captured by published figures. For example, Paul Krugman in the *New York Times* highlighted commentators who discounted the amount of disinflation reported by the CPI and who suggested that actual inflation remained elevated (Krugman 2024). Among those arguing the counter position, the price of rents, and the cost of housing more broadly in the CPI, have come under special scrutiny given their big increases early in the COVID era, their large share of household budgets, and their sluggish return to the pre-COVID rate of increase. For example, Rachel Siegel argued in a *Washington Post* story (2024) that rent inflation had come down more than reported in the CPI.[2]

[1] See Bernanke and Blanchard (2023) for a discussion of the relative importance of different factors in contributing to the upswing in inflation.
[2] Data on asking prices suggest that, by that measure, rental price inflation peaked in late 2021 or early 2022 (Siegel 2024).

Of course, controversy surrounding the measurement of inflation is nothing new. During the earliest days of the CPI, labor and business interests argued over how much the cost of living was changing and what those changes should imply for wages, as carefully documented in Stapleford (2009). Within more recent memory, the mid-1990s were another high point in controversies surrounding inflation measurement. Alan Greenspan, then the chair of the Federal Reserve Board, suggested in congressional testimony in 1995 that the CPI was likely overstating inflation. Those comments led to the appointment of a panel, the so-called Boskin Commission, to investigate Greenspan's assertion. The Commission's influential report estimated that the CPI was overstating the true rate of increase in the cost of living by 1.1 percentage points per year, with new products and quality change accounting for the largest share of the bias, followed by consumer substitution of products in response to relative price changes (substitution bias) (Boskin et al. 1996). Given the widespread use of the CPI for indexing government programs—Social Security benefits (since 1972), parts of the federal tax system (since 1985), inflation-linked bonds (since 1997), and income eligibility levels for government assistance—overstating the inflation rate had significant implications for the federal budget. A great deal of research and commentary followed, and in subsequent years, the Bureau of Labor Statistics (BLS) made changes to the CPI that dealt with many of the issues raised by the Boskin Commission.[3]

Even beyond the federal budget, the accuracy of the official price measures is of paramount importance. The CPI is also used to index many labor contracts (or to serve as a benchmark), as a key input into the Federal Reserve's decisions about monetary policy, and as a general gauge of the economy's performance. If the CPI and other official measures are incorrect, that mismeasurement has likely contributed to poor economic decisions and policy mistakes as well as implying that efforts to compensate households or others for changes in the cost of living are providing too much or too little compensation. Moreover, given the degree to which elevated inflation has played into political debates, mismeasurement also could have unintended political consequences. Accordingly, the CPI affects millions of Americans and, indirectly, many others around the world.

This paper takes on this question of the accuracy of official inflation measures, evaluating recent critiques of the CPI. We focus primarily on the CPI because this is the most widely known and used measure, though we will also discuss other measures. We believe we are well positioned to consider this question. Sichel was the chair of the Committee on National Statistics (National Academies of Sciences, Engineering, and Medicine) panel that authored the consensus study report *Modernizing the Consumer Price Index for the 21st Century* (NASEM 2022); Mackie was the Senior Program Officer for the study (Sichel and Mackie were the coeditors of the report, hereafter referenced as the *Modernization Report*). The study was commissioned by the BLS to

[3] See also Moulton (2018) and Sichel (2019). Sometimes, however, remedies to correct for biases can create new problems—for example, the chained index formula used to capture the effect of consumer substitutions may understate inflation for certain groups, such as the elderly, if they do not have flexibility to modify their spending patterns.

provide independent guidance as part of its ongoing efforts to continually update their methods to keep up with the changing data landscape and the changing economy itself. The report focused on the potential of alternative data sources to improve the timeliness, detail, and accuracy of the CPI; it also pointed to strategies for improving traditionally difficult-to-measure expenditure categories such as housing/shelter and medical care. This paper draws heavily on the analysis in that report.

Our bottom line is that, for the most part, the CPI provides an accurate and defensible broad measure of inflation. In addition, we would highlight that the BLS performed well under unprecedentedly difficult circumstances during the COVID era—especially during the early months, when much of the nation was on lockdown. Even as the traditional way of collecting data for the CPI quickly became untenable, the price index was published on time every month. Moreover, no serious study has reviewed the agency's performance and called into question the fundamental integrity or accuracy of the data that were released during that period. For the extraordinary effort during that period, the nation owes the BLS a debt of gratitude.

In arriving at this bottom line, we make the case that the CPI is built on a solid methodological foundation and provides important and largely accurate information about inflation trends. We also argue that some recent critiques of the CPI appear to reflect a misunderstanding of the CPI's purpose or its methodology and rely on data that measure something different from what the CPI is intended to measure. We do add the qualifier "for the most part" to our evaluation. There is always room for improvement in economic statistics. Different measures of inflation are appropriate for different purposes, and the CPI may not be the best index to use in all cases. For example, the Federal Reserve's 2 percent target for inflation is based on the price index for personal consumption expenditures (PCE), a broader measure of consumer prices than the CPI, although closely related—and indeed, heavily derived from CPI components.

Moreover, the *Modernization Report* highlights the steps its authoring committee recommended the BLS should take to continue improving the CPI given ongoing changes in consumer markets and the data environment. We touch on many of these recommendations throughout the paper. Fortunately, BLS is making progress on these fronts; however, the agency—along with other statistical agencies—has faced budget constraints that have limited the pace at which they can continue to improve the quality of economic statistics. Indeed, meaningful progress on sustaining and improving the quality of the CPI and other critical economic statistics will require significant additional budgetary resources.[4]

The remainder of this paper is organized as follows: Section 2 briefly describes the conceptual framework underlying the CPI and its mechanical construction, giving special attention to the

[4] A recent report by the American Statistical Association (Auerbach et al. 2024, p. 6) concludes that the nation's federal statistics are at risk in terms of "their ability to produce relevant, timely, credible, accurate, and objective statistics and to innovate to the extent necessary to meet the nation's information and evidence requirements in the 21st century." The report also highlights the "lack of sufficient resources (both budget and staffing levels) to carry out, not only basic responsibilities but also the testing and development to meet demands for new, revised, and more detailed information."

shelter component of the index. Other widely used measures of inflation are discussed as well, along with debates and controversies in the literature about their suitability for various purposes. Section 3 evaluates several critiques of the CPI and proposed steps to address those with the most validity. The focus here is on criticisms that resurfaced during the COVID era—the need to keep up with rapidly changing consumer purchasing patterns; to integrate alternative, detailed, and high frequency data into index construction; to review the methodology and data sources used for the shelter component of the index; and to account for rapidly changing characteristics of goods and services in the marketplace. The distinction between price change and price levels, and the related disconnect that sometimes confuses the general public, is briefly discussed. A concluding section summarizes thoughts on next steps for the BLS as the agency moves forward with its price measurement program.

2. Background

Conceptual Framework

Price measurement is conceptually complicated and data intensive. A central source of conceptual complexity is that no two people or families buy exactly the same things; nor do they always pay the same prices for their purchases; nor do they buy the same bundle of things over time. To cover the broad consumer landscape, each month the BLS collects prices from about 23,000 retail establishments and rents for about 8,000 housing units.[5] While this sample reflects only a small fraction of all the types of goods and services bought and sold in the United States—Amazon alone directly sells over 12 million different products—it is carefully designed to be statistically representative of the goods and services consumers are buying and where they buy them. The magic of the CPI is that it harnesses all of these complexities to produce a single number (actually a set of numbers, as discussed below) that is nationally representative, has a sound conceptual basis, is intuitive, and provides a consistent measure of changes in prices faced by consumers over long spans of time.

The CPI emerged from price measurement efforts during World War I. At that time, prices were rising rapidly, and that backdrop generated a need to track changes in the cost of living in industrial centers for the purpose of adjusting wages. Following the war, in 1921, regular publication of a national index—the US city average—was initiated, with data extending back to 1913. Many methodological updates and improvements have been incorporated since.[6]

While the CPI began as an index purely tracking the cost of a fixed basket of items, over time it evolved into what is known as a conditional cost-of-living measure, or COLI. That is, the CPI's underlying framework or intent is to track how much a typical household would need to change its expenditures over a given period to maintain its utility or material standard of living. To our ears, that is a sensible and intuitive approach to thinking about inflation.

[5] See https://www.bls.gov/opub/hom/cpi/data.htm.
[6] For a detailed history of the CPI, see BLS (2023) at https://www.bls.gov/opub/hom/cpi/home.htm.

Estimating a true COLI is aspirational given that we cannot realistically calculate the amount of money needed to hold living standards (or utility) constant over all consumers. Accordingly, the modifier "conditional" is included because, in practice, the index covers only private goods and services and holds constant environmental background factors—including life expectancy, crime rates, and the environment.[7]

While the conditional COLI approach certainly has limitations, it is the most widely used and accepted methodology for measuring inflation. Indeed, statistical agencies around the world have generally settled on the conditional COLI approach to measuring changes in the price level.

Several features of the CPI are relevant for evaluating recent critiques of the CPI or comparisons with other measures of inflation. First, as noted, the CPI is nationally representative, with a sample (of both prices and households' expenditures) that is carefully chosen to be statistically representative. The most widely cited headline index, the CPI-U, represents over 90 percent of the US population. Specifically, the index covers all urban households in core-based statistical areas (a large urban area and surrounding economically integrated jurisdictions) and in urban places of 10,000 inhabitants or more.[8] In contrast, some privately produced price indexes rely on data gathered from a sample that may not be representative, whose characteristics may change unpredictably over time, and for which the motivation for collecting data may have little to do with obtaining a consistent and reliable measure of inflation.

Second, the CPI is designed to measure changes in the cost of living for a typical household's purchases, usually defined by average expenditure shares across all households. Thus, the inflation impact of price changes that affect only a fraction of all households would have a relatively modest impact on the CPI, unless the price changes were extremely large. For example, if rents on newly leased housing units rose significantly while rents on many previously leased units did not change, the CPI would record a rent increase that reflected both the rise in rents in new leases but also the stability in rents in other housing units.

The CPI's focus on average expenditure shares across households also dictates that there is no single "true" rate of inflation, and price changes measured by the CPI inevitably differ from those experienced by a particular household. Indeed, prices faced by any individual, family, or household vary depending on what they buy and where they buy it—a household whose members make long commutes makes different purchases than does a mostly work-from-home household, and may pay different prices for a range of items. As another example, an analysis of data from Adobe's Digital Economy Index found that online prices over the period 2014 to 2017 rose by about 3 percentage points less than the increase in overall prices during that period.[9]

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[7] The COLI approach can be contrasted with a conceptually simpler "cost of goods" approach, where the underlying idea is to measure how much the cost of a fixed set of goods and services has changed over a given period. See NRC (2002) for a discussion.

[8] See www.bls.gov/opub/hom/cpi/design.htm.

[9] The difference between online and brick and mortar price changes also connects to differences in household income. Goolsbee (2021, p. 150) notes that "shopping online is far more common among high-income people…and during the pandemic the practice has grown more prevalent."

Accordingly, the observation that a household's inflation experience differs from the CPI does not necessarily imply that the CPI is incorrect, just that it is not measuring that particular household's rate of inflation. It is especially noteworthy that, as indicated above, the CPI only measures the inflation experience of urban consumers (that is what the "U" stands for in CPI-U). An analysis by the Congressional Budget Office[10] estimated that rural areas experienced higher inflation than urban areas during the early periods of the pandemic, which again points to the fact that the CPI reflects the inflation experiences of some groups better than others.

Third, the CPI adjusts prices for quality change. That is, if a product's posted price does not change but the quality improved by 10 percent, the CPI would, in principle, record a 10 percent price decline, a so-called quality-adjusted price change. This feature implies that the CPI may not line up with casually observed changes in posted prices. In a similar vein, suppose cookies cost $5 for a package of 10, but that the size of the package dropped to 8 cookies still priced at $5. In this circumstance, the CPI would record an increase of 25 percent to reflect the "shrinkflation" as the price per cookie rose from $0.50 to $0.625; that is, basic shrinkflation is captured in the CPI.

Fourth, the weights used by the CPI to combine price changes for different goods and services are updated annually with a lag but are fixed within any calendar year. Under current methodology, the weights introduced in January 2023 were based on spending patterns from the 2021 Consumer Expenditure Survey.[11] This lag can create difficulties, such as during COVID when expenditure patterns changed dramatically but were not picked up in the CPI in a timely way. For example, when the pandemic hit, airfare purchases plunged, along with their prices. The CPI picked up the drop in prices but applied too large a weight to those falling prices since it took some time before the weight on airfares was updated, thereby understating inflation.[12] Furthermore, as the pandemic eased and air travel was recovering, the very low weights from early in the pandemic were then folded into CPI calculations, causing the opposite problem. Even in retrospect, it is not possible to align the timing of expenditure shares and price change, because by convention the CPI is not revised, except in rare instances to correct an error,[13] and the expenditure shares are not available as quickly as the price quotes.

As noted, CPI weights are fixed for the year and do not change month to month, making the CPI a quasi-fixed-weight price index. (A true fixed-weight index would leave the weights the same for all time.) Accordingly, demand shifts in response to changing prices during a year will not be captured in the CPI. For example, if egg prices rise substantially mid-year and purchases drop back as consumers shift to other items whose prices did not rise as much, the CPI would continue to apply the same weight to egg purchases even though the quantity of eggs purchased fell. This approach would lead to an overstatement of inflation, as too high a weight

[10] See www.cbo.gov/system/files/2022-01/57794-Smith.pdf.

[11] Prior to January 2023, updates of weights used a different procedure that created even longer lags between the time spending patterns were measured and when the weights were applied to the CPI.

[12] BLS discussed these issues in Matsumoto, Miller, and Montag (2022).

[13] BLS maintains an Errata page (https://www.bls.gov/errata/) to document the date of corrections and their status.

would be applied to the surge in egg prices.[14] Bias from this source is known as substitution bias.

Measuring the Cost of Housing in the CPI

One particularly consequential element of the CPI's conceptual framework is the treatment of housing. Indeed, among policymakers, researchers, and the media, the rising cost of shelter—specifically rents, which soared during and immediately after the pandemic—has received sustained attention. Concerns over the cost of shelter are heightened by the fact that it represents by far the largest monthly expense for most families. In April 2024, shelter made up 36.1 percent of the CPI by expenditure share. The growing housing affordability crisis, especially acute among renters, adds to the focus on measurement of issues.[15]

The large share of family budgets that goes toward housing also means that it asserts an outsized influence on inflation calculations. In recent years, the CPI shelter component has risen in the 5-6 percent range over 12-month periods. CPI shelter inflation was at 6 percent as recently as January 2024 (and 5.2 percent in August), versus a typical rate of 3-4 percent pre-pandemic (as shown in figure 2). Without shelter, the 12-month increases in the CPI would have ranged from 1.1 to 2.3 percent from September 2023 through August 2024; with shelter included, the index is noticeably higher.

The methodologies used for the CPI for rent and for owner-occupied housing are discussed in detail in the next section.

Other Widely Used Measures of Inflation

Given the CPI framework and the diverse applications of price measurement, the headline CPI cannot be the best measure of inflation for every purpose; no single index can be. For example, adjusting income thresholds for government assistance programs may best be done with a price measure that captures the inflation experience of lower-income households that are most likely to use those programs. And although it is not current practice, indexing Social Security may best be accomplished with an index that captures the experiences of older households that tend, for example, to have higher expenditure shares on medical care. Although the CPI is far and away the best-known gauge of inflation, government statistical agencies produce several other important price indexes.

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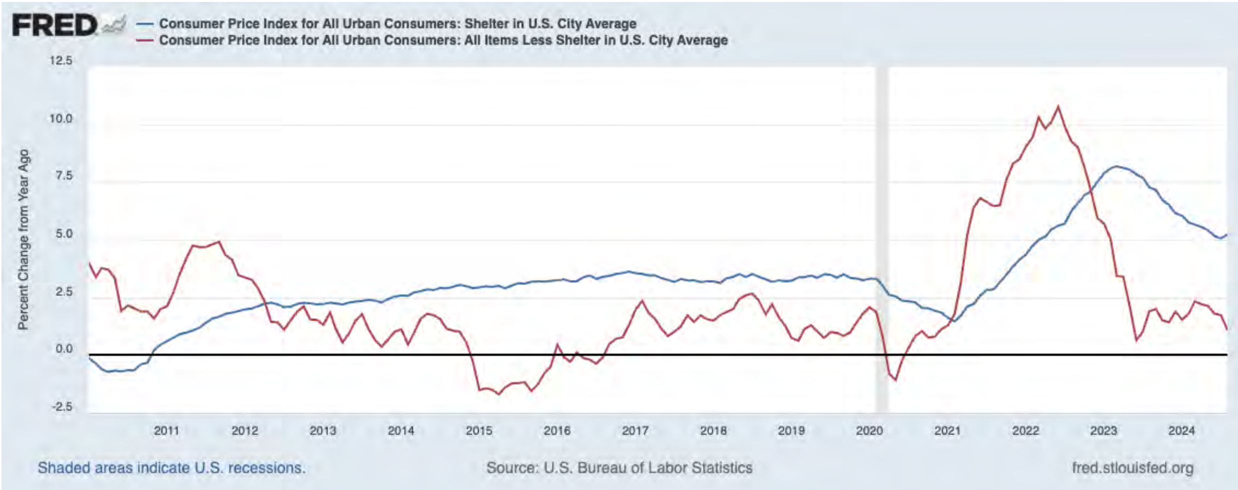
[14] Other price measures allow weights to change month-to-month, including the chained CPI and the price index for personal consumption expenditures. The CPI cannot do the same in real time due to data limitations and because of the convention to not revise the CPI (one exception is revisions to seasonal factors in the BLS's seasonally adjusted series).

[15] The Census Bureau tracks housing cost burden—the number of households that spend more than 30 percent of their income on shelter—using the American Community Survey, an alternative source of data on rent and utility expenditures (and income levels). See www.census.gov/library/stories/2022/12/housing-costs-burden.html). Also, using data from Zillow, a *Washington Post* (2024) analysis of homelessness concluded that rising rents has been a central contributor to the problem.

Figure 2 CPI shelter versus CPI all items less shelter (percent change from a year earlier)



Source: Bureau of Labor Statistics (BLS) data as processed by the Federal Reserve Bank of St Louis.

The BLS produces several variants of the CPI as well as detailed information on price changes for individual items. Table 1 shows the most important of these CPI variants. The most extensively used version of BLS's inflation measure is the Consumer Price Index for All Urban Consumers (CPI-U). The so-called "core" CPI is the CPI-U excluding food and energy. Prices of those items can be volatile, so the core measure often gives a better read on underlying trends in inflation. For analyses that require deflating prices or dollar values on a consistent basis over a long time period, researchers often turn to the CPI's Retroactive Series (R-CPI-U-RS, formerly known as the Research Series) since it adjusts the readings from previous years to reflect current methodology. Another important variant is the chained CPI (C-CPI-U) which more fully takes into account modifications by consumers in their buying patterns in response to changes in relative prices. The chained CPI measure of inflation typically runs a bit below the "regular" CPI-U, reflecting that consumers tend to modify purchases in response to price changes to improve their material well-being. The R-CPI-E provides a measure of inflation for Americans over 62 using weights that reflect different patterns of purchases.[16] The CPI-W reflects buying patterns of wage earners and clerical workers, who currently represent about 29 percent of the US population. Regional CPIs also are available, as is component detail at a high level of disaggregation.

The BLS also publishes the producer price index (PPI)—used to measure changes in the selling prices received by domestic producers (thereby excluding things like imports and sales taxes), as opposed to the CPI's focus on changes in prices consumers pay at the retail level—as well as price indexes for imports and exports.

[16] Although the R-CPI-E attempts to more realistically capture the market basket composition of consumers over the age of 62, it assumes that older consumers execute their purchases through the same outlets as the overall population.

Table 1 CPI indexes produced by BLS

CPI variants	Description
CPI-U	Headline index described above for urban households
Core CPI	Prices for all items excluding food and energy
R-CPI-U-RS	Research index incorporating current methodology back in time
C-CPI-U	Chained CPI that adjusts expenditure shares every month
R-CPI-E	Research index covering Americans 62 years of age and older
CPI-W	Urban hourly wage earners and clerical workers
Regional CPIs	For various regions and sizes of urban areas

Inflation measures have also been developed in an attempt to capture the experiences of various subgroups within the population. For example, the BLS has estimated CPI-like indexes for subgroups positioned at different points along the population's distribution of income. These analyses are typically based only on differences in the mix of goods and services that are purchased by the specific group, with different spending weights then applied to the same set of underlying basic (item) price indexes. So, for example, this kind of index could capture that households with lower incomes are more likely to spend a larger share of their budget on shelter, which would be reflected in a higher weight assigned to that expenditure category. Since prices for shelter rose faster than average overall prices in 2022, the overall inflation measures for households in the lower quintile group would be pulled upward. Similarly, these indexes would show lower-income households being disproportionately impacted by increases in the price of food, since that category constitutes a higher portion of their expenditures. However, subindexes based on differences in expenditure shares would not account for cases in which different groups pay different prices for the same items due to outlet accessibility or other reasons.

Other researchers have taken more experimental approaches to estimating differential price inflation across the income distribution. Jaravel (2018) used transaction data from the Nielsen Company on specific goods purchased by US households to estimate inflation rates as a function of income. For consumer goods observable in the Nielsen data, such as food products, household supplies, and health and beauty products—which account for 30-40 percent of expenditures on goods, or about 15 percent of total expenditures—Jaravel (2018) incorporated product-level data on both prices and quantities. One finding, for the 2004-15 period, was that annual inflation was approximately 0.65 percentage point lower for households earning above $100,000 a year when compared with households making $30,000 or less per year (*Modernization Report*, p. 148).

The Bureau of Economic Analysis (BEA) also produces important price indexes as part of the estimation of real gross domestic product (GDP). The most influential of these is the PCE price index, mentioned above, used to deflate personal consumption expenditures in the national accounts. It has broader coverage than the CPI[17] and also uses a different formula to aggregate prices and better reflects month-to-month shifts in consumer expenditures. In part due to these characteristics, the PCE is the reference statistic for the Federal Reserve in defining its 2 percent inflation target. Due to their coverage and methodological differences, since December 1978, PCE inflation has run about 0.30 percentage point below CPI inflation, although the difference jumps around a fair bit (Janson, Verbrugge, and Binder 2020).

3. Critiques of the CPI; Proposed Steps to Modernize

The underlying methodology of the CPI, pragmatically developed to function in the production environment required of statistical agencies, ensures the monthly release of an objective measure of average price changes faced by American consumers. As noted above, inflation measurement has always engendered controversy, and the set of issues raised during and after the pandemic intensified these critiques. In this section, we review several areas of criticism, focusing on those that have been especially relevant to price measurement experiences of the past 5-10 years, including the recent runup and dropback in inflation. The critiques we consider include:

1. The CPI does not keep up with rapid changes in consumer expenditure patterns.
2. The CPI relies too much on an older methodology and does not sufficiently make use of high detail, near real-time digital transaction data, especially given the fading viability of the 20th century survey-centric paradigm.
3. The CPI's method of tracking changes in the price of shelter does not reflect what is really happening in housing markets.
4. The CPI does not sufficiently keep up with an increasingly dynamic marketplace in which the characteristics of goods and services evolve more quickly than ever.
5. While inflation has slowed, prices are still up substantially since before the pandemic, creating burdens for many households.

As noted, the BLS is well aware of these critiques and, as was the case with the 2022 *Modernization Report*, has periodically sought outside expertise to help improve its methodology. Discussion in this section draws heavily on material in that report.

Criticism 1: The CPI does not keep up with rapid changes in consumer expenditure patterns (or, the need for timely information on *current* consumer behavior)

Bottom line: This criticism has validity**.** While the BLS has largely eliminated substitution bias and made progress in shortening the lag between the setting of expenditure

[17] The CPI covers so-called "out-of-pocket" expenditures, while the PCE price index covers all household consumption. The health care category highlights this difference. The CPI only includes the portion of health care paid for directly by individuals (insurance premiums, copays, and direct payments), while PCE also covers health care financed by the government and employers (to the extent employers share part of the cost burden with their employees).

weights and their use in the CPI, that lag remains 24 months on average. A major update of methodology will be necessary to significantly shorten the lag further.

For many users of economic statistics, timely—in some cases, near real time—data have become the standard expectation. In the context of cost-of-living measurement, this means tracking changes in the prices and quantities of the things that people are buying now, or at least recently, as opposed to in years past. Contemporary information is especially crucial during extraordinary times when the composition of goods and services being bought and sold is changing rapidly from period to period, such as during the pandemic.

