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WORKING PAPER

# 22-17 25 Years of Excess Unemployment in Advanced Economies

## Lessons for Monetary Policy

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**ABSTRACT**

For about 25 years before the COVID-19 pandemic, inflation was very low and stable in most advanced economies. A little noticed dark side of this impressive achievement is that unemployment rates were almost always higher than needed to keep inflation low. This widespread and persistent policy error arose because of a major flaw in standard macroeconomic models—the use of a linear Phillips curve. This flaw would have been far less costly if central banks had not chosen such a low target for inflation. This paper thus adds to the arguments in favor of a moderately higher inflation target. Even without a higher target, central banks need to use a broader range of economic models and should verify their estimates of the natural rate of unemployment by running the economy hot from time to time in order to see nascent inflationary pressure before throttling back.

**JEL Codes:** E24, E31, E52, E58

**Keywords:** Nonlinear Phillips curve, equilibrium rate of unemployment (U*), equilibrium real rate of interest (R*), inflation target, downward wage and price rigidity

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## INTRODUCTION

Economic disruptions from the COVID-19 pandemic and the policy responses to it have pushed inflation to multidecade highs in many countries. For about 25 years before 2020, inflation in the advanced economies was extremely low and stable. But this apparently good performance had a dark underside that was not widely understood: Unemployment was almost continuously higher than needed to keep inflation low. Unless central bankers change their economic models, the world is likely to return to chronically excessive unemployment in the years after the COVID-19 inflation surge.

In 2018, Federal Reserve Chair Jerome Powell gave a speech at the Fed's annual Jackson Hole symposium that attracted much attention in central banking circles.[1] He questioned the accuracy of the key economic measures the Fed uses to guide its policy decisions. He noted that estimates of the equilibrium real rate of interest, R*, and the equilibrium rate of unemployment, U*, were being marked down. He urged caution in the use of these navigational "stars." In particular, he supported a policy of allowing unemployment to fall below the current estimate of U*, as long as it did not lead to excessive inflation.

This paper concludes that Powell was right. His policy advice was relevant not only for the United States but also for most advanced economies. Moreover, the evidence supports an even more controversial step—raising the inflation target from 2 percent to at least 3 percent. Even without an increase in the inflation target, following Powell's advice should help central banks to achieve lower rates of unemployment without sacrificing their inflation goals.

In the 18 months following Powell's speech, the US unemployment rate fell to 3.5 percent, the lowest level reached in 50 years. Inflation remained well controlled. Indeed, a modest decline in core inflation in mid-2019 caused the Fed to cut its policy rate 0.75 percentage point below the level consistent with its estimate of R* in late 2019. One implication of Powell's speech and its aftermath is that the Fed had based its policy decisions for some time on inappropriately high values of R* and U*. In other words, policy was too tight and unemployment did not fall as far or as fast as it could have.

It seems likely that for at least 25 years, unemployment has been above U* almost continuously in most advanced economies. In many of these economies, the case that unemployment exceeded U* is even stronger than it is in the United States. These results bolster the case for dual mandates for central banks, as achieving the single mandate of stable low inflation does not imply that central banks have achieved the maximum sustainable levels of output and employment.

Factors contributing to persistent excess unemployment include (1) the sustained shift to ultra-low inflation in the mid-1990s, (2) demographic and other trends that reduced R* and U* but were not understood by central banks in real time, (3) the zero lower bound on interest rates, and (4) downward wage and price rigidity.

The factor that has received the least attention is downward wage and price rigidity. The next section explains why this rigidity matters. The following section presents evidence for all four factors and their interconnection. The penultimate section considers implications of the COVID-19 pandemic and the subsequent burst of inflation. The final section provides policy conclusions.

1 The text of the speech is available at https://www.federalreserve.gov/newsevents/speech/powell20180824a.htm.

## THE MACROECONOMICS OF DOWNWARD WAGE AND PRICE RIGIDITY[2]

### Microeconomic evidence of downward rigidity

Slow adjustment of wages and prices has long been a central feature of modern economies. Many economists have modeled this stickiness symmetrically for increases and decreases in wages and prices. An alternative view is that wages, in particular, are more rigid in the downward direction than in the upward direction (Keynes 1936).[3] A number of papers have documented that cuts in individual wages are rare in advanced economies (Akerlof, Dickens, and Perry 1996; Dickens et al. 2007; Fallick, Lettau, and Wascher 2016).

The data show that the distribution of individual wage changes is almost truncated, with an excessive number of workers receiving no wage change and very few taking wage cuts. The evidence of asymmetric downward rigidity in prices is less clear, in part because firms occasionally offer reduced sales prices and sometimes charge different prices for certain types of customers. Nevertheless, published nonsales prices tend to be sticky and cuts in these prices are rare outside of the commodities and electronics sectors. To the extent that prices are markups over marginal cost and wages are the largest component of marginal cost, downward wage rigidity ought to cause prices over the business cycle to tend to fall proportionately less in response to slumps than they rise in response to booms.

### Downward rigidity bends the Phillips curve

The most widely used model of aggregate wage and price adjustment is the Phillips curve, which describes a tendency for inflation to rise when unemployment is low and to fall when unemployment is high (Phillips 1958). Studies show that the effect of unemployment on inflation has declined in advanced economies over the past three decades, and thus the Phillips curve has flattened (Ball and Mazumder 2011; Blanchard 2016; Gordon 2018; Del Negro et al. 2020).[4]

Three recent studies argue that downward wage and price rigidity may explain the observed flattening of the Phillips curve (Daly and Hobijn 2014; Gagnon and Collins 2019a; Forbes, Gagnon, and Collins 2022). The key result is that the decline of inflation to around 2 percent or so since the 1990s has bent the Phillips curve into a nonlinear shape. The curve, which was steep and linear in the 1970s and 1980s, remains steep for low rates of unemployment but is now flat for high rates of unemployment.