Depending on the circumstances prevailing in the economy, the CPI may display upward biases (overstating inflation) or downward biases (understating inflation). As noted, sources of bias in the CPI have also long been recognized. However, one potential source of inaccuracy—the use of outdated information on consumer expenditures—was particularly, and dramatically, exposed during COVID-era economic upheavals. In fairness, COVID-19 shutdowns and post-pandemic adjustments cast a glaring light on the value of timely economic statistics generally. For price measurement, the rapid shifts in consumers' buying patterns—reflecting the types of products demanded in a shutdown economy and by what was available given supply chain disruptions—rendered data that, even if only a year or two old, was unrepresentative of what was occurring then in the economy.

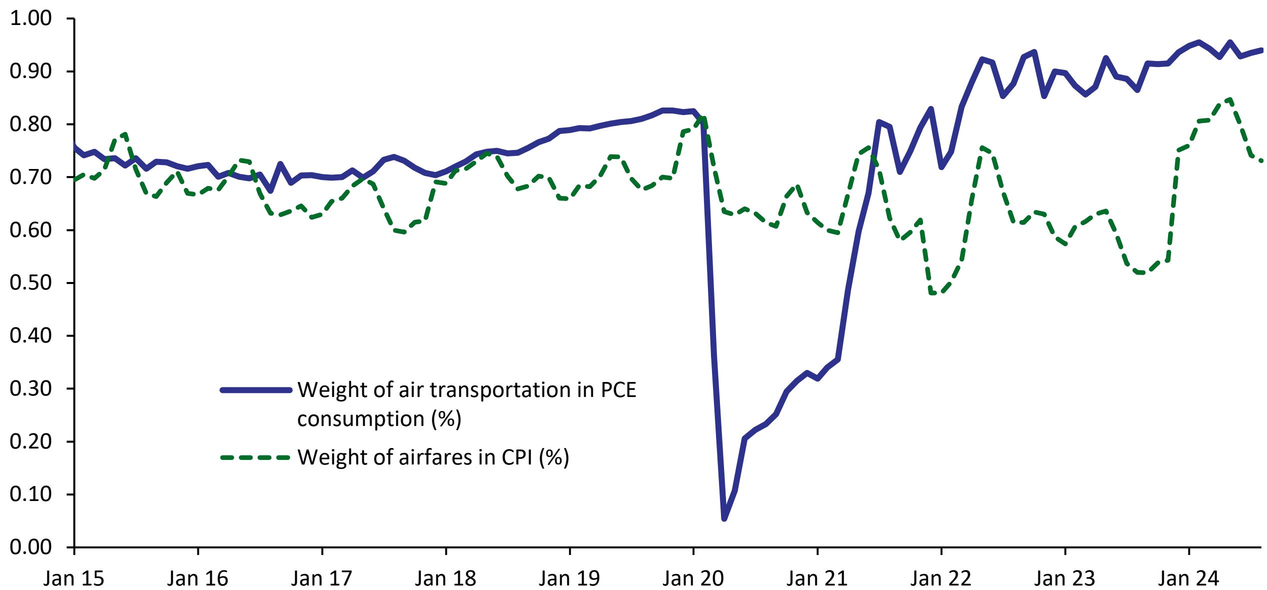
During the economic lockdowns of 2020, the decline in spending on some categories of goods—e.g., travel, food away from home, admissions to movies, theater, and sports—was so severe that it essentially amounted to a "disappearing products problem" (Cavallo 2023; Diewert and Fox 2020). Alternative data sources (that is, sources other than the Consumer Expenditure Survey) clearly reveal massive changes in expenditure patterns for some of these categories. Air travel provides a salient example. Figure 3 highlights the divergence in the expenditure weights assigned to airfares in the CPI and in the PCE estimated by BEA, with the PCE weights capturing the pandemic-related collapse and the subsequent robust recovery in a way not reflected in the CPI weights. The PCE price index is able to update weights more quickly because they are based on data collected from businesses and trade organizations on an ongoing basis.[18] This highlights the importance of firms' willingness to respond to surveys for price measurement and expenditure estimates.

The contrasting stories portrayed by the different data sources provided fodder for CPI critics. While these kinds of expenditure shifts are historical outliers, it is certainly true that cost-of-living indexes based on pre-pandemic weights[19] had become outdated by the end of 2020, at least temporarily, with the above-mentioned items overrepresented while others, such as laptop computers and furniture for home offices, were underweighted. By Cavallo's (2023)

[18] Also, the expenditures shares in the PCE index are calculated from aggregate data, which are much easier to assemble and handle than household-level data of the kind used to construct CPI weights.
[19] Spending weights used in the CPI for the period January 2020 through December 2021 were based on consumer purchases made in 2017 and 2018.

estimates—which took advantage of publicly available data on consumers' credit card transactions captured in near real time—an index reflecting contemporaneous purchasing patterns increased faster than the official CPI. This mis-weighting bias peaked in May of 2020, when Cavallo's COVID index showed that "annual inflation was 1.02 percent compared to just 0.13 percent in the CPI." The divergence was attributed mainly to outdated information on fuel and food at home expenditures.[20] Other researchers came to similar conclusions.[21]

Figure 3 CPI and PCE weights (expenditure shares) for air transportation, 2014-24



Source: *Modernization Report*, generated using data from BEA and BLS.

The benefit from more frequent updating of expenditure share weights is clear, particularly when temporally detailed price indexes are the goal. As the *Modernization Report* concluded, the pandemic and subsequent recovery "made the importance of updating the weights during unpredictable, turbulent times painfully apparent and showed that failure to keep the weights up to date can lead to lost credibility if households cannot recognize the market basket" (p. 63).

Solutions to the problem of outdated expenditure weights seem almost self-evident, but they are not so easy to implement in the context of CPI production and the measurement objectives of the index. Work done on pandemic pricing was illuminating and valuable in advancing price

[20] Food accounts for around 14 percent of the CPI. Purchases of food at home makes up more than half of this category (and more during the pandemic), and grocery price increases (and expenditures) were higher than the averages of other categories early on during this period. See www.hbs.edu/ris/Publication%20Files/Paper_Covid_Price_IMFER_23_4663bd2c-c1a8-4448-aa9f-98a3bc197142.pdf.

[21] Diewert and Fox (2020) showed a downward bias in official consumer price indices resulting from current calculation methodologies; Reinsdorf (2020) likewise found that biases associated with underweighting of rising food prices and overweighting of falling transport prices to be the leading causes of the underestimation of inflation early on in the pandemic.

measurement methods, but critics who suggest that the BLS should simply adopt those methods are missing some important points. As discussed below, digital transaction data of the kind used in real time analyses only cover a portion of expenditures made by consumers. Scanner datasets, for example, generally do not cover services, which account for about 60 percent of the CPI by weight, and only about half of goods. Other types of alternative data sources covering major expenditure categories—such as housing and vehicles—may help extend the coverage, though these categories would require additional development before being usable for a monthly production index. Additionally, some of the alternative indexes, such as Cavallo's, require data from the CPI as raw material, because he used official price indexes for individual items but with updated weights (Cavallo 2023).

Another alternative approach, the PCE index, also has limitations due to its grounding in expenditure data collected from businesses instead of households. Crucially, as its name indicates, the Consumer Expenditure Survey estimates people's purchases in a way that links buying patterns to households. It would not be difficult to obtain aggregate expenditure shares without a household survey. However, as long as the production of price indexes for population subgroups, such as the older population, or by income group, remains a significant measurement objective for the CPI, purchases must be linked to households. Some countries have gone down the path of relying on aggregate expenditure data to produce their price indexes, but they have made the choice to produce only one headline CPI in a way that has been able to take greater advantage of alternative data sources. What's clear is that the BLS faces a tradeoff as it contemplates the possibility of moving to alternative ways of capturing expenditure patterns: Building the expenditure weights from a dedicated household expenditure survey offers greater flexibility in producing multiple population subgroup indexes, but comes at a cost in terms of processing time and survey data demands. The *Modernization Report* concluded that even if an important priority is to integrate alternative sources to bring more timely data into the methodology, a nationally representative survey to collect data from consumers about their purchases—namely the Consumer Expenditure Survey or a successor, ideally optimized for its role in estimating CPI expenditure weights—will be needed.

However, this defense of BLS methods aside, COVID-era research pointed toward important improvements that could be made to the CPI. To improve timeliness of the index, the *Modernization Report* recommended updating upper-level item category weights—which at the time, on average, lagged 36 months behind actual expenditures—more frequently. The report also called for improving the accuracy of weights for specific items that the Consumer Expenditure Survey "measures poorly and for which alternative data are likely more accurate" (p. 75). Consumer Expenditure Survey weights for clothing, tobacco, and alcoholic beverages are typically well below the corresponding weights in PCE, for example. The panel recommended calculating expenditure weights based on data for a 12-month period ending no more than 6 months prior to their introduction. New CPI weights introduced in, say, January 2025 would reflect expenditure patterns from July 2023 to June 2024.

BLS, it should be emphasized, has already begun moving toward achieving this goal. Beginning in January 2023, the BLS began updating CPI spending weights annually, reflecting spending that took place from two years beforehand so that, for example, the weights for 2025 will be based on spending patterns in 2023 (an improvement from the prior methodology that would have used average spending patterns for 2021 and 2022). The revised schedule results in spending weights that are lagged, on average, 24 months from the date of the index.[22]

> **Criticism 2: The CPI relies too much on an older methodology and does not sufficiently make use of high detail, near real-time digital transaction data, especially given the fading viability of the 20th century survey-centric paradigm.**
>
> **Bottom line:** This criticism has some validity. The main focus of the *Modernization Report* was on exactly this point, highlighting the need to make wider use of alternative data. The BLS is well aware of this imperative, though making progress is challenging, both for technical reasons and because of constraints on the agency's budget that limit resources available for necessary updates to systems, the data infrastructure, and the composition of staff skills needed for implementation.

BLS has already begun moving in the direction of a blended data approach, having stated its strategic objective to convert a significant proportion of the CPI market basket from traditional collection to nontraditional sources and collection modes, including harnessing large-scale data (*Modernization Report*, p. 25). Pandemic-era constraints accelerated their efforts. This transition requires at least a partial departure from the 20th century survey-centric approach to estimating the CPI. The most essential aspect of the data modernization strategy is tapping into opportunities generated in the digital data environment—specifically, data on prices and quantities generated by electronic transactions, with some important sources described next.

Scanner Data

Integration of consumer transaction data from retail checkout scanners or from households has been in the research (and occasionally) production pipelines of statistical agencies' price measurement programs for decades. Twenty years ago, a Committee on National Statistics panel argued that "scanner technology has the potential to improve the entire process of data collection for the CPI computation" (NRC 2002, p. 275).

To date, most of the BLS's work on integrating data sources generated "organically" by electronic transactions has been for use in constructing elementary indexes, the most detailed item-location level at which prices are aggregated.[23] The agency's research on scanner data (which typically originates with retailers but, with additional technology, can also be collected from households) has mainly focused on obtaining price quotes in place of in-store price checking, and mainly for the food at home category. However, scanner data does offer

[22] See www.bls.gov/cpi/tables/relative-importance/

[23] The CPI tracks the average price change of 243 items (241 commodities and services plus 2 housing item categories) within 32 geographic areas for 7,776 (32 × 243) area-item combinations (BLS 2023). For more see www.bls.gov/opub/hom/cpi/.

simultaneous information on prices and quantities while also making it feasible to vastly expand the coverage of product varieties and outlets. In so doing, traditional small samples of a handful of items to represent broad product categories can, in principle, one day become a constraint of the past (*Modernization Report*, p. 31).

Several national statistical offices are at comparatively advanced stages of their data modernization programs, phasing out survey-based production systems and calculating price indexes directly from alternative data sources. Statistics Norway began research to use scanner data to compute the subindex for food and nonalcoholic beverages in 2005. Statistics Netherlands introduced supermarket scanner data into its CPI in 2002 (de Haan, Willenborg, and Chessa 2016). Beginning around 2008, Statistics New Zealand began researching use of scanner data to estimate price change for products sold by supermarkets and for consumer electronics (*Modernization Report*, p. 35).

Again, though, there are valid reasons why the BLS has not moved more quickly to integrate alternative data sources as some critics would want. Most obviously, scanner data are not available for all commodities. For some items, notably goods purchased online or goods where individual firms have large market shares (e.g., smartphones), scraping price data available on the internet provides an alternative to scanner data or traditional survey-based methods. Even the Australian Bureau of Statistics (ABS), which has incorporated into its CPI a pricing approach that relies heavily on sales data generated at supermarkets (accounting for approximately 84 percent of all expenditures at those supermarket outlets), can only cover about 16 percent of total expenditures using scanner data. These limitations notwithstanding, the *Modernization Report* recommended that the BLS draw on the experiences of statistical agencies in other countries in the adaptation of nonsurvey data sources.

Web-Scraped Data

The most prominent US player in the web-scraped price index research is not a statistical agency, but MIT's Billion Prices Project and spinoff company PriceStats. PriceStats currently tracks about 25 million prices per day from 1,100 retailers in 50 countries. In the United States alone, it collects two million prices per day in real time on a daily basis from not only online retailers such as Amazon.com, but also from the websites of traditional and large multi-channel retailers that sell both online and offline (*Modernization Report,* p. 36).

Out of necessity, on March 16, 2020, the BLS suspended all in-person data collection due to pandemic shutdowns. CPI data collectors were instructed "to attempt to collect data normally collected by personal visit by telephone, email, or by internet from the website of the establishment, if a website exists" (www.bls.gov/covid19/effects-of-covid-19-pandemic-on-consumer-price-index.htm). Field staff quickly changed course, filling up virtual carts online to check prices. This process, brought on as a stopgap measure in the face of the immediate crisis, mimicked the in-store price checking activity but stopped short of systematic web scraping. The basic approach would need to be automated (perhaps using PriceStats methods as the model) if timeliness and efficiency gains in data collection are to be fully realized. (*Modernization Report*,

p. 37). The report recommended following up shutdown economy practices by prioritizing development of a systematic approach to permanently automating web-scraping of price data. Opportunities are especially present for the food, electronics, and apparel elementary indexes, where a large share of transactions take place online, and work by other statistical agencies and private-sector organizations have demonstrated feasibility.

A number of national statistical offices in other countries have also pushed forward more aggressively with web scraping in their CPI programs. For example, Statistics Belgium scrapes around six million prices per month in categories such as clothing, footwear, hotel reservations, airfares, international train travel, secondhand cars, consumer electronics, books, and video games (*Modernization Report*, p. 38). ABS systematically uses transactions (and web-based) data in its CPI and was able to provide timely information about shifts in consumer expenditures during the pandemic lockdowns. The agency was also well positioned to deal with disrupted access to outlets, as most of its direct data collection was already conducted online or over the phone (*Modernization Report*, p. 30).[24]

Quality of Alternative Data Sources

Among the challenges of integrating alternative data sources into official statistics is the need to develop methods for assessing the quality of nonsurvey data. A previous expert committee recommended that federal statistical agencies adopt broader methods for evaluating nonsurvey data that step beyond conventional sampling statistic metrics and that take into consideration dimensions that better reflect user needs such as "timeliness, relevance, accuracy, accessibility, coherence, integrity, privacy, transparency, and interpretability" (NASEM 2017, p. 117).

In keeping with this goal, in the context of the CPI, which will increasingly rely on data blended from multiple sources, the *Modernization Report* recommended that the BLS "regularly publish information on the characteristics of alternative data they plan to incorporate. Important quality indicators include the following: number of products covered, number of observations/price quotes, type of price quote (listed price, transaction price, etc.), how many matches of products can be made across periods, extent of coverage within and across expenditure categories, frequency of updates, and level of product detail (p. 46).

Declining Survey Response Rates and Deterioration of the Survey Paradigm

The need to modernize economic statistics is being driven not just by new data opportunities, but also out of necessity in light of questions about the viability of the survey-centric federal statistical system given falling response rates. For the CPI, this trend is particularly problematic for the Consumer Expenditure (CE) Survey, which serves as the basis for constructing item category weights. As documented in the *Modernization Report* (p. 27), "the CE-Interview unit response rate fell from 72.5 percent in October 2010 to 50.3 percent in December 2019, and the

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[24] Less than 2 percent of the Australian CPI (by expenditure weight) is collected by field staff in retail stores (www.abs.gov.au/articles/methods-changes-during-covid-19-period).

CE-Diary fell from 73.6 percent in October 2010 to 47.2 percent in December 2019." Response rates declined to even lower levels during the early stages of the COVID-19 pandemic but then recovered somewhat thereafter. As response rates of important federal surveys decline, concerns grow about the representativeness of samples underlying them.[25]

Even if it were not the case that people have become less willing to respond to surveys, the lags associated with collecting and processing information from households about what they buy (and where they buy it) create some well-known biases, as discussed above. In contrast, the arrival and exit of goods is immediately seen in both scanner and web-scraped data when a transaction occurs or is posted online. The breadth and detail of transaction data have the potential to help address concerns about sample representativeness heightened by falling response rates in the CE and underreporting by consumers of their expenditures.

Even with the growing challenges associated with the survey-centric statistical system, for the foreseeable future, traditional surveys will continue to be essential inputs into federal statistics. However, to ready the CPI for this future data environment, "modernization will need to focus on integrating multiple (public/commercial, survey/nonsurvey) data sources. The ability to integrate electronic transactions data—ideally, data that are linked to households making purchases—represents the ideal scenario for price measurement" (p. 52).[26]

Given the backdrop of recent rapid changes in the economy and in data collection for statistical purposes, it is important to also envision what the consumer economy (and the data for tracking it) will look like in 10 or 20 years. Eventually, it seems likely that nearly all consumer transactions will be electronic and generate a trail of data that can be used to construct price indexes—this is already the case in some countries, such as China. Scanner data, web scraping, credit cards, and peer-to-peer payment platforms like Venmo and PayPal all generate information on consumer spending (though they also come with challenges regarding access and privacy). "Tracking electronic payment data could be especially helpful to identify price trends in new or changing services" (*Modernization Report,* p. 51).

It is not overly futuristic to envision an economy in which data on prices and quantities—along with product identifiers and characteristics, and information about outlets where purchased—are available in near real time for transactions of the universe of goods and services sold. Transaction data generated as a byproduct of day-to-day commerce have the potential "to make small sample sizes an issue of the past and reduce sampling error" (Konny, Williams, and Friedman 2019).

Finally, in assessing the promise of a more diverse data approach for constructing the CPI, it would be remiss to not point out that such a strategy comes with its own set of challenges. As extensively described in the *Modernization Report*, obstacles to incorporating alternative data

[25] Declines in response rates have been even more dramatic in the United Kingdom, with response rates falling so low in October 2023 that the Office for National Statistics had difficulty publishing reliable data.
[26] See Ehrlich et al. (2022) for an innovative effort to reengineer the US statistical system along these lines.

sources are very real, and include the sometimes high cost of acquiring data from commercial firms, the nonrepresentative nature of most data collected for "nonstatistical" purposes (e.g., convenience samples), and the lack of transparency in terms of how datasets are created and curated. Also, replacing traditional price collection with data obtained from the private sector may lead the statistical agency to depend on the data providers; "even with strong contract provisions, these data could be changed or discontinued without notice" (p. 41). Thus, "big data" are not a panacea. They are not a perfect substitute for current data collection methodologies; nor do they alleviate the need to address the deteriorating survey infrastructure that underpins many of our key economic statistics. However, even with these cautions acknowledged, the *Modernization Report* argues that—given an appropriate amount of time, adequate resources, and proper attention to quality assessment of nonsurvey data—most of the challenges associated with using alternative data sources can be managed. Supporting this conclusion are the successes demonstrated by statistical agencies internationally incorporating new data methods as well as some success by some US statistical agencies.

Criticism 3: The CPI's method of tracking changes in the price of shelter does not reflect what is really happening in housing markets, with assorted rent indexes telling different stories than the CPI.

Bottom line: While the CPI's methodology for housing leads to the shelter index lagging changes in the market, many recent critiques are invalid. For example, critiques of the CPI based on a comparison of, say, the CPI rent index to an index of currently signed market leases reflect a misunderstanding of what the CPI shelter index is intending to measure.

As noted in Section 2, among policymakers, researchers, and the media, coverage of rising shelter costs—and especially rents, which soared during and immediately after the pandemic—is the storyline that has received the most sustained attention. Some of this attention arises because estimation of the CPI shelter component—whether for renters or homeowners—is methodologically complex, data are collected in a way that differs from other goods and services, and concerns are further heightened by the fact that housing represents by far the largest monthly expense for most families.

The CPI shelter index is based on a methodology that involves sampling approximately 50,000 renters across the country during a year. This sample is divided into six panels with each housing unit in a panel contacted (by phone or in person) every six months on a staggered basis; for example, panel 1 is contacted in January and July. The sampling proceeds regardless of when lease agreements were signed. Accordingly, the rents sampled within a month include some newly signed leases, but also many units for which leases were signed sometime in the past.[27] Respondents are asked about cash rent paid to the landlord for shelter and included utilities,

[27] More precisely, over 80 percent of rentals in the CPI sample each period are tenants continuing to occupy the same unit (www.bls.gov/blog/2022/measuring-changes-in-shelter-prices-in-the-consumer-price-index.htm).

plus any government subsidies paid to the landlord on the tenant's behalf.[28] The only-every-six-months sampling schedule is justified by the observation that, in normal times, rents paid do not change as frequently as do the prices of most other goods and services that are tracked in the CPI. Sampling at six-month intervals also allows the BLS to sample more housing units given budget constraints, rather than relying on a smaller sample that was contacted more frequently.

However, if an apartment is surveyed in January and the rent goes up in February, that increase will not show up in the data until the apartment is surveyed again in July. This practice causes the CPI data to lag behind current conditions, which may be consequential during periods of high inflation, since market rents "adjust more quickly to economic conditions than what landlords charge their existing tenants."[29] Such was the situation that arose during the pandemic.

For rental units, estimating price inflation for shelter is relatively straightforward. However, for owner-occupied units, BLS methodology is more complicated and is referred to as rental equivalence. For an owner-occupied unit, the BLS identifies rental units with similar characteristics and uses the sample rents for those units to estimate the change in rent that would have been paid for the owner-occupied unit. These estimates are used to construct the CPI's estimate of owners' equivalent rent, the part of the shelter index accounting for housing costs of owner-occupied housing.

Criticism of the CPI Rent Index

One prominent strand of media criticism of the CPI's rent index argues that "there's something off in the data"; that it is "based on bad shelter data"; or that it relies on convoluted statistical methods.[30] Such observations typically reference near real-time data published by firms such as Zillow, CoreLogic, or Apartment List that track "asking rents" prevailing in the current housing market.[31] Indeed, as shown in figure 4, the Zillow Observed Rent Index has moved quite differently than the CPI; the other listings-based data sources have shown similar patterns to the Zillow index.[32] Based on these observations, some analysts have concluded that the CPI is incorrectly measuring shelter costs.

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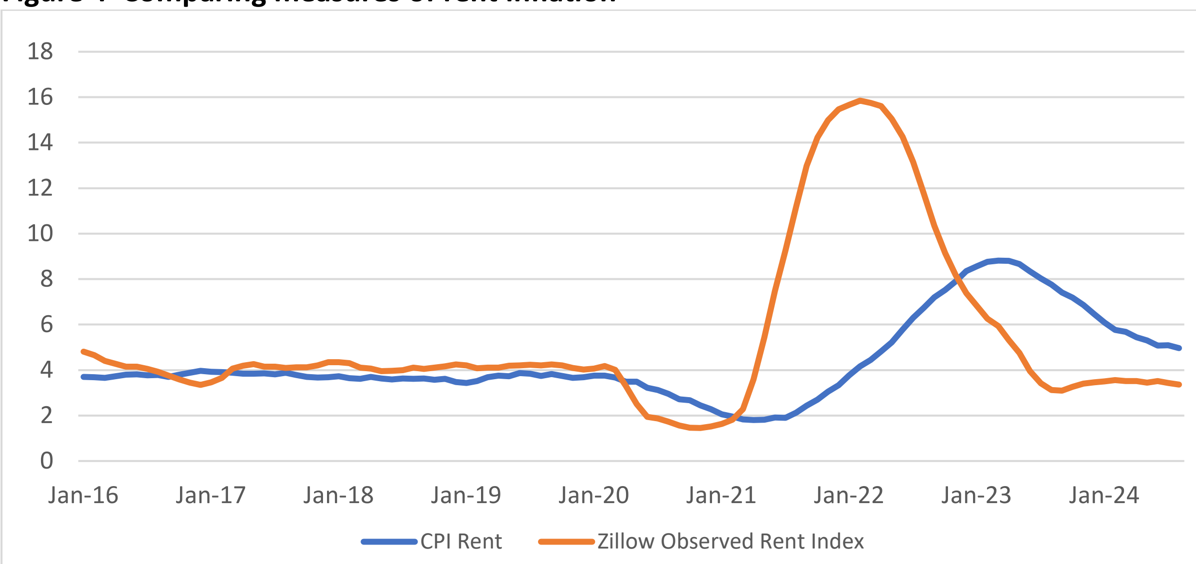
[28] As discussed below, if a unit is owner-occupied, the BLS computes what it would cost to rent that home in the current housing market, known as owners' equivalent rent (OER). Utilities paid by homeowners are measured separately in the CPI.
[29] Speech on "US Economic Outlook and Housing Price Dynamics" by Federal Reserve vice chair Philip N. Jefferson (www.federalreserve.gov/newsevents/speech/jefferson20240520a.htm).
[30] See for example, www.washingtonpost.com/business/2024/03/03/rent-cpi-housing-fed/; https://ritholtz.com/2024/01/cpi-increase-is-based-on-bad-shelter-data/; www.nytimes.com/2024/05/15/business/economy/inflation-owners-equivalent-rent.html.
[31] It is worth noting that just because a market has higher asking rents, it is not necessarily the case that many people are paying them.
[32] See figure 2 in www.frbsf.org/research-and-insights/publications/economic-letter/2023/08/where-is-shelter-inflation-headed/.

However, the CPI methodology differs from that of these private rent indexes in two important ways. First, as noted, the CPI tracks a sample of all existing rents, including for people continuing to occupy their current unit (which is most renters) and who are in stable pricing scenarios, and not just rents on units with newly signed leases (or asking rents). The CPI therefore better represents the average price change experience of all consumers than a sample of current market listings. Second, as noted earlier, the CPI samples rents on housing units only every six months, and this feature means that the CPI will capture rent changes with a lag relative to an index collecting rents every month. Which difference is most important for explaining gaps between the CPI and private rent indexes? Recent research (e.g., Adams et al. 2024) has found the discrepancy in rental inflation rates between the CPI and the alternative measures to be largely explained by differences in rent growth for new tenants relative to that for the broader population of all tenants.

Figure 4 Comparing measures of rent inflation



Source: Bureau of Labor Statistics (BLS) data through Federal Reserve Bank of St. Louis and Zillow.

Differences in approaches to estimating changes in rents occur largely by design. The CPI is intended to capture rent price changes facing all tenants, a large portion of which are rents faced by in-place tenants. In contrast, the focus of commercial firms is typically on the market for available rentals at a point in time which directly represents shelter costs for only a small fraction of the population.

None of this is to say that data on current rental markets is not useful. Media coverage of inflation-rated topics is often focused on a particular item, whether it be eggs, used cars, or gasoline (while the BLS's mandate is to present a broad view of price change for the entire consumer economy). To some extent, this was the case with coverage of shelter, especially by the media which had easy access to commercial data on currently available rental listings, not lease rates paid by incumbents.[33] A high visibility example of a narrow (but important) cost of living story is the growing unaffordability for younger people seeking to be first-time home buyers. The CPI is not the right place to look to quantify this; in contrast, something like the S&P CoreLogic Case-Shiller price index is—and that index showed that home prices increased in the neighborhood of 40 percent nationally from the end of 2019 to mid-2021.

In contrast, the mandate for the CPI is to measure month-to-month changes in the cost of living for the entire population. The price of houses on the market is an important issue but, as discussed below, house purchases include an investment component, so house prices are not the preferred measure of the cost of housing services period to period. That said, even though the CPI rental pricing method is, in our judgment, sound, additional specialty indexes should still be generated to serve a broader range of stakeholder needs. For example, an experimental quarterly index of new tenant rent (New Tenant Rent Index) produced through a collaboration of researchers at the BLS and Cleveland Fed, "uses a similar method to the Zillow index and data from the CPI Housing Survey . . . to track market rents using only observations in the CPI dataset that follow a change in tenant."[34]

Extending the Rental-Based Methodology to Homeowners

More Americans own than rent their homes. Accordingly, the flow of shelter services provided by owner-occupied houses accounts for three-quarters of the CPI shelter index and more than one-quarter of overall expenditures. One challenge with owner-occupied housing is that the price of purchasing a house reflects both its value as an investment asset, which the CPI in principle should exclude, and as a source of shelter services to its inhabitants, which the CPI must include. To address this challenge, the BLS has used an owners' equivalent rent (OER) approach to measure housing inflation since the 1980s; prior to this, the CPI calculation did in fact track mortgage interest rates and other direct housing costs.

As was sketched earlier, the rental equivalence method essentially estimates the amount that would be required for a homeowner to rent a home with all the characteristics of that household's owned home. Alternatively, it can be thought of as the opportunity cost of living in an owned house rather than renting it out. The most compelling rationale for this approach is that the CPI is intended to capture changes in the consumption cost of the shelter that a house provides; it is not intended to track changes in the price of a housing asset.[35]

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[33] For example, a recent *Washington Post* story on escalating rents used data from the CoStar Group for 1,660 counties for June of each year from 2019 to 2024. See Janice Kai Chen, Rachel Lerman, and Kate Rabinowitz, "How much are rents going up? See how prices have changed in your area," *Washington Post*, August 1, 2024, https://www.washingtonpost.com/business/interactive/2024/rent-average-by-county-change-rising-falling.

[34] The collaboration also produces an All Tenant Repeat Rent Index which tracks the CPI year over year rent index very closely (www.bls.gov/osmr/research-papers/2022/ec220100.htm).

[35] Reiterating this position, a recent report on developing integrated measurement of income, wealth, and consumption (NASEM 2024) categorizes the value of an owned house as a "nonfinancial asset" that is part of wealth. Data from the Federal Reserve's Survey of Consumer Finances and Distributional Financial Accounts, which follows this convention, indicates that owned housing accounts for about 28 percent of total gross household wealth in the United States.

Another motivation for the 1980s-era switch to OER is that, because interest rates and mortgage costs can be extremely volatile (as was dramatically the case during the period leading up to the change), the adoption of the approach has led to a more stable index of inflation over the period since (Hazell et al. 2022). For these and other reasons, the *Modernization Report* recommended that BLS continue to use rental equivalence as the *primary* approach to estimating the price of housing services for owner-occupied units.

Even so, there is room for *secondary* approaches in the shelter index methodology. Imputing rent for owner-occupied homes works best when there is a high degree of overlap in terms of geography and housing quality between the market of homes for sale and the rental market. When overlap of rented and owned properties of a given quality is limited, a user cost approach—which treats an owned home as a capital good and includes actual expenses incurred by homeowners, such as those on repairs, maintenance, financing borrowing, as well as likely capital gains—could add value. Research comparing rental equivalence estimates to user cost estimates for individual properties could be undertaken to help assess where the rental equivalence method is performing well and where it is not, such as may be the case for pricing housing services associated with higher-end properties (NRC 2002, p. 8-9).

Another advantage that OER offers is consistency with underlying approaches used in other official economic statistics and with practices in other countries. While the OER approach is not universally used in the price measurement programs of statistical offices around the world, it is a commonly used approach.[36] Other economic statistics—most prominently, those derived from the National Income and Product Accounts calculated by BEA, such as estimates of disposable personal income—also include imputed rents from homeownership. The NASEM (2024) report on measuring income, wealth, and consumption conveys the underlying logic of OER this way: "Homeownership frees up resources that would otherwise have to be spent on rent. For this reason, for most distributional analyses, estimates of the level of resources available to individuals and households attempt to include homeowner access to housing assets that deliver a cash flow of rental income or a flow of housing services to the owner" (p. 78).

Steps to Improve the Shelter Index, as Recommended by the **Modernization Report**

While the *Modernization Report* generally supports the methods underlying the CPI shelter index, it highlighted the potential for greater use of alternative data sources, expanding survey coverage, and publishing additional detail about the prices in housing markets.

As described above, the CPI methodology has traditionally relied on survey data to provide information on rent changes and housing expenditure shares. The *Modernization Report*

[36] Canada, Iceland, and Sweden have used the user cost of capital approach; the Czech Republic, Australia, and New Zealand the net acquisition cost approach; Japan, Norway, Switzerland, and the United States the rental equivalence approach. For price quotes (not expenditure weights), the Harmonized Index of Consumer Prices (HICP) used for the Eurozone and European Union currently only includes rentals for housing (paid by tenants) and auxiliary housing expenditures (paid by both tenants and owners).

provides guidance for how the CPI Housing Survey could be supplemented with creative use of market-generated information, and even datasets maintained by the growing number of large institutional landlords and property management companies. Detail in these datasets may help improve the accuracy of imputations of rent changes to owner-occupied houses—for example, by expanding coverage of high-end rentals and single-family homes, both of which are currently underrepresented in the BLS's housing survey. By allowing information for a given housing unit to be collected in consecutive months, as opposed to every six months as is the case with the CPI Housing Survey, the ability of BLS to improve the sensitivity and timeliness of shelter indexes may be enhanced during times when rents change rapidly (*Modernization Report*, p. 8). The report also recommended exploring the value of property tax records, which often include rich data on housing characteristics, and the Census Bureau's American Community Survey data for estimating expenditure shares for owner-occupied housing.

In tracking the price of shelter in the United States, geographic detail is especially important because so much variation exists across and within regions. With this in mind, the *Modernization Report* recommended that BLS publish additional detail on the housing components of the CPI, such as indexes by structure type and for a larger number of metropolitan areas than the roughly 20 areas for which figures are currently available.

Criticism 4: The CPI does not sufficiently keep up with an increasingly dynamic marketplace in which the characteristics of goods and services evolve more quickly than ever.

Bottom line: Capturing changes in products and the marketplace has been a challenge since the inception of the CPI. The BLS has continually introduced methodological changes to address this issue although there is, and will continue to be, room for further progress, especially given the growing importance of information goods and services.

For many years, critics argued that the CPI did not adequately adjust observed price changes to account for the changing quality of products and for the appearance of new, often improved goods and services in the market. The report of the Boskin Commission almost 30 years ago highlighted this problem for price indexes designed with the intent to track the population's true cost of living. BLS responded by extending its use of hedonic methods within its COLI framework to track the characteristics (attributes) of more products being priced for elementary indexes. With this information, adjustments could be made to observed market prices to make period-to-period price comparisons as like-to-like as possible. For example, if airbags were added to a vehicle model, a portion of an observed price change would be attributed to the value added by that feature, as opposed to being assigned as a pure price change. For a more extreme automotive example, the price of a 2024 Tesla could not reasonably be compared to the price of a 1908 Ford Model T without adjusting for changes in characteristics and quality.

Some researchers, while acknowledging major progress by the BLS, argue that still more work is needed to keep up with changes in the marketplace, which is much more dynamic and diverse than it was just a few decades ago.[37] Many more products exist and a larger share of people's market baskets consists of information goods and services; thanks to the internet, people's choice of outlets from where to purchase is largely unconstrained by geography; the characteristics of goods and services evolve more quickly than ever, and new goods are introduced more rapidly. Such dynamism increases the need to pay attention to quality change and the mix of products being bought and sold.

Quantifying the gains (or losses) that the internet has brought to consumers is difficult, in part because so much of what is used has no price. The presence of free or less expensive digital goods has been missed (though to what extent is a topic that elicits a wide range of views). For example, today's quantity and quality-adjusted family entertainment budgets, where innovations such as YouTube and streaming services have emerged, may be less expensive than those of decades past, which may have included movie theater tickets and more away-from-home events. Similar changes have occurred with activities such as communicating with family and friends, planning vacations, and paying bills (to say nothing of the consumer surplus generated from the time saved by using the internet).

Brynjolfsson et al. (2020) studied the price measurement implications associated with the emergence of free (or nearly free) services that have become available in the internet age—from the ability to web search to the proliferation of electronic-mediated apps that make it easier (and sometimes cheaper) to hire a ride across town, to taking and sharing photos. They ask how much consumers would need to be paid to do without them. In the United States, search (Google) is the most valued category of free digital goods with a median valuation of more than $17,000 a year, followed by email and maps. One UK-based study using a similar methodology found a wide range of median annual values for different free goods, with search (£1,500) and personal email (£3,500) the most highly valued categories. In comparison, Facebook and some other free apps had much lower values, at £150 to £10 a year, respectively (Coyle and Nguyen 2020).

Even for more conventional goods bought in traditional outlets, electronic transaction datasets are available that often include barcodes that embed information on characteristics of each product. These datasets make it possible to better account for quality change with hedonic techniques given that a change in product codes typically accompanies meaningful changes in the quality of a given product (Jaravel 2018).

Alternative data are also useful for price measurement in the most challenging expenditure categories. For example, for medical care, the *Modernization Report* encouraged BLS researchers to continue their work evaluating how to "take advantage of insurance claims data, hospital data, health plan data, and scanner data on drugs to improve the coverage, detail, and timeliness of price and quantity information in the medical care component of the CPI" (p. 130). This kind of information is also crucial for assessing the outcomes of medical treatments (NRC 2010).

[37] See, for example, www.nber.org/digest/20239/correcting-quality-change-when-measuring-inflation.

As part of its recommendation that BLS accelerate research on methods of blending different types of data sources for the construction of elementary indexes, the *Modernization Report* noted the importance of building quality change measurement into the methods. A key aspect of a multi-pronged data approach involves incorporating information on product attributes in a way that quality change adjustments can be applied. Sometimes this kind of detailed information can be found in product codes but, in some cases, it can also be extracted from retailers' or manufacturers' websites. Methodological improvements along these lines could be consequential when high expenditure items, such as communications goods and services (internet, streaming, mobile, and cable) are involved.

Criticism 5: While inflation has slowed, prices are still up substantially since before the pandemic, creating burdens for many households.

Bottom line: While this observation is correct, it is not a criticism of the CPI or its methodology per se, but rather one based on what the CPI tells us about cumulative changes in the cost of living. Moreover, basic macroeconomic relationships indicate that it would be extremely unwise for policymakers to endeavor to return prices to pre-pandemic levels.

As all but the most price-insensitive shoppers have recognized, the cost of goods and services has increased significantly in recent years. Prices of many items (milk, gasoline, new cars) have since declined from peaks but are still above where they were ahead of the pandemic. The cumulative percent price increase from February 2020 (the last month before COVID-19 pandemic shutdowns) through November 2024 for a set of commonly purchased goods, listed in table 2, illustrates the point.

Table 2 Cumulative price changes for selected items, February 2020 to November 2024 (percent change)

Gasoline	25.3
Household energy	31.7
Food at home (groceries)	26.2
Rent (primary residence)	26.0
New vehicles	20.1
Used cars and trucks	30.9
Apparel	4.1
Medical care	10.7

Source: All figures based on seasonally adjusted CPI-U data from the Bureau of Labor Statistics.

If the current episode replicates historical patterns, prices will not return to pre-pandemic levels. Rather, over time, incomes will tend to catch up and people will grow accustomed to the new price level. Even so, at least until expectations are reset, people readily express that they do not like paying more for stuff than they used to—and, as repeated consumer sentiment surveys have indicated, this affects their assessment of how the economy is doing. However, recent data indicate that, on average, wages have been outpacing prices in recent months, which should ultimately help allow people to make the mental adjustment to a new normal.[38]

Furthermore, even though the pain to families of higher prices is very real, from a macroeconomic policy perspective, economists broadly agree that a return of prices back to pre-COVID level would be undesirable. It is worth remembering that price deflation was a characteristic of economic episodes such as the Great Depression and Japan's "lost decade" of economic stagnation.

The Federal Reserve targets a positive inflation rate in part to maintain maneuverability to cut interest rates the event of a recession and to "provide insurance against downward movement of prices for goods and services . . . since [many economists] think that the effect of deflation of a given size would be more harmful for the economy than a positive rate of inflation of the same number."[39] Among other reasons that policymakers seek to avoid price deflation include: (1) in a deflationary economy, wages as well as prices often have to fall, "and it's a fact of life that it's very hard to cut nominal wages" and economies typically do not have falling wages unless they also have mass unemployment (Krugman 2010); with expectations that things will cost less tomorrow, consumers are encouraged to put off purchases, creating a potentially enormous shortfall of demand relative to supply; deflation is bad for debtors which leads to spending cuts and greater defaults; and it is difficult for central banks to cut interest rates below zero.[40]

4. Conclusion: A Crucial and Sound Statistic but More Work Ahead

The CPI has been the subject of especially intense criticism in recent years given the turmoil of the pandemic and the sudden increase and subsequent dropback in inflation. This paper, in evaluating several of the most salient recent critiques of the CPI, reaches three main conclusions. First, that the underlying foundation of the CPI is sound. The conditional cost of living framework is sensible, intuitive, and implementable for a statistic published on a monthly production schedule. The basic question the CPI is designed to answer is: "How much did the cost-of-living change for an average household in the United States over a specified time period?" Our judgement is that while there is essential further progress that the BLS will need to make, the CPI does a solid job of answering that question.

Second, with respect to criticism that CPI methodology needs to be more responsive to changes in the economy and the data environment (specifically, criticisms 1, 2, and 4 above), the *Modernization Report* argued for a paradigm shift from a 20th century survey-centric approach to one that blends traditional survey data with alternative data (including so-called "big data").

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[38] BLS data indicate that average hourly earnings (nominal) have increased about 19 percent since February 2020 (calculated using the FRED tool at https://fred.stlouisfed.org/series/CES0500000003).
[39] See https://www.stlouisfed.org/open-vault/2019/january/fed-inflation-target-2-percent.
[40] See www.brookings.edu/articles/5-reasons-to-worry-about-deflation/.

The need for this shift is given added urgency by declines in survey response rates and the growing availability of new data sources with complementary features that can improve economic statistics. While it is easy to say that a paradigm shift is needed, such a shift raises methodological challenges, including new procedures for calculating indexes from blended data and new approaches to evaluating data quality. And the challenge is larger than that. To succeed in making the necessary changes, the BLS will require significant additional resources, changes in the skill mix of its staff, changes in data security protocols,[41] and changes in its administrative structure. None of these changes are easy; all are essential.

Third, some critiques (for example, criticism 3 above) reflect a misunderstanding of what the CPI is designed to measure and of its intended purposes. Critiques of the official measure sometimes take the form of highlighting an individual with a different inflation experience than that reflected in the CPI or an alternative index that reports a different inflation rate than does the headline CPI. In many cases, the alternative indexes are measuring a different concept than the CPI or are using very different data that may not be nationally representative. The CPI is designed to answer questions about changes in the cost of living averaged across households in the United States, conditional on a set of background factors. If the question is different, the headline CPI may not provide the best answer. Accordingly, the BLS publishes a number of variants of the CPI that focus on different demographic groups or use somewhat different methodologies. Other statistical agencies also publish a variety of inflation measures, and private researchers and analysts have generated alternative measures as well. In analyses of inflation developments, it is critical to match an inflation measure to the question being asked as well as possible.

Housing, and specifically rents, provide an illuminating example of the occasional mismatch between what the CPI is measuring and what an alternative indicator captures. A number of critiques have highlighted privately produced indexes of rents built into new leases, and have noted that these indexes rose or fell faster than the CPI over some period. These rent indexes provide valuable information for analysts and policymakers. However, they measure something different than the CPI. While rents on newly signed leases could be changing rapidly, rents on leases signed in earlier months may not be changing much. The CPI incorporates rents for all renters, not just those who have newly signed leases. Thus, care is required to make meaningful comparisons of the CPI rent index to other rent indexes. That said, we do believe there is scope for improvement in the CPI's housing indexes, along the lines highlighted above.

Finally, we note that the critique concerning the level of prices highlights a concern about what the CPI tells us, not a critique of the CPI itself. For those who are more concerned about the cumulative increase in the price level over some period, the information is there in plain sight; all that is required is a slightly different computation using the CPI.

[41] The need for updated security protocols and state-of-the-art release technologies is highlighted by recent incidents in which the BLS mishandled a release of key data. See Casselman (2024).

Looking ahead, we are generally optimistic about the future of the CPI. We believe the conceptual framework of the CPI is sound, and while the road likely will be bumpy, the BLS and the broader set of statistical agencies can rise to challenges that lie ahead.

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PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

24-23 Labor Market Tightness and Inflation Before and After the COVID-19 Pandemic

Justin Bloesch

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ABSTRACT

This paper reviews evidence on the role of the labor market in driving inflation and analyzes the US labor market, and its contribution to inflation, during the COVID pandemic and recovery. I argue that the quits rate is a good measure of labor market tightness and is the best predictor of nominal wage growth. I further argue that wages largely pass through into prices, but other factors like sector-specific supply shocks are needed to explain the dynamics of price inflation. The COVID pandemic created large disruptions in the labor market, resulting in an increase in job openings and quits, high nominal wage growth, and temporary labor market mismatch. The shocks associated with COVID have subsequently faded, and nonlinearities in both the wage Phillips curve and Beveridge curve allowed for nominal wage growth to normalize without a large increase in unemployment. Lastly, I argue that the relationship between wages and prices is mostly one-directional: Past price increases are not a major driver of wage gains. The period of high nominal wage growth in the recovery from COVID therefore reflected temporarily high labor demand as the economy quickly reopened, but not a classic wage-price spiral.

JEL Codes: J63, E31, E24, J31

Keywords: Labor Market Tightness, Inflation, Wage Growth

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1 INTRODUCTION

During the COVID-19 pandemic and its aftermath, the United States experienced large increases in inflation, rapid wage growth, and tight labor markets. This has led to significant debate about the role of the labor market in contributing to high inflation. Prior to the pandemic, decades of price stability raised doubts about whether there is a relationship between the labor market and price inflation at all. To the extent a structural relationship between labor market tightness and inflation does exist, what indicators of the labor market should we use to both understand and predict inflation, and what are the forces governing this relationship? Has the labor market fundamentally changed during the COVID pandemic and the subsequent recovery?

In this paper, I assess the role of labor market tightness in contributing to inflation, drawing on the available research, as well as my own examination of the labor market's contribution to inflation during COVID. I draw three main conclusions. First, tight labor markets do contribute to inflation: The quits rate is the best measure of labor market tightness for predicting nominal wage growth, and empirical evidence suggests that wage increases pass through meaningfully into prices. However, a large portion of the variation in inflation is not well explained by the labor market, and so labor-only stories are insufficient to explain most inflation patterns. Second, the experience of COVID reflects large but temporary disruptions to the labor market, combined with elevated demand for labor, most of which have already receded. Third, the general absence of contractual cost-of-living adjustments lessens the likelihood of the US entering a wage-price spiral, minimizing the need for the Federal Reserve to depress the labor market to bring inflation back to its target.

I will begin by reviewing evidence on how labor market tightness affects nominal wage growth and price inflation in the labor market prior to COVID. I argue that the wage Phillips curve is alive and well: Tight labor markets increase nominal wage growth. I will also argue that the quits rate, the rate at which workers voluntarily leave their jobs, is theoretically and empirically the best predictor of nominal wage growth. Next I will turn to price inflation, where the connections to the labor market are more nuanced. While the minimum wage literature suggests that increased wage costs are largely passed through into prices, there are various factors that complicate a clean relationship between labor market tightness and price inflation, such as procyclical labor productivity and sector-specific supply shocks. Tight labor markets may also affect inflation through channels other than wage growth: Strong employment gains provide the income for strong consumer demand, so rapid growth in total labor income may push up prices, particularly in sectors where the supply of goods and services is inelastic. On the whole, the evidence from the years prior to COVID suggests that tight labor markets contribute meaningfully to price inflation, but a large share of variation in price inflation is not explained by the labor market.

With this evidence in hand, I will examine the labor market and inflation during the COVID period, which was characterized by a very large increase in the number of job openings, a rise in quits, a decrease in labor supply, and rapid wage growth and inflation. These patterns, and the rise in job openings in particular, led economists and policymakers to worry that COVID had permanently made it harder to match workers to jobs, leaving the economy with a higher natural rate of unemployment. I will argue instead that COVID will have minimal lasting impacts on the labor market, and that inflation can normalize without a large increase in unemployment. Focusing first on job openings, I will argue that the rise in job openings during COVID represented a combination of three forces: (i) a surge in labor demand as firms were rehiring all at once, (ii) a temporary increase in labor market mismatch, and (iii) a continued upward time trend in the job openings series that existed prior to COVID. The decline in labor supply was also temporary, and nonlinearities in both the wage Phillips curve and Beveridge curve allowed demand for labor and wage growth to fall without a large increase in the unemployment rate. With labor demand, labor supply, and mismatch normalizing, the labor market today increasingly resembles the labor market prior to COVID.

Lastly, I will argue that the US did not exhibit dynamics of a wage-price spiral: The rise in wage growth experienced over the last few years was not the result of a feedback from price inflation into wage growth. Instead, the wage growth experienced in the US was the result of high labor demand, as the rise in wage growth in job postings preceded the rise of inflation during this cycle. The lack of wage-price spiral dynamics lessened the risk of inflation becoming entrenched, limiting the need for the Federal Reserve depress the labor market to stabilize inflation.

2 LABOR MARKET TIGHTNESS, WAGE GROWTH, AND INFLATION

In this section, I will discuss evidence on both the wage Phillips curve and price Phillips curve, i.e., how labor market tightness affects nominal wage growth and price inflation. I will compare various measures of labor market slack in predicting nominal wage growth and argue that the quits rate does a better job of predicting wage growth than other measures, such as the unemployment gap or ratio of vacancies to unemployed workers. I will review the evidence from the minimum wage literature that shows that wages pass through to prices in a way that is consistent with constant markups over marginal cost. I will then discuss various forces that complicate the simple story of labor market tightness increasing inflation, including procyclical productivity and sector-specific shocks that are unrelated to the labor market. I will conclude that while labor market tightness contributes significantly to inflation, most of the variation of inflation over time is not attributable to the state of the labor market, particularly at high frequencies.

2.1 Which Labor Market Variables Predict Wage Growth?

The Modern New Keynesian Phillips Curve: A Primer. Dating back to Phillips (1958), the original Phillips curve is a relationship between nominal wage growth and the unemployment rate. With New Keynesian models using sticky prices to reintroduce a role for monetary policy into macroeconomic modeling, the modern New Keynesian Phillips curve is an equation that expresses current price inflation, rather than wage growth, as a function of some measure of current slack and expected inflation. More recently, modelers have introduced sticky wages into New Keynesian models, bringing back the Phillips (1958) relationship between labor market tightness and wage growth, but within a New Keynesian framework.[1] To address the question of what indicators of slack are the best at predicting inflation, I will start by exploring which measures of slack are most predictive of nominal wage growth, i.e., what variables should be on the right-hand side of the wage Phillips curve.

Traditional Indicator: Unemployment Gap. In the original wage Phillips curve, the unemployment rate was the variable used to measure slack in the labor market. However, a given rate of unemployment may not have the same effect on wage growth or inflation at all points in time: There may be times when the economy has a harder timer reemploying unemployed workers, and so what should matter for wage growth or inflation is instead the gap between the actual unemployment rate and the "natural" rate of unemployment (Phelps 1967, Friedman 1968), often denoted as u°. This is the lowest unemployment rate that is consistent with stable inflation, which is sometimes called the nonaccelerating inflation rate of unemployment (NAIRU).[2] If the unemployment rate is above the natural rate, then the labor market is slack, and inflation should fall. If the unemployment rate is below the natural rate of unemployment, and workers are in short supply, then inflation should rise.

One challenge of using the unemployment gap as a measure of labor market slack is that one of the crucial components, the natural rate of unemployment, is unobservable and may change over time. Therefore, government agencies and many researchers, such the US Congressional Budget Office (CBO), Barnichon and Matthes (2017), Giannoni et al. (2019), and Holsten et al. (2017) among others, estimate the path of the natural rate of unemployment over time.[3] Estimating the natural rate of unemployment can be very challenging, and most estimates have very wide confidence bounds. In some of the regressions reported below, I will use the CBO estimate of the noncyclical rate of unemployment as the natural rate of unemployment.

Vacancies to Unemployment Ratio. Unemployment alone may not be a sufficient indicator for labor market slack because it does not take into account firms' unmet demand for labor. In many search models where workers and firms match in a frictional labor market, the ratio of job openings (or vacancies, which I will use synonymously) to unemployed workers is the relevant measure of labor market tightness (Pissarides 2000). If posting vacancies is costly, tight labor markets (i.e., many vacancies per unemployed worker) make it harder for firms to hire workers, making firms' search for workers more costly. Similarly, when vacancies are abundant, workers have an easier time finding jobs, improving workers' bargaining position. Both forces will push wages up, and so the

1 Erceg et al. (2000) introduced nominal wage rigidities in a DSGE model, and Galí (2011) use their environment to estimate the old wage Phillips curve: a regression of wage growth on the unemployment rate. Phillips (1958) discusses a nonlinear relationship between the unemployment rate and wage growth, while most current models are linearized and by default can only study a linear relationship between slack and wage growth.

2 These concepts may have slightly different meanings: The NAIRU is sometimes to considered to be a short-run concept and the natural rate a longer-term concept.

3 Some researchers emphasize variations of the unemployment gap, such as Ball and Mazumder (2019) who focus on fluctuations in short-term unemployment.

ratio of vacancies to unemployed workers may be a good predictor of wage growth. Accordingly, the ratio of vacancies to unemployed workers has become increasingly popular as a measure of labor market tightness (Domash and Summers 2022; Benigno and Eggertsson 2024; Barnichon and Shapiro 2024).

Do Vacancies and Unemployment Matter Equally? In simple search models, the only people who search for a job are unemployed workers. This would imply that the ratio of vacancies to unemployed worker summarizes the state of labor market tightness.[4] However, in practice, a firm looking to fill a vacancy will encounter more than just unemployed workers: Searching workers may include workers who are already employed as well as people who are not in the labor force (Abraham et al. 2020, Andolfatto and Birinci 2022). Therefore, the unemployment rate is not a sufficient indicator of the total number of searchers in the labor market, and vacancy and unemployment rates should not be treated symmetrically when defining labor market tightness.

To illustrate this point, consider a simple example where the unemployment rate is U, so fraction $1 - U$ of the labor force is employed. Suppose that employed workers search with probability λ. Labor market tightness is then defined as

$$\text{tightness} = \frac{\text{vacancies}}{\text{searchers}} = \frac{V}{\lambda(1 - U) + U},$$

where the numerator is the number of vacancies or job openings, and the denominator is the sum of workers who currently have jobs and are searching $\lambda(1 - U)$ plus the number of unemployed workers U. In this setting, a 10 percent increase in vacancies will result in a 10 percent increase in tightness: Tightness and vacancies will move one-for-one. However, a 10 percent increase in the unemployment rate will not have a proportionate effect on labor market tightness, as unemployed workers are only a fraction of the searchers in the labor market.[5] Building on this logic, Bloesch, Lee, and Weber (2024) show in a New Keynesian model with on-the-job search that the weight on vacancy rate in the wage Phillips curve should be 2–3 times the weight on the unemployment rate: A 10 percent increase in the vacancy rate will raise wages by 2–3 times as much as a 10 percent decrease in the unemployment rate. The fact that on-the-job search models put more weight on vacancies than unemployment in the wage Phillips curve makes the job openings rate a conceptually appealing indicator for predicting how slack affects wage growth. Unfortunately, recent trends in the job openings series in the Job Openings and Labor Turnover Survey (JOLTS) raise doubts as to whether the vacancy rate is a useful indicator for real time analysis, as I will discuss next.

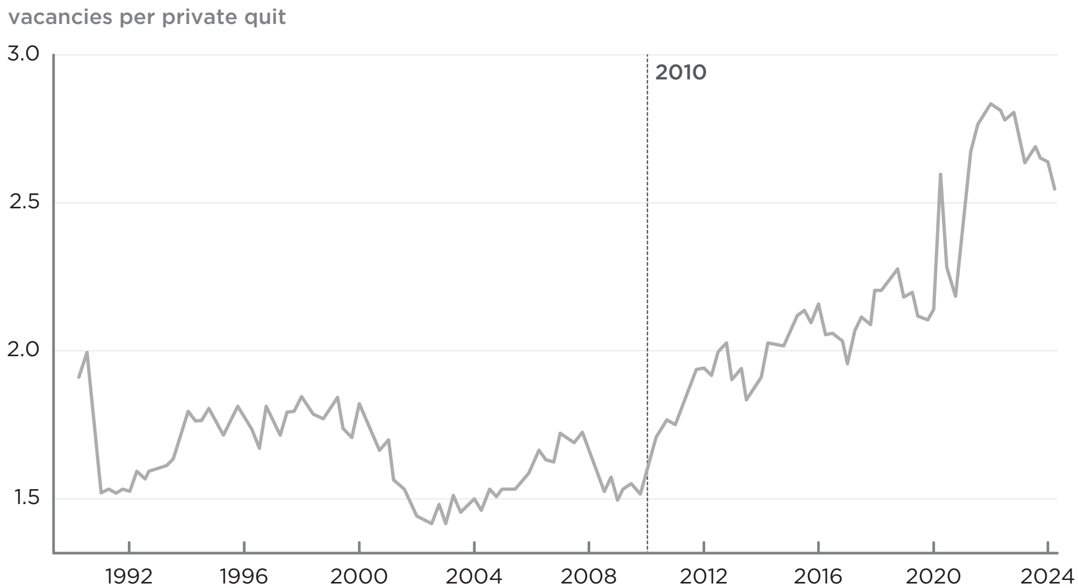
An Upward Trend in the JOLTS Measure of Job Openings. While the rate of job openings or vacancies is theoretically a very important object to measure firms' demand for labor and labor market tightness, it is uncertain whether measured job openings are recently as useful as they were in the past for assessing the state of labor market tightness. Mongey and Horwich (2023) show that beginning

4 For example, see Gagliardone and Gertler (2023) and Benigno and Eggertsson (2024).

5 This is even more the case when accounting for individuals who are not in the labor force, who may be searching for jobs with a low intensity but are not counted as unemployed.

Figure 1

Rising vacancies per private quit since 2010 suggests that the vacancy rate is not comparable over time



Notes: This figure shows the ratio of total job openings over private industry quits. The series are aggregated by averaging at the quarterly level. Job openings prior to 2001 come from Barnichon (2010), and after 2001 from the Job Openings and Labor Turnover Survey (JOLTS). The private quits series prior to 2001 comes from Davis et al. (2012), and JOLTS thereafter. Both vacancies and quits are procyclical, and the volatility of vacancies is greater than for quits. Therefore, we would expect the ratio of vacancies to quits to rise in booms and fall in recessions. This pattern of falling V/Q during slumps is evident in the early 1990s recession, early 2000s recession, and in 2008. A similar figure of nonfarm job openings to nonfarm quits, rather than private industry quits, using JOLTS since 2001 when such data is available, shows a similar rise beginning in 2010.

Sources: Barnichon (2010); Davis et al. (2012); US Bureau of Labor Statistics via St. Louis Federal Reserve Economic Data (FRED).

around 2010, the ratio of job openings to quits measured in JOLTS started rising significantly above what would be expected during an economic recovery. Figure 1 demonstrates this upward trend by plotting the ratio of vacancies to quits.[6] These series should be closely related, as a higher vacancy rate gives workers more opportunities to voluntarily quit to other jobs. If both series were measured consistently, and if there were no shifts in the efficiency of matching workers to jobs, we should expect that the ratio of vacancies to quits should not change much over time. Prior to 2010, the ratio of vacancies to quits typically varied between 1.4 and 1.8. However, around 2011, the rate of job openings began accelerating rapidly, and the ratio of vacancies to quits continued to rise throughout the 2010s cycle. While some of this is to be expected as the labor market recovered through the 2010s, by 2019 the ratio of vacancies to quits was over 2.2. This trend has continued through COVID: By the second quarter of 2024, this ratio was still above 2.5. I will discuss the rise in the vacancy rate

6 Specifically, we use nonfarm job openings and private quits. For job openings prior to 2001, we use the Barnichon (2010) Composite Help-Wanted Index, which covers all nonfarm employment. For quits prior to 2001, we use the Davis et al. (2012) series, which covers private industries. To maintain consistency, we continue to use nonfarm job openings (JTSJOL from FRED) and private quits (JTS1000QUL from FRED) from JOLTS beginning in 2001.

during COVID more extensively in Section 3.1, and I will focus only on the pre-COVID trends in this section.[7]

A substantial literature sought to explain the rise in vacancies in the early 2010s, when the rate of job openings was surprisingly high given the depressed state the labor market. However, as I will argue, none of these explanations provide a good account of the continued rise in the vacancy rate in the later 2010s, leading to doubt about the long-run consistency of the measure. To start, Gavazza et al. (2018) seek to explain why vacancies did not fall as much as expected after 2010. The authors argue that firms' recruiting effort per vacancy is also cyclical, and so many job openings will remain unfilled as firms put only marginal effort into filling them. The presence of many job openings coinciding with high unemployment would lead to lower measured "matching efficiency" in the labor market. Şahin et al. (2014) investigate whether increased mismatch between workers' skills and the jobs and occupations where there are openings might help explain the rise in vacancies in the early 2010s. The authors find some role for mismatch but conclude that mismatch accounts for at most one third in the rise of unemployment after the Great Recession. Similar to lower recruiting efforts, greater labor market mismatch would imply that a high vacancy rate and a high unemployment rate can coexist, also implying low matching efficiency. Bagga et al. (2023) similarly estimate that matching efficiency persistently fell in the 2010s and never recovered.

Despite this extensive body of research, explaining the continued rise in job openings since 2010 with lower matching efficiency remains unconvincing. The main reason is that if matching efficiency falls, the natural rate of unemployment should rise: When matching workers to jobs is harder, workers will linger longer in unemployment.[8] However, the mismatch story predicts a rising natural rate of unemployment u^* and is thus challenged by the observation that the unemployment rate reached its lowest level in decades in the 2010s, attaining a low of 3.5 percent in 2019. Further, wage growth and inflation in the late 2010s were muted by historical standards, suggesting that unemployment was not below its hypothetical natural rate. There is therefore little reason to think that poor matching efficiency was the source of high vacancies by the late 2010s. We need an alternative explanation.

One possible reason for a rising level of measured job openings could be that online job websites made it cheaper and easier for firms to advertise vacancies. However, the development of online job boards alone is not a compelling explanation for rising job openings in the JOLTS series, as the Bureau of Labor Statistics surveys firms directly about positions that are available and ready to be filled, which the cost of posting an ad online should not directly affect. One more speculative reason for greater reporting of job vacancies is a shift toward formality and transparency in hiring, in which firms seek to avoid discriminating

7 The rise in job openings during the 2010s is not only relative to quits: The job openings rate also rises above what would be predicted using past job openings' past relationship with hires, the unemployment rate, or wage growth. All of these other labor market series have mostly stationary relationships with each other, while the job openings rate uniquely rises during the 2010s.

8 This logic is outlined in more detail recently by Blanchard et al. (2022).

or the perception of discrimination.[9] Historically, many hires occurred without a formal vacancy (Davis et al. 2013), and cultural or political efforts to fight discrimination, combined with greater ease of formalizing openings with an online platform, may help explain the rise in stated openings by firms.

Whatever the reason for its increase, the dramatic rise in the job openings rate since 2010 should make researchers and policymakers cautious about using the job openings series as a measure of labor market tightness or for making comparisons over periods of time longer than a few years.[10] Most recently, the job openings rate rose dramatically following the COVID pandemic as well, sparking debate about the extent of labor market tightness in the economic recovery from the COVID shock. As I will discuss in section 3.1, a mismatch in the labor market likely did increase, but long-term trends in the job openings series still plague the series as a useful indicator of labor market tightness.

The Quits Rate as a Measure of Labor Market Tightness. The challenges in measuring job openings leave a clear favorite for measuring labor market tightness: the quits rate, defined as the share of workers who voluntarily leave their job every month. This measure is closely related to another series that is prominent in the academic literature: the job-to-job transition rate, often called the "EE rate," to denote employment to employment transitions. In this section, I will review the evidence on the impact of the quits rate and job-to-job transition rate on wage growth and discuss why the quits rate is a better predictor of nominal wage growth.

As a matter of definitions, job-to-job transitions and quits are highly related, as most workers who quit their job leave for another job.[11] Both job-to-job transitions and quits are good measures of labor market tightness because they reveal the strength of workers' outside options. If workers are receiving more offers from other employers or feel confident enough to leave their jobs without future employment secured, that is a strong indicator that demand for labor is high and labor markets are tight.

Extensive research has shown that both measures are strongly predictive of wage growth. Faberman and Justiniano (2015) report a very strong relationship between the quits rate and wage growth, particularly for the employment cost index. Moscarini and Postel-Vinay (2016) show that job-to-job transitions dominate the job finding rate of the unemployed in explaining wage growth. Crucially, these authors also show that wage growth for stayers (defined as workers who do not change employers) is also strongly predicted by the rate of job-to-job transitions. To the extent that higher wages may contribute to inflationary pressure, the wage growth of stayers is of particular interest because wage growth for these workers is by definition not due to productivity-enhancing

9 This mechanism was suggested by Professor Joseph Stiglitz.

10 Another concern with series from JOLTS is that the response rates have fallen dramatically over the last decade, to a recent low near 30 percent. However, the declining response rate would not explain why the job openings series and quits rate series have diverged in JOLTS.

11 Some job-to-job transitions may be the result of firings or layoffs where workers find jobs in advance or very quickly, and some quits are voluntary separations into unemployment or non-participation. However, these measures will be very similar, as most job-to-job transitions are voluntary quits on the part of the worker.

reallocation. Karahan et al. (2017) similarly find that the rate of job-to-job transitions is more important than the job finding rate of the unemployed in predicting wage growth.

While research demonstrates that both series predict wage growth, I favor the quits rate, for both theoretical and empirical reasons. On a theoretical basis, if turnover is costly for employers, firms should be equally concerned about turnover associated with workers leaving for another firm and with that associated with workers leaving for nonemployment. Bloesch et al. (2024) show in a structural DSGE model with on-the-job search that the quits rate is a good summary statistic for labor market tightness that is predictive of nominal wage growth. Qiu (2022) shows that quits from employment to non-participation is procyclical, and so job-to-job transitions may not fully capture the pro-cyclicality of turnover that firms face. Empirically, Heise et al. (2024) estimate the wage Phillips curve and show that quits outperforms numerous other labor market indicators in predicting wage growth, including the ratio of vacancies to unemployed workers and the hiring rate, among others. The measure of job-to-job transitions from Fujita et al. (2024), which predicted wage growth very well prior to COVID, did not rise to high levels during the COVID recovery.[12] Therefore the job-to-job transition rate has a hard time accounting for the increase in wage growth during COVID, as I will show in the next section.

Evidence on the Aggregate Wage Phillips Curve. In this section, I use simple time series evidence to evaluate which measures of labor market tightness best predict nominal wage growth. Table 1 shows results from regressing the four-quarter percent growth in wages and salaries in private-sector industries measured by the employment cost index (ECI) on four measures of labor market slack: the unemployment gap, measured by the unemployment rate less the CBO estimate of the noncyclical rate of unemployment, the V/U ratio, the monthly job-to-job transition rate (denoted as the EE rate), and the monthly private quits rate. The measures of labor market slack are aggregated by averaging at the quarterly level, and then smoothed using a four quarter moving average.[13] The ECI is a desirable measure of wage growth because it controls for industry and occupation composition.[14] I use private quits data from JOLTS starting in 2001 and the extended quits series for private industries from Davis et al. (2012) for 1991–2000. For job openings prior to 2001, I use the Help-Wanted index from Barnichon (2010). The job-to-job transition rate from Fujita, Moscarini, and Postel-Vinay (2024) is available beginning in the first quarter of 1995.[15]

12 Moscarini and Postel-Vinay (2023) derive a job ladder model and find that the ratio of the job-to-job mobility over the rate of job finding from unemployment, which the authors call the “acceptance” ratio, predicts wage growth and inflation. Heise, Pearce, and Weber (2024) find that the quits rate outperforms the acceptance ratio in tracking nominal wage growth measured by the employment cost index.

13 Including measures of inflation expectations in the regression, such as the University of Michigan’s 1-year ahead expected inflation, or the four-quarter growth rate in the CPI lagged by one year, do not significantly change the results.

14 The employment cost index is not adjusted for composition in the sense that the composition of workers within an occupation and industry will change as labor market tightness changes. If during slack labor markets, firms can be more selective in the workers they hire, this means that worker quality in a particular occupation or industry will be countercyclical.

15 Figure A.1 in the appendix shows a time series for these labor market variables.

Table 1

Labor market variables and nominal wage growth, 1991–2019

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ECI	*ECI*	*ECI*	*ECI*	*ECI*	*ECI*	*ECI*
Unemployment Gap	−0.365*** (0.033)				0.060 (0.104)		
V/U Ratio		1.713*** (0.495)				−0.938*** (0.312)	
EE Transition Rate			2.808*** (0.240)				1.101*** (0.297)
Quits Rate				1.872*** (0.105)	2.140*** (0.509)	2.441*** (0.250)	1.285*** (0.174)
Observations	116	116	94	116	116	116	94

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Notes: This table reports a quarterly regression of four-quarter growth in the employment cost index (ECI) wages and salaries for private industries on various four-quarter moving averages labor market variables. The unemployment gap, V/U ratio, job-to-job transition rate (labeled "EE transition rate"), and quits rates are averaged at the quarterly level. The job-to-job transition rate is available beginning in the fourth quarter of 1995 and is regularly updated. Standard errors are Newey-West with a lag of 4.

Sources: Fujita et al. (2024); US Bureau of Labor Statistics via FRED; Barnichon (2010); Davis et al. (2012); Congressional Budget Office via FRED.

Columns (1–4) of table 1 report the coefficients separately for each measure of labor market tightness. Low unemployment, a high V/U ratio, a higher EE rate, and a high quits rate are all correlated with faster nominal wage growth. The regression coefficients are all in levels, so for example, the coefficient in column (1) can be interpreted as a one percentage point increase in the unemployment rate being associated with 0.365 percentage points lower wage growth. In column (4), a one percentage point increase in the monthly quits rate is associated with 1.87 percentage points higher wage growth. Column (5) shows that when including both quits and unemployment, the coefficient on the quits rate increases, and the coefficient on unemployment becomes statistically insignificant. Column (6) similarly shows that when including both the quits rate and the V/U ratio, the quits rate remains significant, while the V/U ratio takes on the wrong sign.[16] Column (7) shows that when including the job-to-job transition rate and the quits rate, both remain significant in the sample that ends in 2019.

16 In the on-the-job search model in Bloesch et al. (2024), we show that when including quits and other labor market variables in a wage Phillips curve regression, the model implies "wrong-signed" weights on variables like the job openings rate or unemployment rate when also including the quits rate as an independent variable. This is because the quits rate is a near-ideal proxy for labor market tightness that puts more weight on vacancies than unemployment, so the inclusion of additional variables may mean those additional variables get negative or opposite-signed weights.

Table 2
Labor market variables and nominal wage growth, 1991–2024Q2

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ECI	*ECI*	*ECI*	*ECI*	*ECI*	*ECI*	*ECI*
Unemployment Gap	–0.383*** (0.051)				0.074 (0.058)		
V/U Ratio		1.803*** (0.232)				0.338 (0.336)	
EE Transition Rate			2.556*** (0.415)				–0.220 (0.397)
Quits Rate				2.165*** (0.162)	2.432*** (0.274)	1.889*** (0.247)	2.283*** (0.267)
Observations	134	134	112	134	134	134	112

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Notes: This table reports a quarterly regression of four quarter growth in the employment cost index (ECI) on various four-quarter moving averages of labor market variables. The unemployment gap, V/U ratio, job-to-job transition rate (labeled "EE transition rate"), and quits rates are averaged at the quarterly level. The job-to-job transition rate is available beginning in the fourth quarter of 1995 and is regularly updated. Standard errors are Newey-West with a lag of 4.

Sources: Fujita et al. (2024); US Bureau of Labor Statistics via FRED; Barnichon (2010); Davis et al. (2012); Congressional Budget Office via FRED.

Table 2 reports the same regression results, except now including the data through the second quarter of 2024 to include the COVID period. The results are quite similar, except that now the quits rate outperforms the job-to-job transition rate. This is because the quits rate during COVID was elevated relative to historical levels, while the job-to-job transition rate was not.

Across multiple specifications in table 2, an increase in the quits rate of one percentage point is associated with two percentage points faster growth in nominal wages measured by the ECI for wages and salaries of workers in private sector industries. This slope should be considered steep: A typical business cycle sees the quits rate fluctuate by 0.5–1 percentage points, indicating a 1–2 percentage point change in nominal wage growth.[17]

2.2 Do Wages Pass Through to Prices?

In the previous section, I confirmed that nominal wage growth is higher when labor markets are tight, and that the quits rate is the best recent predictor of nominal wage growth. To understand how tight labor markets affect inflation, a natural step is to explore the evidence on how much firms raise prices when wages increase.

A recent literature on minimum wage increases provides a useful setting for understanding wage to price pass-through. Ashenfelter and Jurajda (2022) study the effects of minimum wages on the price of Big Macs at McDonald's. These authors find a cost-weighted pass-through of around 0.7: For every 10 percent

17 Using the log levels of labor market variables does not meaningfully change the results.

that wages are exogenously increased, prices would increase by 7 percent at a firm where its only cost was labor. Harasztosi and Lindner (2019) study a sudden and large minimum wage increase in Hungary. The authors find that consumers pay for the majority of the wage increase, and firms that are more intensively affected by the higher minimum wage raise their prices more. Their results are consistent with nearly one-to-one pass-through of wages to prices in proportion to labor's share of costs in production and support a simple model of constant markups over marginal cost. The authors find that pass-through of wages to prices is significantly dampened in firms that produce tradable goods and exported goods. This comports with the results from Heise et al. (2022), who show that the pass-through of wages to goods prices has fallen over time, as domestic producers are increasingly subject to competition from imports and have less power to pass through wage increase to prices.

Overall, the empirical evidence suggests that the pass-through of wage costs to prices is substantial. At the same time, an increase in the minimum wage is a different shock than, say, an expansionary monetary policy shock that raises both wages and aggregate demand generally. Can we use the minimum wage evidence to understand how wages pass through to prices in response to a change in monetary policy? If anything, one may expect that a monetary policy shock that achieves the same wage increase would lead to more price inflation, since consumer demand would rise and tighter labor markets would increase costly competition for workers, both of which would contribute to firms raising prices beyond the amount that would result from exogenous wage increases alone. There may be offsetting effects that tight labor markets provide workers better chances to move to more productive matches, alleviating inflationary pressures. In the next section, I will discuss these forces and review evidence on how labor market tightness affects price inflation.

2.3 Labor Market Tightness and Price Inflation

If labor market tightness affects wages, and if wages pass through at least partially into prices, then we should expect to see a correlation between our measure of labor market tightness (here the quits rate) and price inflation. Table 3 reports results from regressing various measures of nominal wage growth and price inflation on the quits rate from 1991 to 2019—thus, excluding the COVID period. Column (1) reports the same regression of growth in wages and salaries from the employment cost index for private sector industries on the quits rate as in table 1. Column (2) reports a similar regression but for the employment cost index total compensation as the dependent variable, showing a smaller coefficient on compensation than for wages. This is in large part because growth in the cost of health insurance benefits, which is included in compensation but not in wages and salaries, varies substantially over time but is largely noncyclical.

Columns (3)–(7) report similar regressions but using various measures of inflation as the dependent variable. Column (3) reports the coefficient of the CPI for personal care services on the quits rate. Of all components of inflation, the personal care services category is a component where we should expect the greatest pass-through of wages to prices, since personal care services are highly labor intensive and are not subject to large changes in trade, technological change, or intermediate input costs. Indeed, we find a similar effect of the quits

Table 3
Quits rate and nominal growth variables, 1991–2019

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ECI Wages Private	*ECI Compensation Private*	*CPI Personal Care*	*Core PCE*	*PCE Services*	*Core PCE Services less Housing*	*Market PCE Services less Housing*
Quits Rate	1.872*** (0.105)	1.544*** (0.263)	1.972*** (0.243)	0.314 (0.229)	0.761** (0.341)	0.350 (0.344)	0.300 (0.362)
R-squared	0.765	0.395	0.522	0.035	0.131	0.022	0.009
Observations	116	116	116	116	116	116	116

CPI = consumer price index; PCE = personal consumption expenditures

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Notes: This table reports the results for quarterly regressions of various measures of nominal wage growth and price inflation on the private quits rate. Quarterly price indices calculated as the value the end of the quarter to be consistent with the employment cost index (ECI). The nominal growth variables are four-quarter growth, and the independent variable is the 4-quarter moving average of the quits rate. The time period for every regression is 1991–2019.

Sources: US Bureau of Economic Analysis via FRED; US Bureau of Labor Statistics via FRED; Konczal (2024); Davis et al. (2012).

rate on price growth for CPI personal care services as for nominal wage growth. Column (4) reports the coefficient of the quits rate on the personal consumption expenditures chain-type price index excluding food and energy (core PCE), with a coefficient of 0.314, which is not statistically significant. Column (5) reports the coefficient of the quits rate on the inflation rate in all PCE services, which includes housing services, with a coefficient of 0.761, less than half the coefficient on wage growth. In Column (6), the dependent variable is core PCE services less housing. The coefficient on quits drops by more than half and is no longer statistically significant. Column (7) reports the coefficient for market-based PCE services less housing (but includes energy services), which excludes imputed prices, some of which are imputed directly from labor costs. The coefficient on the quits rate drops further and the R-squared drops to 0.009. As for magnitudes, the quits rate rose by 1.1 percentage points over the course of the recovery from the Great Recession; the results from these regressions imply that such a rise would be associated with faster annual wage growth by around 2 percentage points, higher PCE services inflation by under 1 percentage point, and a statistically insignificant higher core PCE services inflation less housing by a less than half a percentage point.

There are few takeaways from this table. First, using the quits rate on the right hand side of the Phillips curve does not undo the results that many researchers have found of a weak effect of labor market variables on overall price inflation in the post-Volcker era.[18] Second, the relationship between the labor

18 Hazell et al. (2022) show using state-level data that the Phillips curve using the unemployment rate was flat, even during the Volcker period. Recent work by Rubbo (2023) shows that in a New Keynesian model that takes into account nominal rigidities and the input-output structure of production, the slope of the Phillips curve is an order of magnitude lower than in a single sector economy.

market and price inflation varies significantly across sectors, and a large portion of the positive correlation between labor market variables and services inflation in this time period is in housing (Stock and Watson 2020, Amarnath and Williams 2022). This strong correlation between housing rents and the labor market may be partially explained by procyclical household formation: When nonemployed workers find jobs, they are more likely to form a new household (Kaplan 2012, Rios-Rull et al. 2016). Given the weight that housing has in inflation indices, it may be relevant to track aggregate labor income growth—which combines wage growth and employment growth—when predicting inflation in sectors where supply is inelastic, such as housing.[19] Third, even when including housing in column (5), variation in the quits rate can account for less than one seventh of the variation in price inflation, and it has an R-squared of 0.13. This suggests that at high frequencies, there are various shocks or pricing idiosyncrasies that drive price inflation that are unrelated to labor market tightness.

2.4 Tight Labor Markets and Labor Productivity

A major confounder for a simplistic pass-through of tight labor markets to wages to prices is that labor productivity may be procyclical. If high productivity accompanies strong labor demand, then workers can earn higher wages without firms charging higher prices, as the per-unit cost of production would not rise as fast as wages. Here I will discuss three ways that tight labor markets may induce increases in labor productivity: procyclical match quality, endogenous productivity effects from demand, and procyclical investment in labor-saving technologies.

The first way that tight labor markets will encourage productivity gains is by giving workers greater opportunities to quit into more productive jobs and higher-quality matches. Barlevy (2002) argues that strong labor markets create more opportunities to quit into more productive jobs. Moscarini and Postel-Vinay (2023) argue these kinds of gains are concentrated early in a labor market recovery, as workers make up for lost transitions during recessions when labor market churn is low. A second mechanism by which tight labor markets increase productivity is outlined in Michaillat and Saez (2015): Workers that provide services are frequently idle at work due to low demand. When demand increases, workers spend a higher fraction of their time producing services, endogenously increasing output per hour.

The above two mechanisms provide one-time increases or level shifts of productivity as the labor market tightens. As is the case in Moscarini and Postel-Vinay (2023), late in a recovery when the economy has returned to full employment and workers have had ample opportunity to find better matches, the productivity-enhancing forces of tight labor markets exhaust themselves. In order for the high wage growth in tight labor markets to not contribute to employment costs and inflation, tight labor markets must affect the growth *rate* of productivity.

19 Boehm and Pandalai-Nayar (2022) find evidence for convex supply curves across a wide range of industries. This means that the marginal cost of production is increasing, so increases in demand will push industries up their supply curve, so prices will increase as demand rises.

This leads to the third mechanism: that firms invest more in labor saving technologies when labor markets are tight (Habakkuk 1962), which could generate pro-cyclical growth in productivity. Examples of recent work that show that firms invest more in labor-saving technologies when labor is scarce include Ilzetzki (2023), San (2023), and Mann and Pozzoli (2022). Mui (2024) argues that productivity growth is correlated with prime-age employment rates in the US since 1986. While these studies are encouraging that tight labor markets improve the pace of productivity gains, it is difficult to quantify the magnitude of these effects. It also stretches the imagination to believe that productivity growth consistently responds one-for-one with wage growth as labor markets tighten. Therefore, increases in productivity gains can help mitigate the pass through of wage costs to prices, but productivity gains are unlikely to completely offset the inflationary impact of tight labor markets.

2.5 Putting the Pieces Together: Tightness, Wages, and Inflation

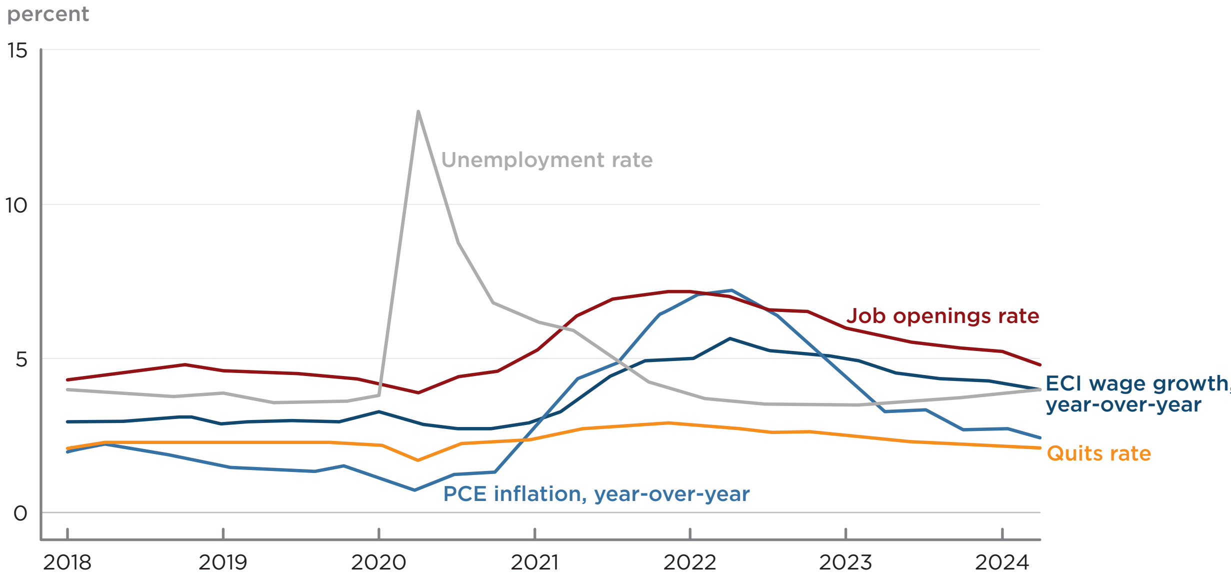
The most common story for how labor market tightness affects inflation is by tight labor markets increasing wage growth, which is a cost to firms that is passed through to prices for consumers. I summarized evidence that labor market tightness increases nominal wages and evidence that increases in minimum wages induce nearly one-for-one increases in prices (after scaling for the wage share of costs). The pace of aggregate labor income growth may also matter for inflation in sectors where supply is inelastic, such as housing. However, various factors complicate the price Phillips curve, including non-labor market shocks that affect inflation and labor productivity growth that may rise with labor market tightness. In all, greater labor market tightness clearly increases wage growth, and while much of this wage growth is passed on into prices, the majority of variation in inflation is not well explained by the state of the labor market.

3 INTERPRETING THE LABOR MARKET DURING COVID

The COVID shock was anything but a regular business cycle: Workers were intentionally sent home to prevent the spread of disease, household wealth levels grew as fiscal stimulus buoyed income, and millions of workers converted to remote work. Demand for goods surged and demand for in-person services fell. As vaccines were rolled out and health risks abated, consumers returned with a vengeance, and demand for labor greatly outstripped supply. Due to a combination of continued health risks and strong household balance sheets, workers were slow to return to the labor force, and immigration had fallen significantly below trend, lowering supply in the labor market.

Figure 2 shows the path of unemployment, the job openings rate, the quits rate, year-over-year growth in the employment cost index private wage and salaries, and year-over-year growth in the PCE chain-type price index. Unemployment spiked in the spring of 2020, as workers were sent home and fell relatively quickly as business and households adjusted, leveling out around 6 percent by early 2021. The unemployment rate began falling again in the spring of 2021 as vaccines were deployed. In late 2020, as demand was returning, job openings and quits began to surge, peaking in late 2021 and early 2022. Wage

Figure 2
Labor market variables and inflation experienced large swings during COVID



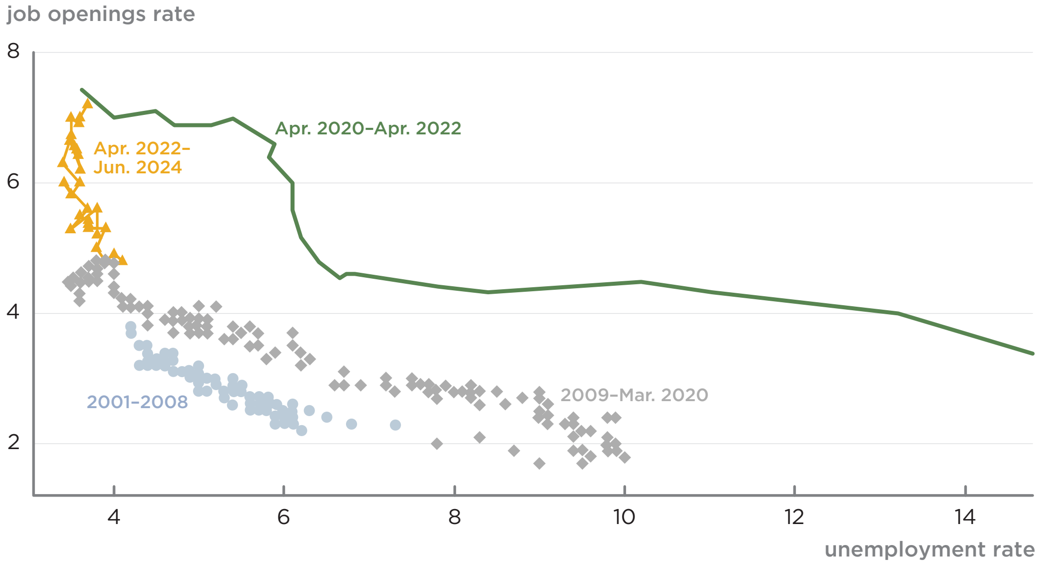
ECI = employment cost index; PCE = personal consumption expenditures
Notes: The job openings rate and quits rate are for nonfarm industries, as opposed to the private quits rate that was used in the previous regressions.
Sources: US Bureau of Economic Analysis via FRED; US Bureau of Labor Statistics via FRED.

growth and inflation followed, rising dramatically and peaking in early to mid-2022. Wage growth has since fallen below a 4 percent annualized rate, and PCE inflation is approaching 2 percent.

The unusual patterns in the labor market in the years following COVID led to numerous questions about whether COVID would persistently alter the dynamics of the labor market. Would the workers that dropped out of the labor force ever come back? Do the skills of available workers no longer match the skills that firms need, leaving greater mismatch in the labor market? Has the natural rate of unemployment risen, meaning that we should expect greater unemployment than prior to COVID? To bring inflation down, does the unemployment rate need to be above its pre-COVID levels?

In this section, I will explore these questions by discussing various features of the labor market during COVID. I will start by discussing the evolution of the Beveridge curve, which is the relationship between job openings and the unemployment rate. I will argue that the shift out in the Beveridge curve (i.e., a high rate of job openings coinciding with a high unemployment rate) during the COVID recovery reflected a mix of temporary labor market mismatch and a continuation of the long-term trends in the measurement of job openings. With labor market mismatch largely fading, I will argue that the natural rate of unemployment likely has not risen, and so the unemployment rate can remain near 4 percent, just above its level prior to COVID, while inflation subsides. Second, I will discuss the decline and recovery of labor supply, as both labor force participation and immigration have recovered. Third, I will discuss various nonlinearities and interactions between supply shocks and the labor market that may have amplified inflation during the COVID recovery.

Figure 3
The Beveridge curve shifted out during COVID, but is shifting back inward



Notes: This figure plots the unemployment rate and the job openings rate from 2001–2008, 2009–March 2020, April 2020–April 2022, and April 2022–June 2024. This relationship between job openings and the unemployment rate is called the Beveridge curve. The Beveridge curve shifted out during COVID, as both job openings and unemployment were elevated. Since April 2022, the rate of job openings has dramatically declined, while the unemployment rate has only slightly risen.
Source: US Bureau of Labor Statistics via FRED.

3.1 Mismatch and the Beveridge Curve

As shown in figure 2, job openings surged in early 2021 while unemployment was still elevated. The relationship between job openings and unemployment can be plotted in another format, commonly known as the Beveridge curve. The Beveridge curve can be helpful for understanding when the labor market is tight or loose, as well as if the economy is efficiently matching workers to vacant jobs. When the labor market tightens, vacancies rise and the unemployment rate falls. When the labor market loosens, vacancies fall and unemployment rises. Holding the degree to which workers are efficiently matched with jobs constant, changes in labor market tightness would be represented by a movement along the Beveridge curve. Changes in matching efficiency, however, are captured by shifts in the Beveridge curve toward or away from the origin. If vacancies and unemployment are simultaneously high, this suggests that the economy is matching workers to jobs less efficiently, which would be reflected by a shift out (i.e., up and to the right) in the Beveridge curve. If job openings and unemployment are lower, this indicates high matching efficiency.

As can be seen in figure 3, there was an enormous shift up and to the right in the Beveridge curve during COVID: Both job openings and the unemployment rate were elevated. This can be seen by the green squares, representing the path of unemployment and job openings from April 2020 to April 2022. In April 2020, unemployment jumped and firms laid off many workers. For the next two years, unemployment fell as job openings rose, and the economy moved to the top-left portion of the figure. Since April 2022, job openings have fallen with only a small increase in unemployment, as shown by the yellow triangles. These large shifts in the Beveridge curve in part indicate that matching efficiency deteriorated, and then recovered, over the course of the COVID pandemic and recovery.

Changes in matching efficiency has implications both for the productive capacity of the economy and for inflation. Focusing first on productivity capacity, low matching efficiency implies that the economy can produce less and should have higher unemployment. Michaillat and Saez (2022) formalize this idea by arguing that there is level of unemployment that maximizes output, and that a level of unemployment that is higher or lower would decrease output. Because hiring workers takes real resources, such as the time of incumbent workers who screen and train new employees, there exists an optimal balance of time between production and hiring new workers. The authors argue that the unemployment rate that maximizes output is the square root of the unemployment rate multiplied by the job openings rate: $u^* = \sqrt{uv}$. Lower matching efficiency would raise the output-maximizing unemployment rate and decrease total output. If we observe that the unemployment rate and the job openings rate are high, as was the case from April 2020 through April 2022, this is an indicator that the output-maximizing level of unemployment has risen.

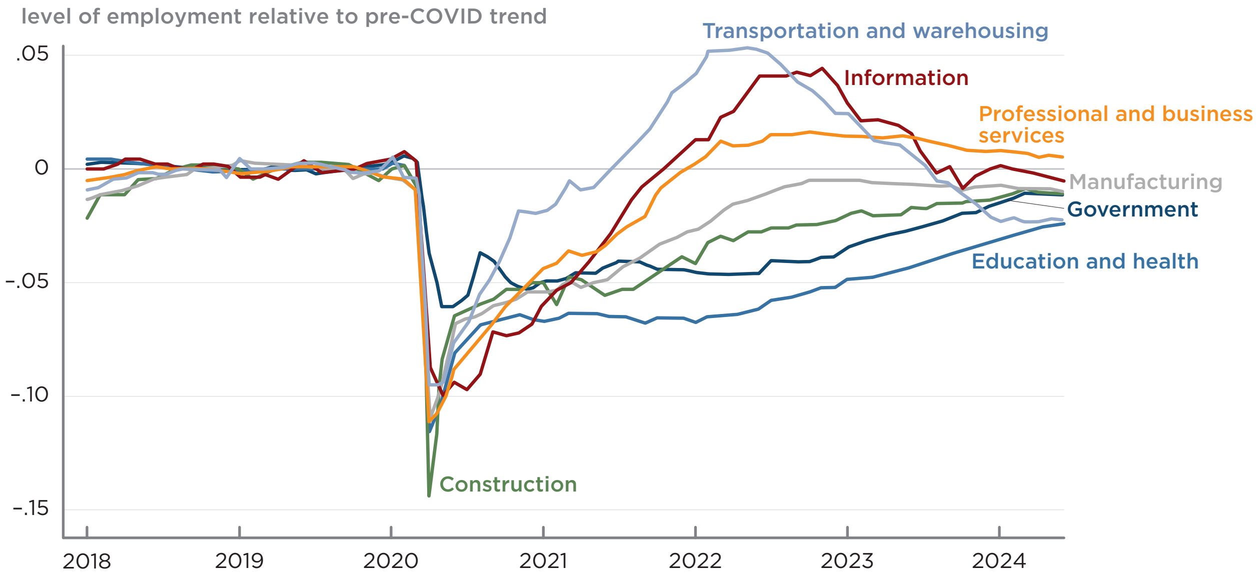
Just as a high job openings rate coinciding with a high unemployment rate means that the output-maximizing rate of unemployment has risen, the coexistence of a high job openings rate with a high unemployment rate also means that the *natural* rate of unemployment has risen, meaning that inflation is stabilized at a higher unemployment rate than before. Blanchard et al. (2022) made this case in April 2022, arguing that the Federal Reserve's optimistic forecasts about falling inflation without higher unemployment were misguided. Ball et al. (2022) similarly argued that unemployment would likely need to rise more than the Federal Reserve was forecasting to bring inflation down.

However, the patterns of job openings and unemployment since April 2022 imply a reversal of the outward shift of the Beveridge curve. The number of job openings has declined sharply from over 12 million in March 2022, to under 7.5 million by September 2024, and at the same time, the unemployment rate has risen only very modestly—from a low of 3.4 percent in April 2023 to only 4.1 percent in September 2024. Interpreted through the lens of the Beveridge curve, this is a shift inward, suggesting that the lowest sustainable unemployment rate has shifted back down.

How should we interpret these dramatic Beveridge curve developments in retrospect? I argue that three factors explain the rise and fall of job openings: (i) the rapid recovery led to a temporary period of high demand when most firms were trying to rehire all at once; (ii) there was significant, temporary mismatch in the labor market due to composition shifts in demand and shifts in supply across industries due to health risks; and (iii) there is a continued upward trend in the job openings series that began prior to COVID.

First and foremost, the rise in jobs openings reflected the rapid reopening, especially as vaccines became available and many households resumed regular spending habits. Additionally, large fiscal stimulus buoyed household balance sheets, enabling households to spend even as their labor market earnings had not fully recovered. A large portion of the rise in vacancies was simply that demand for labor was suddenly very high.

Figure 4
Industry employment converging to pre-COVID trends suggests fading mismatch



Notes: This figure shows the level of employment by industry relative to trend, where the industry-specific trends are computed from July 2018–December 2019. Leisure and hospitality, which experienced a dramatic drop in employment in 2020, was excluded to preserve the y-axis.
Source: Author's calculations based on data from the US Bureau of Labor Statistics via FRED.

The second factor driving the rise in job openings was temporary mismatch, and consequently lower matching efficiency, in the labor market. Figure 4 shows employment in most major industries (excluding leisure and hospitality)[20] from 2018–2024 relative to its pre-COVID trend.[21] If workers' skills are most closely related to the industries that they previously worked in, then dispersion of employment levels across industries relative to industry trends is an indicator of potential labor market mismatch. With the shift to goods spending and greater share of time spent online, employment in transportation and warehousing, information, and professional and business services surged. In-person services like leisure and hospitality and education and health services—as well as government—struggled to rehire, as workers either avoided in-person jobs or found work in higher paying sectors. The dispersion of industry employment levels relative to trend reached its peak in early 2022, just when the number of job openings peaked. Since then, sectors that were relatively underemployed like government, education and health, and leisure and hospitality have grown quickly, accounting for most of employment growth. Meanwhile, industries that saw the fastest employment growth out of COVID, such as transportation and warehousing, information, and professional and business services, have seen the

20 Employment in leisure and hospitality fell by nearly 50 percent between February and April 2020, but recovered to pre-COVID levels in April 2024.

21 The choice of time for the pre-COVID period can have significant effects on this figure 4. I choose a narrow window between July 2018 and December 2019, as the cyclical recoveries in construction and manufacturing from the Great Recession appeared to have slowed down in the second half of 2018. Most other large employment sectors are roughly on their long-term trend in their share of total employment during this time period.

slowest employment growth and in some cases outright employment declines.[22] By the middle of 2024, the employment level in all major industries converged back toward pre-COVID trend levels, suggesting that demand for labor across sectors has returned roughly to its pre-COVID growth trajectories. There is therefore little reason to think that labor market mismatch is much higher now than it was prior to COVID when the unemployment rate was below 4 percent.[23]

Lastly, the high vacancy rate following the COVID period reflects a continuation of the pre-COVID trend in vacancies described in figure 1. Figure 3 shows that the Beveridge curve has mostly returned to its pre-COVID position, but it has not fully returned: As of June 2024, the job openings rate is slightly higher than it was prior to COVID, and the unemployment rate is higher as well. Even if the increase in labor market mismatch has completely reversed, a continued upward trend in measured vacancies would leave the vacancy rate elevated relative to pre-COVID levels. Therefore, policymakers should exercise caution before interpreting a persistent outward shift in the Beveridge curve as a permanent drop in matching efficiency accompanied by a permanent rise in the natural rate of unemployment.[24] Instead, the continued elevated level of job openings likely reflects ongoing trends in how firms report job openings.

Did the Great Resignation Lead to the Rise in Vacancies? One explanation for the increase in job openings is that the pandemic may have inspired workers to reconsider their work and life situations and change jobs, creating a high number of job openings for firms to fill. As this “Great Resignation” subsides, job openings might naturally come down.

Upon inspection, this story does not stand up to scrutiny. When workers quit into another job, that may create a new vacancy for the job the worker who just left, but the worker taking a new job will lead to the filling of another vacancy. The measured number of quits should rise, but the number of job openings should remain unchanged, lowering the ratio of job openings to quits. However, during the labor market recovery following COVID, we saw the opposite: The ratio of job openings to quits surged. A more plausible story tells the causality in the opposite direction: Many firms had laid off workers, and these firms all wanted to simultaneously rehire many workers. Because firms post vacancies to accelerate hiring, this created an abundance of outside options for workers, enabling a greater share of workers to switch to more desirable jobs. Rather than a desire to change jobs leading to more vacancies, a more straightforward story is that the increase in vacancies allowed more workers to change jobs.

There is one compelling alternative story presented by Qiu (2022), who argues that when workers leave the labor force, this creates a vacancy on net because the worker did not accept another job. Qiu (2022) shows that the only other periods in American history where this occurred was during World Wars I and II, and the magnitude of workers leaving the labor force during COVID

22 Employment in levels fell below its post-COVID peak in transportation and warehousing and information.

23 Pizzinelli and Shibata (2023) also find that labor market mismatch was temporary.

24 Crump et al. (2022) take the opposite view, arguing that the natural rate of unemployment was still elevated by the end of 2023 at 6.5 percent, and the disinflation occurred due to supply shocks easing and because agents expected the unemployment rate to increase.

can account for a large fraction of the increase in job openings. Therefore, the decrease in labor force participation may have contributed to the rise in job openings. However, as I will show in the next section, labor force participation has been returning to pre-COVID levels, so this factor raising the job openings rate has been receding.

3.2 Labor Supply

One prominent feature of the early COVID recovery was that the supply of labor was substantially below pre-COVID levels. A combination of a desire to avoid health risks for workers and other members of their households, greater illness and mortality, generous fiscal support, and a near-total shutdown of immigration meant that the total number of individuals looking for work was substantially below pre-COVID levels.

It is not immediately obvious how a decrease in labor supply should affect wage growth and inflation. If individuals are choosing not to work, or if immigration declines, then there is less income being earned, and subsequently there should be less demand for goods and services, leading to lower demand for labor. For lower immigration and increased health risk, it is not obvious how the mix of both lower supply and demand net out. However, the balance of labor supply and demand effects from increased fiscal support are clearer: Greater income support and more generous unemployment insurance enabled workers to stay out of employment for longer, while sustaining demand for goods and services. Indeed, preventing a shortfall in demand while enabling people to avoid risky workplaces was the intention of many of the fiscal measures during COVID.

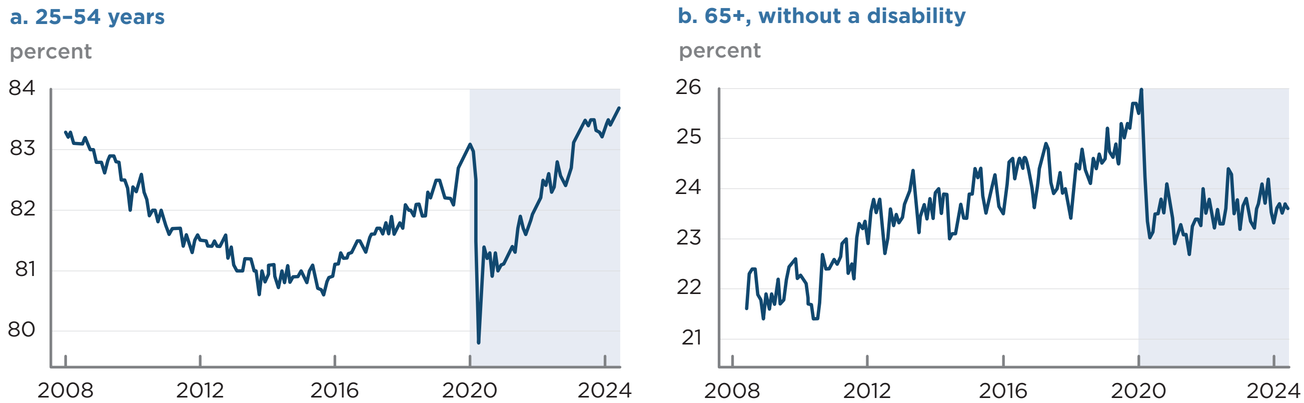
Many of the factors depressing labor supply have passed, as health risks are substantially mitigated and fiscal support has ended. Consequently, labor force participation has mostly recovered. As figure 5a shows, the labor force participation rate for individuals aged 25–54 has recovered and surpassed the pre-COVID level. Labor force participation has recovered to or surpassed its pre-COVID level for workers aged 16–24 and 55–64 as well. The only age group that has not seen a complete recovery of labor force participation is individuals above age 65: Figure 5b shows that the labor force participation rate for individuals 65 and over without a disability has not recovered since its drop in 2020.[25] However, individuals age 65 or over are less than 7 percent of the labor force, so an incomplete recovery of participation by this group has a small impact relative to the recovery in all other age groups.

As for immigration, recent evidence suggests that the rate of immigration not only recovered to its pre-COVID pace but surged in 2022 and 2023, with current estimates finding that 6 million people arrived within those two years (Topoleski 2023; Edelberg and Watson 2024). A rise in immigration would increase labor supply more than demand, and subsequently decrease labor market tightness, if immigrants have higher savings rates than native-born households or are more likely to be of working age. Duzhak (2023) argues that the fall in immigration contributed to higher vacancy to unemployment ratios during COVID, and Duzhak (2024) argues that the subsequent surge in

25 The labor force participation rate for individuals aged 65 and over with a disability is generally quite low, around 8 percent, and has recovered to its pre-COVID trend.

Figure 5

The labor force participation rate has recovered for individuals aged 25–54, but not for individuals aged 65+



Notes: This figure shows the labor force participation rate in percent for people aged 25–54 and 65+ from 2008 to June 2024. The labor force participation rate for people aged 25–54, often called "prime age," has recovered and exceeded its pre-COVID peak. However, the labor force participation rate for people over 65 has not recovered. While not shown in this figure, the labor force participation rate has also recovered for individuals aged 16–24.

Source: US Bureau of Labor Statistics via FRED.

immigration later lowered vacancy to unemployment ratios again. While this early evidence points to the decline and subsequent rebound of immigration impacting labor market tightness in the COVID and post-COVID era, further research is needed to fully evaluate how changes in the pace of immigration affect the labor market and inflation.

In total, even if depressed labor supply was contributing to inflation, the drop in labor supply has reversed, suggesting that any effects of changes in labor supply on inflation have faded.

3.3 Demand Shifts, Nonlinear Phillips Curve, and Supply Shocks Interactions

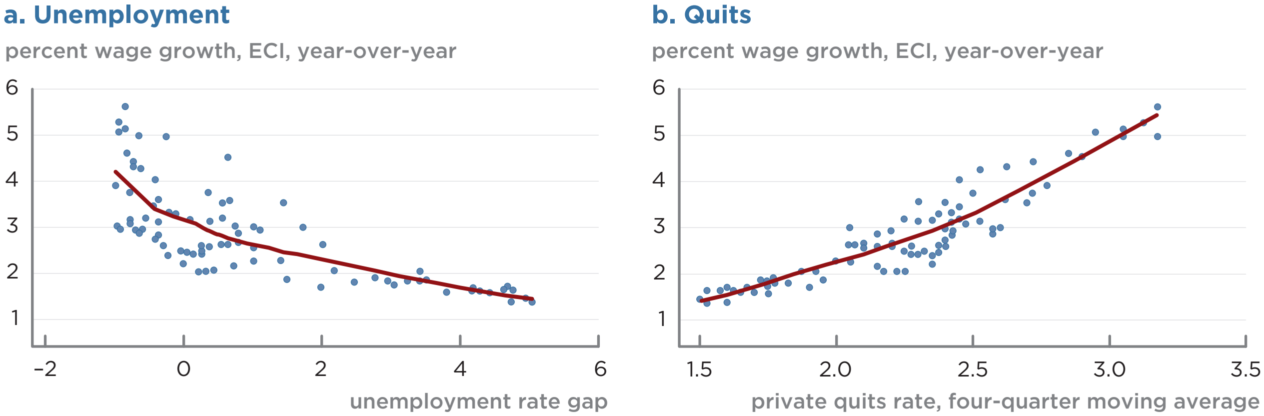
So far, I have only considered linear relationships between labor market variables and wage growth or price inflation. Given the extraordinary increase in both wage growth and inflation during the COVID pandemic and recovery, it is worth considering how nonlinear forces may arise, as well as potential interactions between the labor market and the various supply shocks that were ongoing during the same period.

One of the first interactions studied in the labor market during COVID was the interaction between downward nominal rigidity and sectoral demand shifts by Guerrieri et al. (2021).[26] The authors argue that if the composition of demand shifts across industries and if wages are sticky downwards, then sectors with increasing demand will have high wage growth, but sectors with falling demand will not. They argue that strong demand can help facilitate the reallocation of labor across sectors, but the strong demand would increase inflation as well.

While the sectoral story fit the data well in 2021, by 2022 nominal wages were growing rapidly across all sectors of the labor market, and price inflation

26 Stiglitz and Regmi (2023) discuss additional consequences of shifts in the composition of demand.

Figure 6
Nonlinearities in the wage Phillips curve, 1991–2024



Notes: This figure shows the nonlinear relationship between nominal wage growth, measured by the four-quarter growth of the employment cost index (ECI) wages and salaries for private industries, and two labor market series: in panel (a) the unemployment rate gap, measured as the difference between the unemployment rate and the Congressional Budget Office's estimate of the noncyclical unemployment rate, and in panel (b) the four-quarter moving average of the quits rate for private industries. Lines are fitted using a lowess smoother with bin width of 2. Both figures exclude the year 2020.
Sources: Bureau of Labor Statistics via FRED; Congressional Budget Office via FRED; Davis et al. (2012).

became more broadly based. Labor markets were tight enough and wage growth was high enough that downward nominal wage rigidity was not binding. This observation leads Benigno and Eggertsson (2024) to argue that the Phillips curve is nonlinear: When the labor market is slack, the Phillips curve is flat, as firms are reluctant to cut wages, and prices do not fall because firms' wage costs are not falling either. However, when demand is high and downward nominal rigidity no longer binds, both wage growth and inflation increase rapidly as the labor market tightens. This analysis accords with the view of Gagnon and Collins (2019), who argued prior to COVID that the Phillips curve is nonlinear. Importantly, the Phillips curve may have appeared flat prior to COVID because the economy was below potential—it was only during COVID that the economy was ran up against potential, and we were able to discover the point at which the Phillips curve became steep.

Figure 6 shows evidence of nonlinearities in the wage Phillips curve. Panel (a) of figure 6 plots the relationship between four-quarter growth of the employment cost index wages and salaries for private industries and the unemployment gap, measured as the difference between the unemployment rate and the CBO estimate of the noncyclical rate of unemployment. This figure shows that the relationship between nominal wage growth and the unemployment gap is highly nonlinear: When unemployment is high, the slope of the wage Phillips curve flattens, so small changes in the unemployment rate have smaller effects on the pace of wage growth.[27] In contrast, when unemployment is low, small changes in the unemployment rate are associated with large increases in nominal wage growth. This is consistent with a natural lower limit on the unemployment rate: Even if labor demand is very high, the unemployment rate cannot be

27 The figure with unemployment excludes 2020.

negative, and so increases in labor demand result in higher wage growth without further declines in the unemployment rate. Figure 6(b) plots the relationship between wage growth and the quits rate. This relationship is much closer to linear, but the slope is less steep when the quits rate is low, suggesting that downward nominal rigidity is preventing some firms from lowering wages when the labor market is slack.

While nonlinearities in the wage Phillips curve mean that nominal wage growth will rise rapidly if the labor market tightens beyond full employment, it also means that wage growth and inflation can come down without large increases in unemployment. Relatedly, Figura and Waller (2022) argue that Beveridge curve is also nonlinear: When unemployment is low, further increases in labor demand are mostly reflected in higher job openings, rather than lower unemployment. These two nonlinearities are connected: In a slack labor market, higher labor demand increases employment—thereby lowering unemployment—but has modest effects on wages. Once the pool of unemployed workers dries up, further increases in demand are reflected in job openings and quits, raising interfirm competition for already-employed workers and driving up nominal wage growth.[28] Thus, there is nonlinearity in both the wage Phillips curve and the Beveridge curve, where both curves become steeper when the labor market is tight. In periods such as the last few years when demand for labor starts very high, falling labor demand is reflected in declining job openings, quits, and wage growth, with only modest effects on the unemployment rate. The nonlinear wage Phillips and Beveridge curves therefore provide a good explanation for how the United States has achieved deceleration in wage growth without a large increase in unemployment.

While I argue that there is some nonlinearity in the relationship between wage growth and labor market variables (and clear nonlinearity between unemployment and wage growth), it would be a mistake to estimate nonlinearities in the *price* Phillips curve using data during the COVID pandemic and recovery. This is because the COVID period contained coinciding tight labor markets and large negative supply shocks. Therefore, exercises such as in Ball et al. (2022) that fit a nonlinear Phillips curve of price inflation on the V/U ratio, while including the COVID years in the sample, will overstate the slope of the Phillips curve on the steep portion of the curve.

Lastly, there is evidence that the interaction between supply shocks and tight labor markets amplified inflation during the COVID period. Benigno and Eggertsson (2024) argue that tight labor markets amplify the effects of inflationary supply shocks, and Amiti et al. (2023) show that when supply shocks disrupt importing goods from foreign firms, demand for the goods of domestic producers increases. This increases demand for domestic workers, and since domestic firms are less subject to international competition, these firms are more able to pass on higher wages into prices. Together, these papers suggest that a

28 The choice of labor market variable matters greatly when considering nonlinearities. For example, the job openings rate and the unemployment rate have a very nonlinear relationship, as do the quits rate and unemployment rate. This means that the relationship between wage growth and quits will be much more linear than the relationship between wage growth and unemployment. Further, in extremely tight labor markets, when wage growth is very high, there is a natural lower bound to the unemployment rate, making the slope of wage growth very steep with respect to small changes in unemployment.

tight labor market and negative supply shocks amplified each other's effect on inflation. With supply chains normalizing, falling labor market tightness pushing the economy away from the steep parts of the wage Phillips curve and Beveridge curve, and with the composition shifts in demand and supply shocks receding, the forces that fed inflation during the early COVID recovery continue to ease.

3.4 The Labor Market During COVID: A Summary

The labor market simultaneously experienced numerous shocks during the COVID shock and the recovery: shifts in the composition of demand, supply chain disruptions, increased risk and incidence of illness, generous fiscal support, and a drop of immigration. These shocks occurred in a labor market where the underlying wage Phillips and Beveridge curves are nonlinear, and high demand for labor pushed the economy onto the steep part of both of these curves. In total, the combination of these shocks and the underlying nonlinearity pushed job openings, quits, wage growth, and inflation to levels far outside the range of normal over the last 40 years. However, every one of the shocks listed has at least partially abated, and the labor market has gradually returned to patterns similar to the labor market prior to COVID without a large increase in unemployment.[29]

4 WAS THE UNITED STATES AT RISK OF A WAGE-PRICE SPIRAL?

A great deal of commentary during the last few years has compared the current inflationary experience with experience of the United States in the 1970s: Was inflation becoming entrenched, and was the United States entering a wage-price spiral? Might the future hold a wage-price spiral? Either by anticipation of future inflation or in response to realized inflation, high inflation could influence the prices specified in nominal contracts—including wages—raising firms' costs and household incomes and making inflation more persistent. In such a scenario, central banks may conclude that they must depress the economy significantly below potential to break the cycle, generating a sustained period of high unemployment. However, I will argue here that the United States did not exhibit wage-price spiral dynamics: Nominal wages were increasing due to high labor demand, and prices were increasing due to supply shocks and greater pricing power by firms. But there is little evidence that wages were themselves responding to the high prices.

I define a wage-price spiral here as a cycle where wage increases pass through into higher prices, and prices pass through back into wages, regardless of how tight the labor market is. In the previous sections, I established that wages largely pass through into prices. However, for this kind of wage-price spiral to develop, it must also be the case that wages respond to prices. In Bloesch, Lee, and Weber (2024), we explore this question of how wages respond to shocks to the cost of living. The thought experiment is to ask how wages respond

29 In this paper, I have not addressed the increase in working from home, which increased sharply during COVID. Working from home has important implications for the distribution of jobs across space, pay differences across occupations that can provide this amenity, and possible effects on labor supply for women and people with disabilities. Greater demand for work from home policies may have increased labor market mismatch, but this mismatch is likely receding with time as workers and firms adapt to the option of remote work.

to a shock that affect workers' cost of living but does not have a direct effect on workers' productivity: For example, how firms would change their wage policies in response to the increase in food prices due to the war in Ukraine.[30] Matching a range of microeconomic evidence on how wages are determined in the United States, we derive a New Keynesian model where firms set wages, and firms choose wages to avoid their workers being poached by other firms. Because a higher cost of living lowers real wages at all jobs proportionately, higher cost of living does not improve workers' outside options relative to their current job. If workers' outside options are not improved, then they are no more likely to quit their jobs, and so firms have no incentive to raise wages. In the end, a cost-of-living shock lowers real wages, but otherwise the labor market is unaffected. Real wages are restored when the shock that raised the cost of living recedes.[31] Consistent with this theory, Bernanke and Blanchard (2023) and Bernanke and Blanchard (2024) estimate that there was no "catch-up" of wages in response to higher prices in the United States.

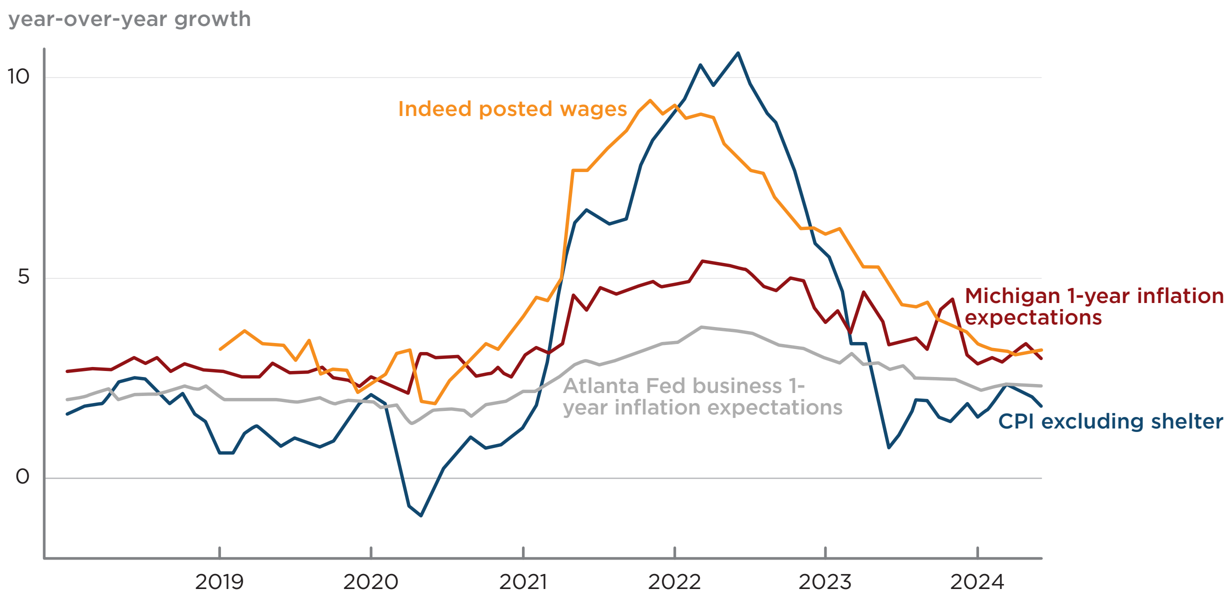
This view that nominal wages are unresponsive to cost of living shocks informs the interpretation of high nominal wage growth during the COVID recovery. Interpreted through the lens of a model where wages do not respond to prices, the rise in nominal wage growth during COVID is exclusively the result of tight labor markets, while overall inflation is driven both by rising nominal wages and supply shocks. For policymakers, this means that if the labor market variables such as the quits rate are stabilized to pre-COVID levels, then nominal wage growth will return to return to pre-COVID levels as well. If wages pass through to prices, and as long as negative supply shocks do not continuously get worse, then inflation will return to normal when the labor market and wage growth are stabilized.

Figure 7 shows suggestive evidence that the rise in wage growth during COVID was not a response to price inflation. The figure plots year-over-year growth in posted wages from the Indeed Wage Tracker, year-over-year growth of the consumer price index excluding shelter (to exclude a category known for built-in lags), 1-year ahead inflation expectations from the University of Michigan survey, and the mean 1-year ahead inflation expectations from the Federal Reserve Bank of Atlanta's Business Inflation Expectations. I focus on posted wages here because (i) posted wage growth leads actual wage growth; and (ii) posted wages will reflect the current level competition for workers that firms perceive, unaffected by longer-term wage contracts that firms decided on months or years ago. Figure 7 shows that the rise and fall of year-over-year growth in posted wages preceded or coincided with realized inflation and measures of households' and business' expectations of inflation. Posted wage growth peaks and begins reversing by the end of 2021, while realized and expected inflation peak in the spring of 2022. If wages were responding to inflation or expectations, we should have expected to see a revival in posted

30 Cost-of-living shocks are not representative of supply shocks, but they are helpful for isolating the mechanism of wage responses to inflation.

31 Both Lorenzoni and Werning (2023) and Weber and Wasner (2023) present scenarios where workers have influence over wage setting and demand higher wages in response to elevated inflation. Both of these papers argue for a more benign form of wage-price dynamics: a supply shock occurs that raises prices, wages respond, but the feedback between wages and prices eventually fades.

Figure 7
Posted wage growth precedes or coincides with realized and expected inflation



Notes: The figure shows the year-over-year growth in median posted wages from the Indeed Wage Tracker, the consumer price index (CPI) excluding shelter, the University of Michigan 1-year median inflation expectations, and the Federal Reserve Bank of Atlanta's business 1-year mean inflation expectations.
Sources: Federal Reserve Bank of Atlanta Business Inflation Expectations Survey; Indeed Hiring Lab; Surveys of Consumers, University of Michigan via FRED; US Bureau of Labor Statistics via FRED.

wage growth after the Russian invasion of Ukraine in February 2022. Instead, posted wage growth continued a steady path down as the labor market became less tight. The timing of the rise and fall of posted wage growth suggest that the surge in wage growth in 2021 and 2022 reflected changes in the labor demand relative to supply, not responses to realized or expected inflation. Accordingly, posted wage growth from Indeed peaked in November 2021, almost the exact same time that Indeed's index of the number of job postings peaked in December 2021, consistent with the theory that high wage growth reflected high demand.

The are some caveats in order. If the economy continued to be in a higher inflation environment, it is plausible that new norms would develop where firms are expected to provide raises that are roughly in line with inflation each year. The longer that inflation persists, the more that cost of living adjustments may also be bargained for in collective bargaining contracts.[32] Therefore, if the US economy maintained a tight labor market and very high inflation for an extended period of time, wages may begin responding to inflation directly, and the relationship between wage growth labor market variables such as quits would change.

32 For example, the United Auto Workers won a reinstatement of collective bargaining contracts through their strike in 2023 that was lost following the Great Recession.

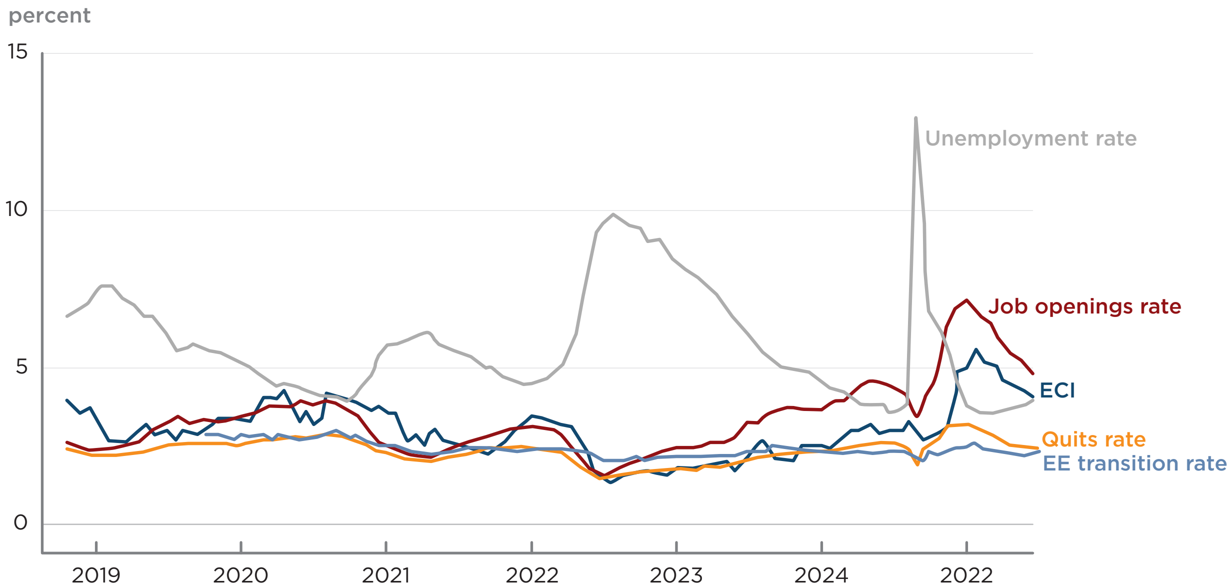
5 CONCLUSION

In this paper, I assess the relationship between labor market tightness and explore how the labor evolved during the COVID pandemic and recovery. I argue that the quits rate is the best indicator of labor market tightness and predictor of nominal wage growth. Microeconomic evidence suggests that wages pass through into prices, but the transmission of labor market tightness to price inflation is complicated by procyclical growth in labor productivity and shocks that affect price inflation but are not related to the labor market. I argue that the shift in the Beveridge curve during COVID reflects a combination of temporary high labor demand relative to supply, temporary mismatch, and a long-term trend in the JOLTS job openings series. The labor market has continued on a gradual path towards normalization, and the United States was at little risk of entering a wage-price spiral.

Going forward, questions remain about how the shift to remote work, the green transition, and artificial intelligence will affect the labor market. However, what remains consistent over time is that workers in the United States frequently change jobs, and firms will use compensation to compete for workers, especially in periods when demand for labor is high. Therefore, the fundamental relationships between labor market tightness and wage growth should continue to hold, while the relationship between labor market tightness and inflation will be subject to large and evolving forces as the economy continues to change.

APPENDIX

Figure A.1
Time series of labor market variables



Notes: This figure shows the quarterly time series of the unemployment rate, the job openings rate, the private quits rate, the employment-to-employment (EE) transition rate from Fujita et al. (2024), and four-quarter growth of the employment cost index (ECI) wage and salaries for private industries. Prior to 2001, the job openings rate is from Barnichon (2010), and the private quits rate is from Davis et al. (2012). The job openings rate is defined as the job openings level divided by the labor force, to be consistent with Barnichon (2010). See figure 1 for more details on these extended series.
Sources: Davis et al. (2012); Fujita et al. (2024); Barnichon (2010); US Bureau of Labor Statistics via FRED.

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PIIE PETERSON INSTITUTE FOR INTERNATIONAL ECONOMICS

WORKING PAPER

25-5 US Wage Patterns During and After the Pandemic

Insights from a Novel Data Source

Jeff Nezaj, Nela Richardson, and Liv Wang

April 2025

ABSTRACT

This paper adds to a growing body of evidence on the underlying determinants of pandemic and postpandemic wage patterns by leveraging private-sector payroll records from ADP Inc., a dataset that comprises more than 25 million employees, or about 1 in 6 workers in the United States. The paper finds that the pandemic's disruption of industry sectors and workers drove large swings in pay growth as lower-wage workers left the labor force in the spring of 2020 and were hired back a year later. It also triggered a shift to larger year-over-year pay gains that so far have endured, albeit with some moderation.

JEL Codes: J2, J3, J63, J64

Keywords: Wage Patterns, Labor Force, Employment, Labor Demand, Labor Supply

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Introduction

Between February and April 2020, the United States lost nearly 22 million jobs in the non-farm sector, according to the Bureau of Labor Statistics. In the four years since the COVID-19 pandemic, the economy has journeyed from this steep and swift decline to a robust and prolonged recovery. This recovery has been accompanied by outsized gains in wages.

This paper adds to a growing body of evidence on the underlying determinants of pandemic and postpandemic wage patterns. To reach this conclusion, we turned to private-sector payroll records from ADP Inc., a dataset that comprises more than 25 million employees, or about 1 in 6 workers in the United States. This dataset is an important complement to government collections such as the Current Employment Statistics program, the Current Population Survey, and the Quarterly Census of Employment and Wages.

One limitation of this worker-level data is that it goes back only to 2018, which prevents historical comparisons of the pandemic period with other economic downturns. Our paper begins with background on pandemic employment, then explores wage patterns during the ensuing recession and recovery. Our analysis yields several important insights about pay growth during this period.

- Early in the pandemic, average wages rose, but the lowest-paid workers were most likely to be laid off.
- The initial employment rebound in lower-paying industries led to a decline in average industry wages as lower-paid workers were rehired.
- Upward pressure on wages that emerged with the worker shortage of 2021 proved enduring even as the shortage eased.
- Pay changes for job-changers varied with labor demand during the pandemic.
- Changes in the age structure of employment influenced wage trends during the pandemic.

We conclude with implications for future pay growth.

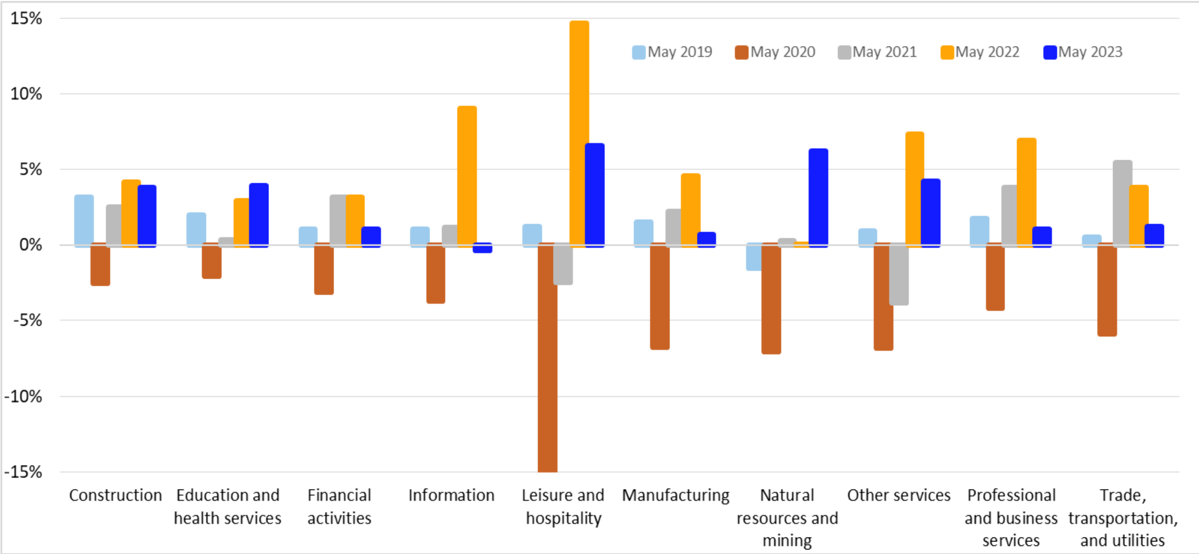
From job bust to job boom

In February 2020, the last month before the pandemic shutdown, the unemployment rate stood at 3.5 percent. This rate capped a 10-year period of economic expansion, the longest in US history. Consistent with low unemployment, the labor market was defined by solid hiring. Wage growth was moderate and higher than price inflation.

These Goldilocks conditions were dramatically disrupted, of course, when businesses, particularly customer-facing service providers, were forced to suspend or shutter operations in the spring of 2020.

By May 2020, every major industry had shed jobs. Figure 1 shows the year-over-year change in employment using the ADP records for 10 sectors between 2019 and 2023. Leisure and hospitality saw the biggest decline, with headcount falling 15 percent from the previous year. The sector shed further jobs between May 2020 and May 2021.

Figure 1 Year-over year changes in US employment by industry, percent (May data)



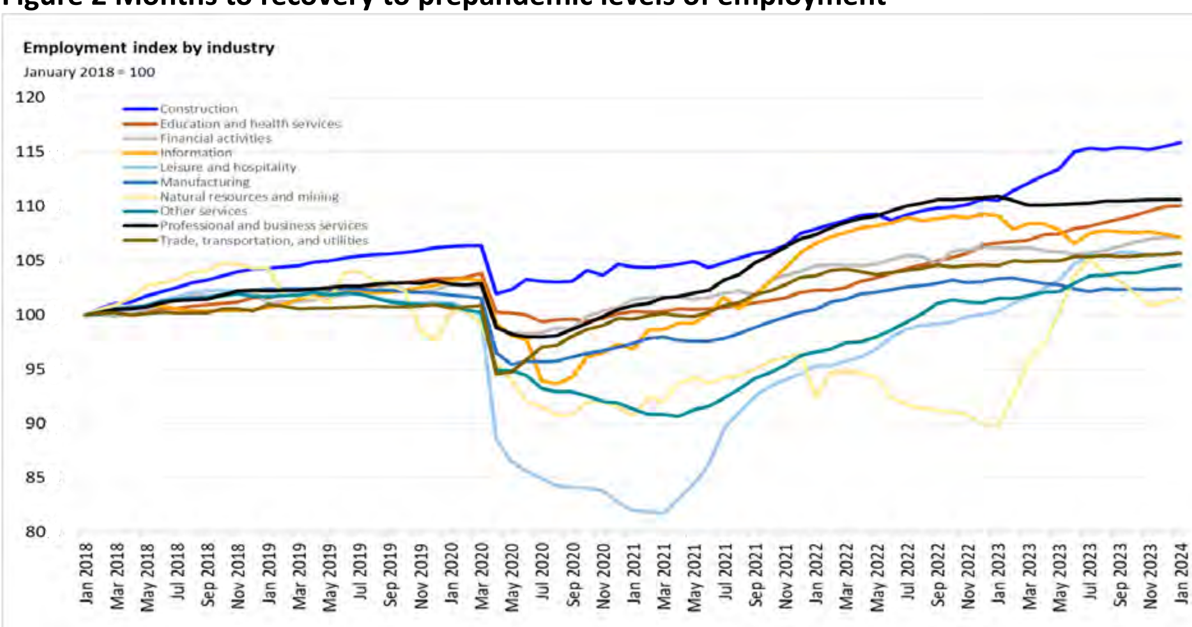
Source: ADP payroll data.

Not only did leisure and hospitality experience the steepest job losses, the sector also took a long time to recover those jobs. In fact, it took the sector 33 months to return to prepandemic employment levels. Only the much smaller mining and natural resource sector took longer, 39 months, to fully recover (figure 2).

Education and manufacturing took 26 months to return to prepandemic employment levels; other services recovered after 30 months.

Finance, professional business services, information, and trade, transportation, and utilities all returned to their prepandemic headcount within two years.

Figure 2 Months to recovery to prepandemic levels of employment



Source: ADP payroll data.

The supply-demand mismatch

For a decade, the United States had low and stable inflation, steady and low unemployment, and moderate wage gains. The pandemic upended this almost-textbook balance of labor supply and demand.

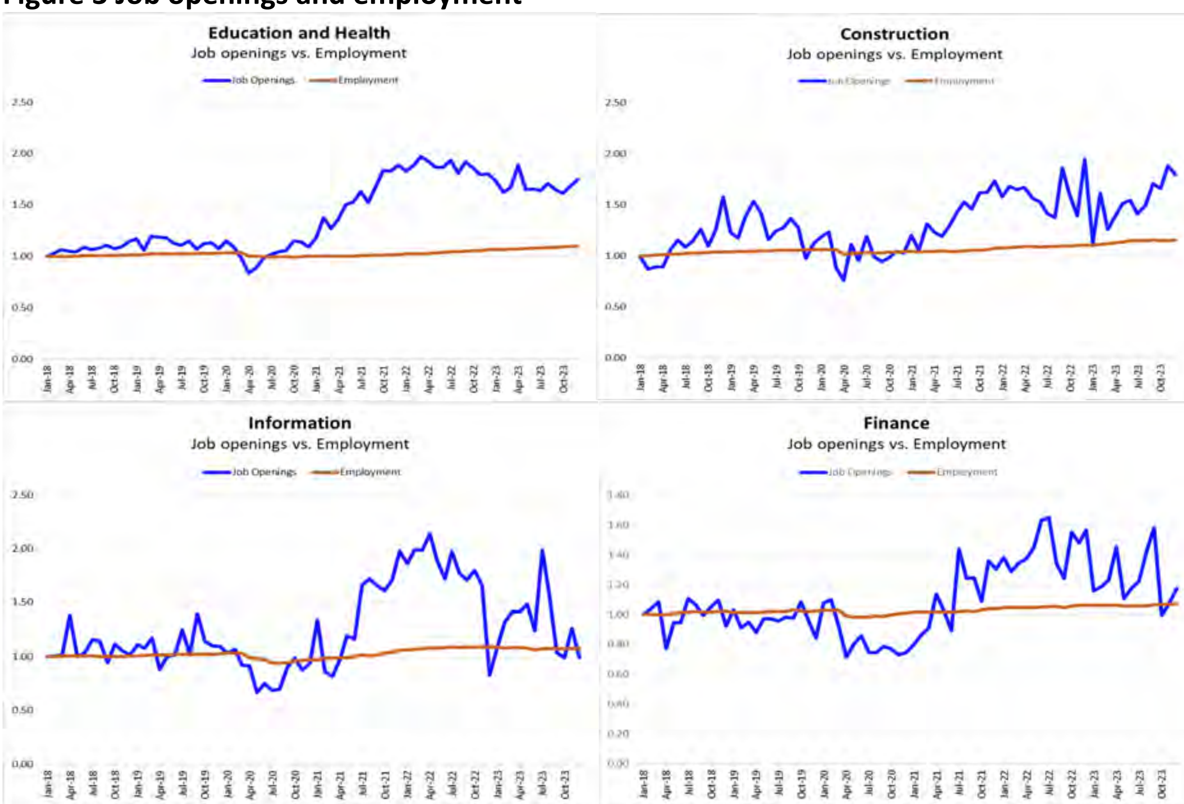
After the steep spring downturn in 2020, companies began to rehire employees aggressively that summer. By the spring of 2021, the Federal Reserve finds that the number of available jobs had begun to exceed the number of available workers as shown in its March 2024 Monetary Policy Report.

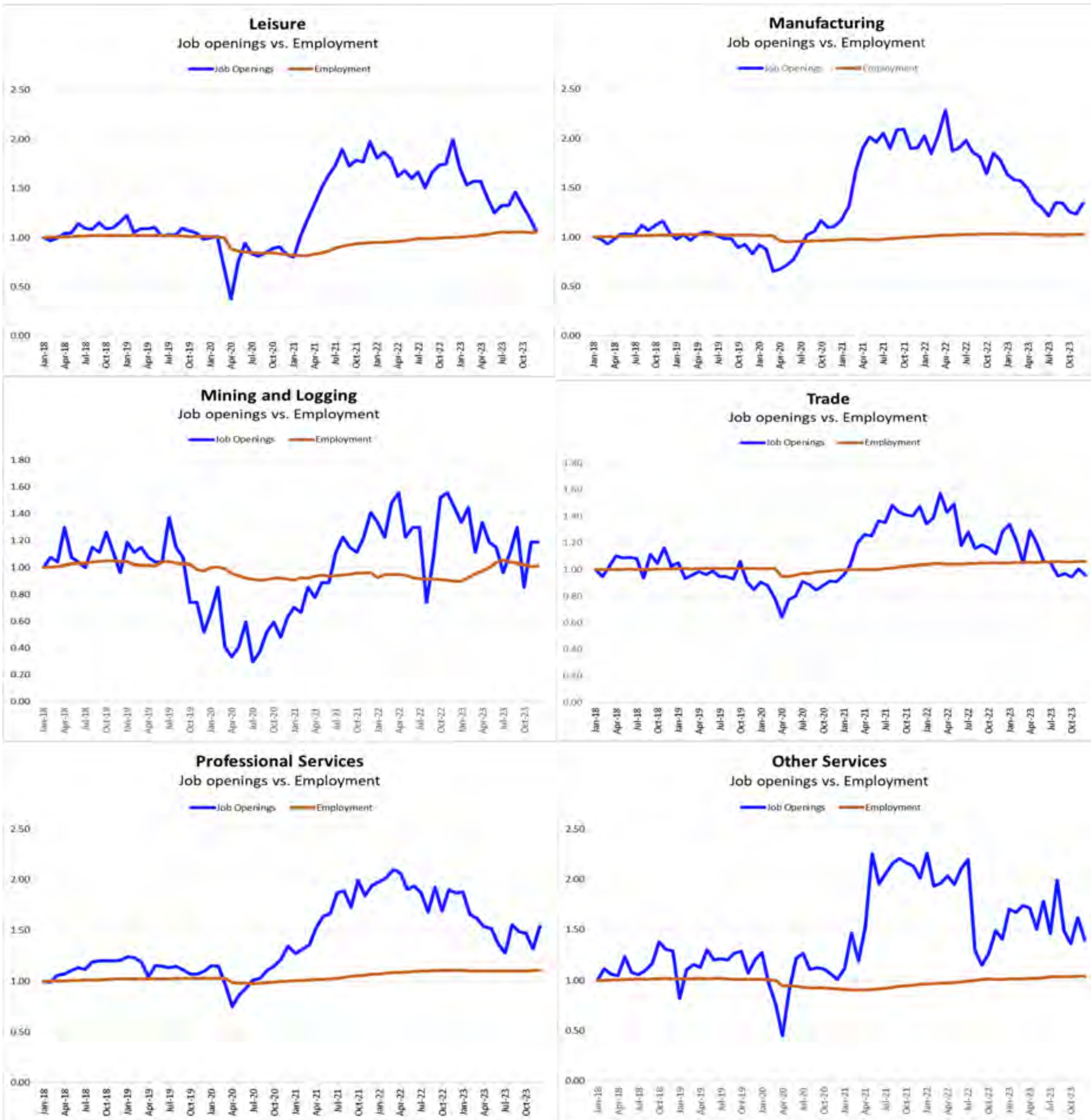
We leverage ADP's finely grained worker-level data to analyze the demand-side dynamics of the labor market at the industry level. An industry-specific analysis is warranted by the disproportionate impact of the pandemic-driven shutdown on service-providing employers, especially in the leisure and hospitality industry.

ADP's private-employer payroll data corresponds to employment—that is, demand that has been satisfied. Data on job openings from the Bureau of Labor Statistics speak to anticipated employer demand that has yet to be satisfied.

In figure 3, we index openings and employment to January 2018. For each of our 10 industry super sectors, job openings fell in spring 2020 before mounting a comeback in the summer. Openings started to rise steadily in the second half of 2020 and then surged in spring 2021, with postings holding fairly steady at high levels through 2022.

Figure 3 Job openings and employment





Source: ADP payroll data; Bureau of Labor Statistics, Job Openings and Labor Turnover Survey.

Still, even aggressive hiring and increased demand did little to expand the pool of available workers. The elevated levels of job openings suggest that worker supply continued to lag employer demand in every industry until fall 2022. Perhaps not surprisingly, the biggest mismatch in worker supply and demand appears to have been in the hardest-hit sector: leisure and hospitality.

Pay growth patterns and their drivers

To analyze the effect of postpandemic employment trends on pay growth, we tracked hourly base pay for an anonymized sample of more than 20 million workers. For hourly workers, we looked at the job's hourly base pay. For salaried workers, the hourly wage is imputed by dividing the base salary by hours worked, assuming those employees are full time. Our pay measures are job-based, with each job defined as a unique pairing of worker and employer.

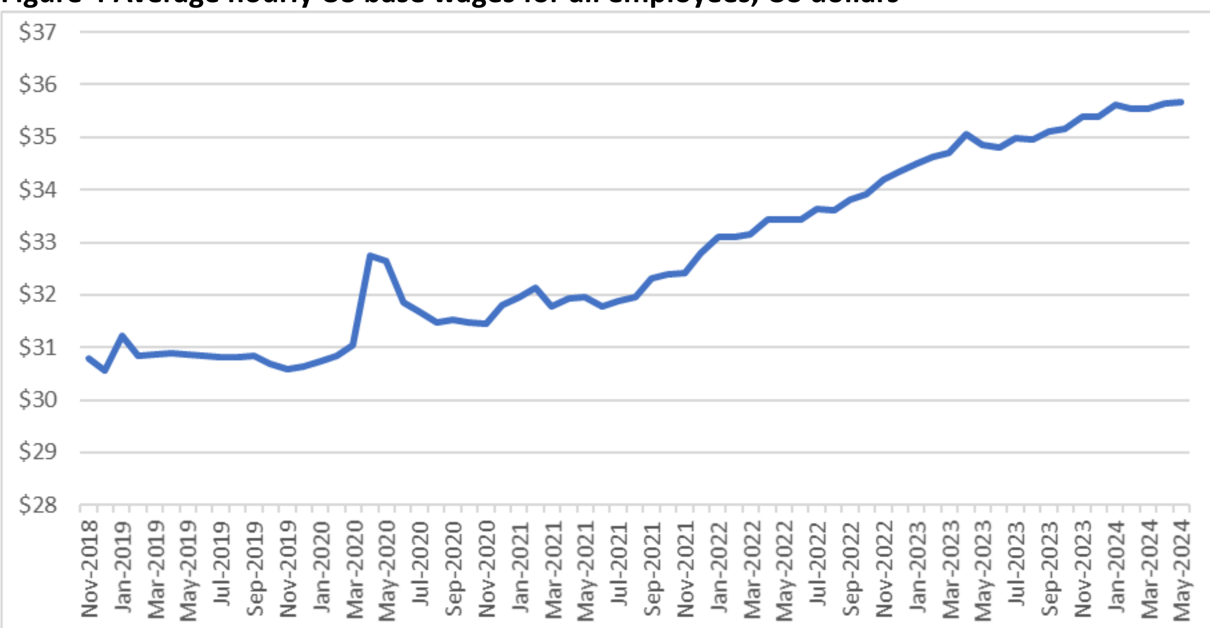
Steep job losses followed by rapid-fire hiring reshuffled pay distribution during the pandemic. In an earlier analysis, Wang and Richardson show that workers in the bottom quartile of the pay distribution saw the largest percentage pay gains between March 2021 and March 2024, while workers in the top quartile saw the biggest dollar increases. The result was a 5-percentage-point widening of the pay gap between top- and bottom-quartile earners.

The insights that follow expand on this analysis.

Insight 1: Early in the pandemic, average wages were elevated by layoffs of the lowest-paid workers.

A notable feature of the pandemic economy was that average private-sector hourly earnings jumped sharply between March and April 2020, rising by more than 5.5 percent, from $31 to $32.70 an hour, as seen in figure 4. (The Bureau of Labor Statistics' average hourly earnings series saw a similarly large jump.)

Figure 4 Average hourly US base wages for all employees, US dollars



Source: ADP payroll data.

This jump in aggregate hourly earnings reflects compositional changes in employment. Job losses were concentrated among workers who tended to have lower earnings, ADP data shows.

Table 1 examines the sector distribution of employment before, during, and after the pandemic. We start by examining the first two columns, which show the share of employment held by each sector in May 2019 and May 2020. This comparison captures the dramatic shifts of the early pandemic period.

Leisure and hospitality saw the biggest change, contracting from roughly 10 percent of employment in 2019 to about 6 percent in 2020. The sector's share subsequently rebounded, reaching its prepandemic share in 2022.

Another sector that shrank in the early pandemic period, though less dramatically, was trade, transportation, and utilities, which includes customer-facing retailers.

Table 1 Share of total US employment by sector, percent (May data by year)

Super Sector	2019	2020	2021	2022	2023
Construction	2.7%	3.3%	3.5%	3.5%	3.6%
Education/health services	15.7%	16.6%	16.3%	15.6%	16.1%
Financial activities	8.6%	9.4%	8.3%	7.8%	7.8%
Information	2.9%	2.8%	2.7%	2.6%	2.5%
Leisure/hospitality	9.9%	6.1%	8.7%	9.8%	9.8%
Manufacturing	16.6%	16.7%	15.1%	14.9%	14.6%
Natural resources/mining	1.0%	1.0%	0.9%	0.9%	0.9%
Other services	4.4%	4.3%	4.5%	4.7%	4.8%
Professional/business services	20.2%	22.6%	22.2%	22.6%	22.7%
Trade/transportation/utilities	18.0%	17.2%	17.8%	17.5%	17.2%

Source: ADP payroll data.

In 2019, leisure and hospitality had the lowest average hourly pay, at $17.81, so the shrinking of this sector alone would be expected to increase average wages in the economy (figure 5). Moreover, within leisure and hospitality, consistent with the rise in average hourly base pay in 2020, the lowest-paid workers were the ones most likely to lose their jobs when the pandemic hit. This intra-industry shift toward higher-paid workers led average hourly pay in leisure and hospitality to jump 22 percent in May 2020 from the year before, an increase of $3.91.

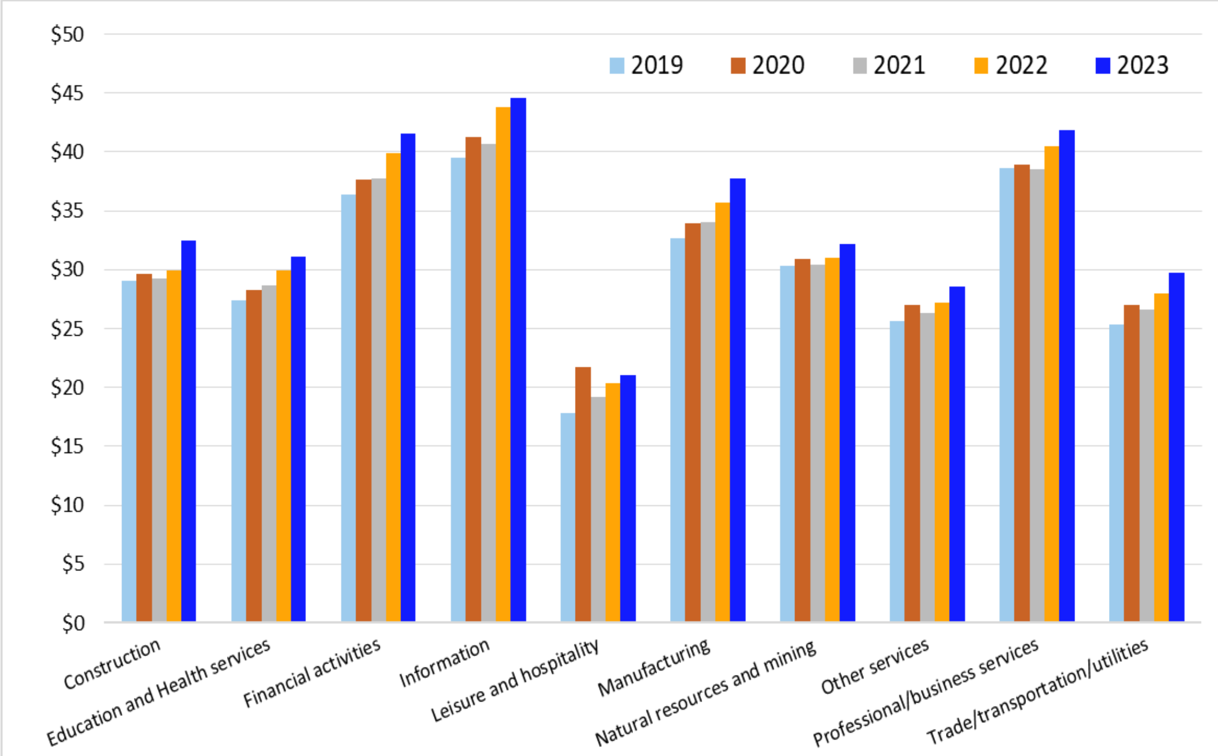
Trade showed a similar but more muted pattern. A loss of its lowest-paid workers led average hourly pay to jump by 6.7 percent in May 2020 from the previous year.

Altogether, shrinking employment in lower-paying sectors, and the compositional shifts within those sectors implied by figure 5, would be expected to boost overall average wages in the early pandemic period.

Insight 2: An employment rebound in lower-paid industries led to a decline in average industry wages as lower-paid workers were rehired.

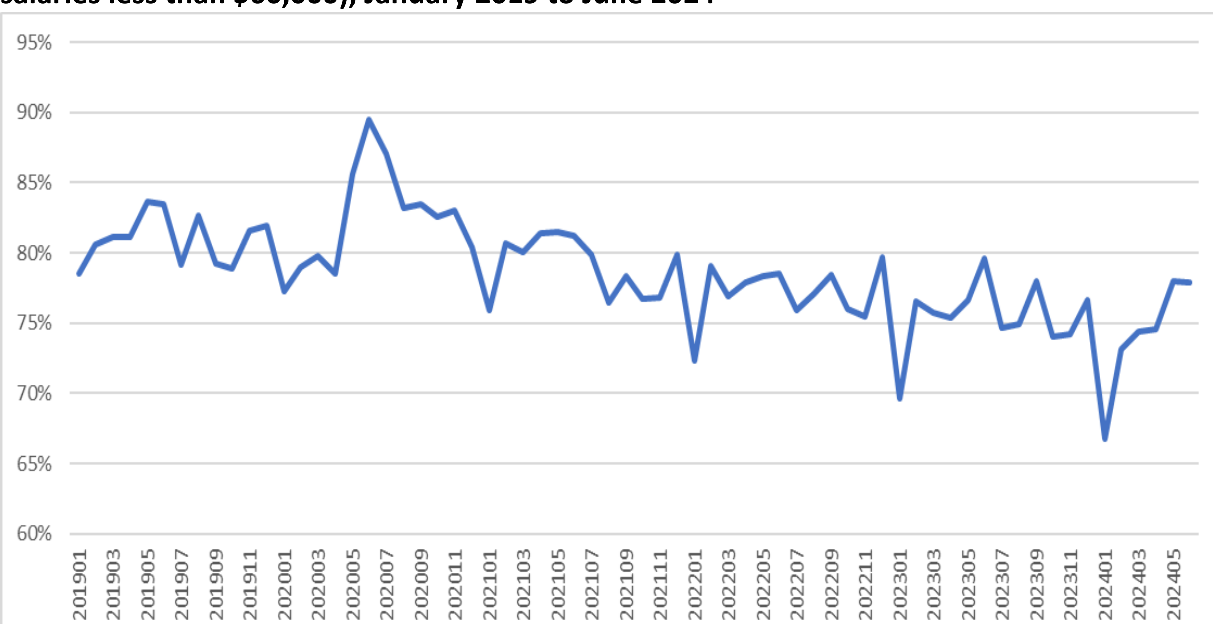
Many low-wage workers in customer-facing industries were temporarily laid off and rehired *en masse* shortly after pandemic-led closures. Figure 6 shows the percent of workers who rejoined their previous employers and who earned less than $60,000 a year. This income group showed an initial spike and an elevated level of rejoins in the first few months of the pandemic.

Figure 5 Average hourly US base wages by industry, US dollars (May data)



Source: ADP payroll data.

Figure 6 Percentage of US workers rejoining a previous employer (workers with annual salaries less than $60,000), January 2019 to June 2024



Source: ADP payroll data.

A striking observation is that average wages *fell* in several sectors between May 2020 and May 2021 (figure 5). The decline was most pronounced in leisure and hospitality, where average hourly pay fell 11.8 percent to $19.17 in May 2021.

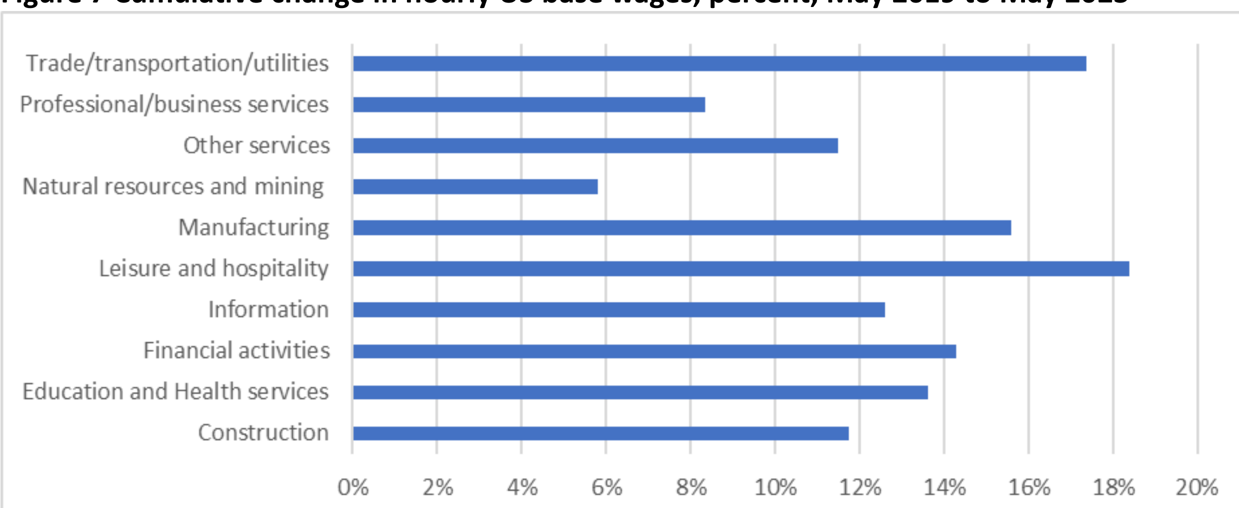
Declines also are seen in construction (-1.3 percent), information (-1.3 percent), natural resources and mining (-1.5 percent), other services (-2.8 percent), professional business services (-1 percent), and trade, transportation, and utilities (-1.5 percent).

These changes aren't a reflection of wage cuts, which would be odd at a time when the economy and labor demand were rebounding. Rather, as we saw in the early months of the pandemic, these swings were driven by compositional differences; the average moved because the composition of the employed population changed.

Insight 3: Upward pressure on wages associated with the 2021 worker shortage proved enduring in leisure and hospitality.

Figure 7 shows cumulative wage changes from May 2019 through May 2023. Industries with the biggest demand-supply mismatches in the immediate aftermath of the pandemic lockdown showed the largest wage gains.

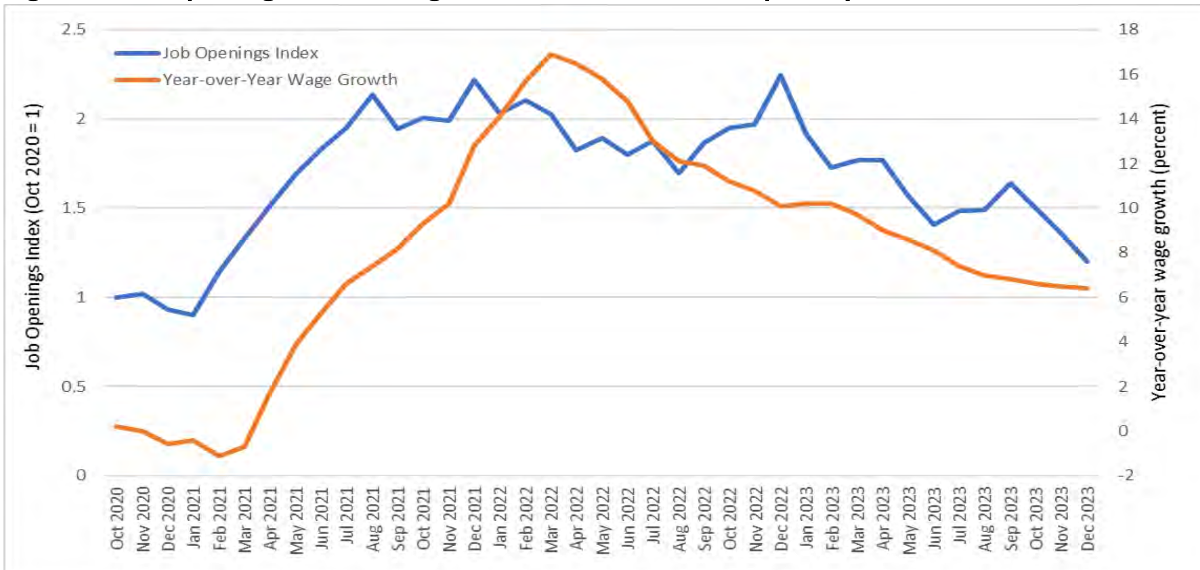
Figure 7 Cumulative change in hourly US base wages, percent, May 2019 to May 2023



Source: ADP payroll data.

As discussed earlier, worker shortages were especially pronounced in leisure and hospitality, which caused wage growth to accelerate faster than for any other industry (see figure 8) The sector's sharp wage acceleration led overall wage growth.

Figure 8 Job openings versus wages in the leisure and hospitality sector



Source: ADP payroll data; Bureau of Labor Statistics, Job Openings and Labor Turnover Survey.

Insight 4: Pay gains for job-changers varied with labor demand during the pandemic.

ADP's unique dataset allows us to analyze the pay growth of people who change jobs. We track workers who changed employers within the previous 12 months, matching these individuals to both their previous and current jobs.

Annualized pay is calculated at the job level, or the worker and company pair, and pay change is calculated as the difference between the annualized pay of the new and old jobs. Workers are considered job-changers if they have a different employer in month X than they did in month X minus 12.

We track the median change of all matched samples from the base year wage paid by the previous employer.

Job-changing often is associated with pay increases, as workers find employment better suited to their skills and are suitably rewarded. But our analysis reveals that pay changes for job-changers also are sensitive to real-time labor-market conditions. (The full series on pay growth for job-stayers versus job-changers can found in the monthly ADP Research Pay Insights report.)

Prior to the pandemic (the 12 months ending November 2019), job-changers in construction, financial activities, and professional business services had the strongest year-over-year pay gains, at 14 percent, 10.9 percent, and 10.3 percent, respectively. Job-changers with the lowest pay growth during this period worked in leisure and hospitality and natural resources, both of which recorded 5 percent year-over-year gains.

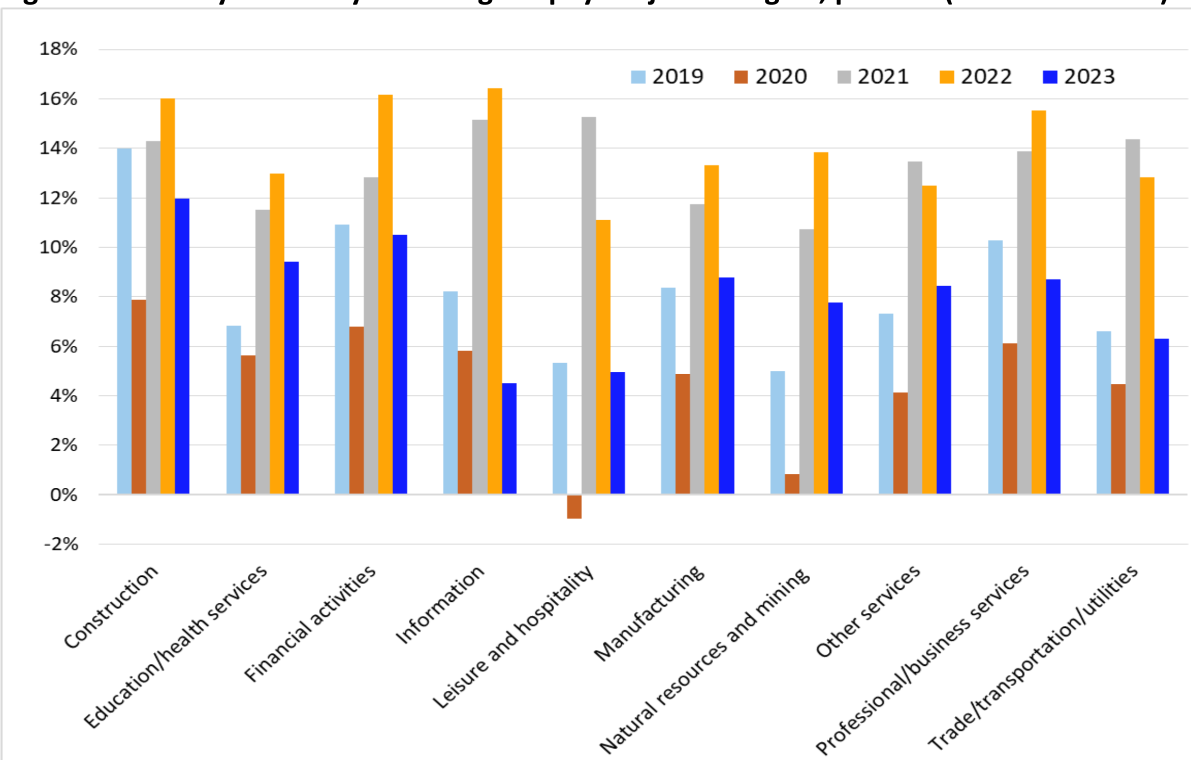
Pay growth for job-changers slowed across all industries in the 12 months ending in November 2020, but leisure and hospitality workers were the only group who lost ground, with pay falling 1 percent year-over-year.

This pattern is consistent with the industry's prepandemic trends. Leisure and hospitality is the only industry in which median pay growth for job-changers is historically lower than for job-stayers. This pattern was reversed temporarily due to rapid hiring and competition for workers during the pandemic recovery.

In 2021 and 2022, pay for job-changers rose by more than 10 percent in all sectors, including leisure and hospitality, where year-over-year pay gains were 15.3 percent in 2021 and 11.1 percent in 2022 and where average salaries are the lowest of any sector.

As labor supply and demand came into balance, every sector saw slower pay growth for job-changers in 2023. Pay growth for job-changers in leisure and hospitality slowed to 4.9 percent, lower than the prepandemic growth rate as seen in Figure 9 below.

Figure 9 Annual year-over year change in pay for job-changers, percent (November data)



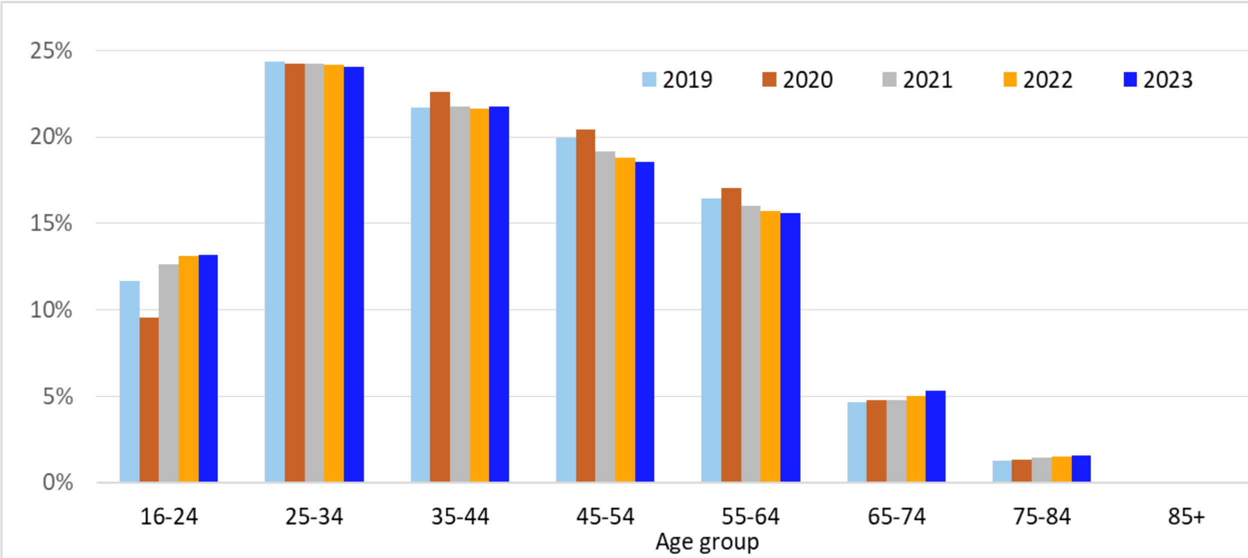
Source: ADP payroll data.

Insight 5: Examining changes in the age structure of employment can shed light on wage growth patterns during the pandemic.

Workforce demographics also saw pandemic-driven fluctuations as well as longer-term changes. Figure 10 shows the percentage of workers by age group from 2019 to 2023. The share of workers aged 16 to 24 shrank between May 2019 and May 2020, sliding more than 2 percentage points from 11.7 percent to 9.6 percent. Shares represented by other age groups increased or were little changed.

Because the youngest workers tend to be lower paid, the sharp decline in their presence at the outset of the pandemic likely is linked to the decline in the average wage. Because leisure and hospitality and trade employ the largest shares of young workers, their shrinking presence likely contributed to the compositional changes that led to stronger gains in average pay in these sectors. Similarly, the initial pandemic rebound in the share of young workers between May 2020 and May 2021 likely contributed to declining average wages during that period.

Figure 10 Percent share of US workers by age group (May data)



Source: ADP payroll data.

Looking past short-term swings in employment demographics associated with the pandemic and its aftermath, we consider longer-term patterns suggested by shifting employee age cohorts between 2019 and 2023. By 2023, the share of employment represented by the youngest workers had outpaced its share in 2019, topping 13.2 percent.

Young workers aren't the whole story. The share of workers aged 45 to 64 was smaller in 2023 than in 2019. This cohort, which aligns roughly with Generation X, who now are between 44 and 59, saw its share of total US employment fall to 18.5 percent in 2023 from 19.9 percent in 2019. The next-oldest cohort, workers 55 to 64, also lost ground, falling to 15.6 percent of the workforce from 16.4 percent.

The shrinking share of 45- to 64-year-old workers could be the result of a pickup in early retirements or new business formations. More tenured workers had the freedom to quit traditional employment thanks to a strong stock market and rising home prices.

Yet workers 65 to 74 grew their ranks, to 5.3 percent. The share of workers 75 and older also grew, from 1.2 percent of the workforce in 2019 to 1.6 percent in 2023.

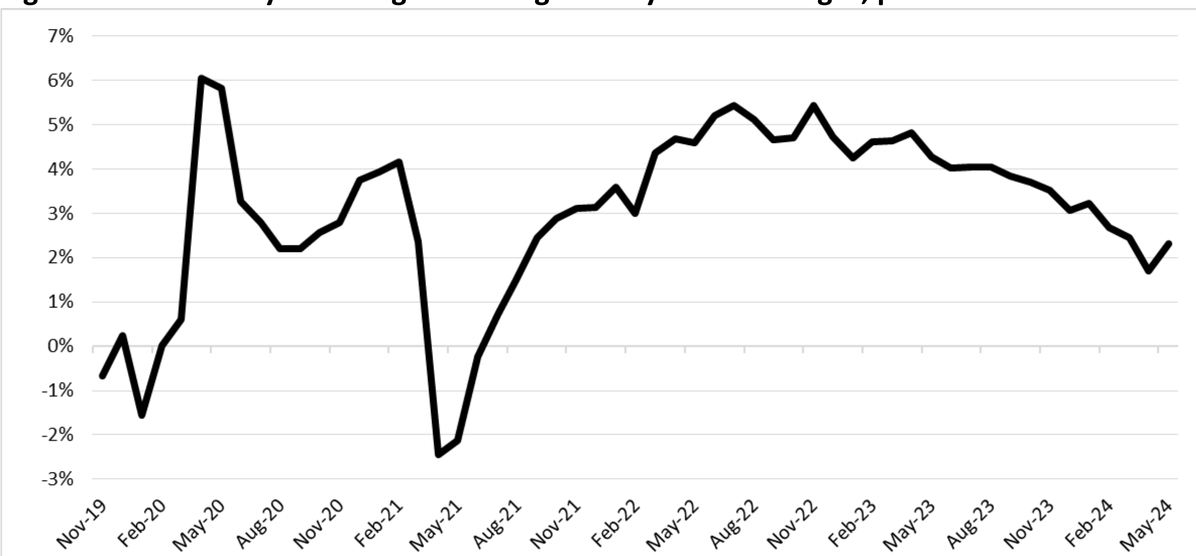
These demographic trends likely reflect various factors. Greater exposure to health risks from COVID and wealth effects from higher asset prices would be expected to reduce participation among the older population. However, all else equal, the overall aging of the US population related to the post-World War II baby boom would be expected to raise the share of the labor market represented by older workers. Older workers might also flow back into the labor market at higher rates due, in part, to social and economic factors that include longer life expectancies and remote work opportunities.

Conclusion

ADP pay data for individual workers goes back to November 2018, giving us an opportunity to calculate annual pay change for a short period prior to the pandemic. Wage growth for this period was consistent with the slow-growth, low-inflation environment that characterized the late-stage expansion.

Average wage growth retreated from its postpandemic highs in the second half of 2022 and 2023 and was little changed in early 2024 at a level higher than before the pandemic, according to ADP data (figure 11). It remains to be seen whether this higher pace will prevail.

Figure 11 Year-over year change in average hourly US base wages, percent



Source: ADP payroll data.

The pandemic's disruption of industry sectors and workers drove large swings in pay growth as lower-wage workers left the labor force in the spring of 2020 and were hired back a year later. It also triggered a shift to larger year-over-year pay gains that so far have endured, albeit with some moderation.

As we document, this acceleration in pay growth was due not just to companies paying workers higher wages. Altered patterns of employment by age and industry left an impression as the distribution of employed workers shifted by sector, pay quartile, and age.

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