Figure 1, taken from Gagnon and Collins, displays the 1959-67 and 1995-2018 (low inflation) US Phillips curve in the left panel and the 1967-94 (high inflation) US Phillips curve in the right panel. The curves show the effect of the unemployment gap on inflation, after controlling for other factors including lags in the inflation process. The unemployment gap is the difference between the

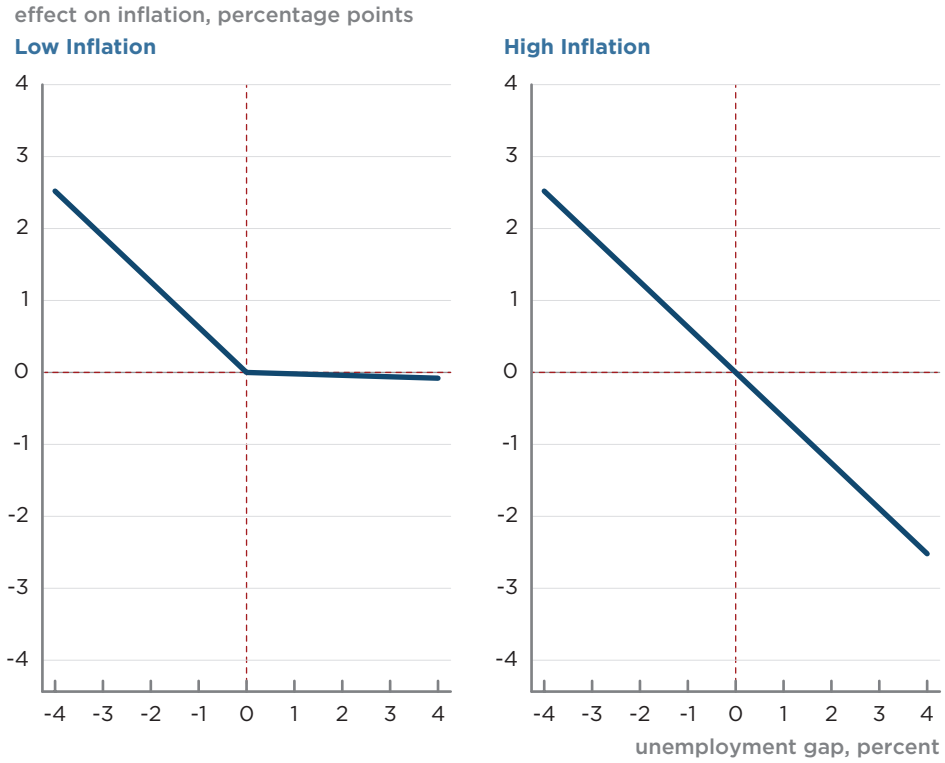
2 "Resistance" may be more accurate than "rigidity," as wages and prices occasionally do decline. But "rigidity" is widely used in the economics literature.

3 Note that this view does not preclude meaningful stickiness in the upward direction. What is essential is that stickiness is more pronounced in the downward direction.

4 Another change is that inflation tends to return to its target or trend level faster than it did in the 1970s and 1980s. This change probably reflects greater credibility of central banks at maintaining their targeted rates of inflation.

unemployment rate and its estimated equilibrium level or U*.[5] An economy is in equilibrium when it is growing at the fastest sustainable rate with inflation stable at its target value.

Figure 1
**Phillips curves for US core CPI inflation, 1959Q2-2018Q4**




CPI = consumer price index

Note: The low inflation sample is 1959Q2-1967Q3 and 1995Q1-2018Q4. The high inflation sample is 1967Q4-1994Q4.

*Source:* Authors' calculations based on GAP coefficients from column 4 of table 1 in Gagnon and Collins (2019a).

When the unemployment rate equals U* there is no upward or downward pressure on inflation. When the unemployment rate is one percentage point below U*, the gap equals -1 and the implied effect is an increase in inflation of 0.6 percentage point. When the unemployment rate is one percentage point above U*, the gap equals 1 and the implied effect is a decrease in inflation of 0.6 percentage point if inflation is initially high (right panel) but almost no decrease in inflation if inflation is initially low (left panel). Because there is so little downward pressure on inflation, it can be difficult to tell that an economy is out of equilibrium when inflation is low and unemployment is high. The nonlinear curve in the left panel is similar to the original Phillips (1958) curve, which was estimated over a period in which inflation was very low on average.

5 Gagnon and Collins take U* from the Congressional Budget Office (January 2019). This estimate moves slowly over time based mainly on demographic changes to the labor force.

The Phillips curve bends because many workers would rather lose jobs than accept a cut in wages, and this asymmetry in the cyclical behavior of labor costs gives rise to a corresponding asymmetry in prices. Even very high levels of unemployment are not able to push many individual wage and price changes below zero, leaving the average change above zero.

The bending of the Phillips curve causes statistical estimates of the slope of an assumed linear curve to flatten to somewhere between the slopes of the steep and flat segments of the true nonlinear curve. Moreover, if economies have operated more often on the flat segment of the Phillips curve than the steep segment, the estimated slope may be very flat indeed, as is demonstrated below. This paper provides evidence that advanced economies have operated on the flat segment of the curve in almost all years since the mid-1990s. Fiscal policies and labor market developments in response to the COVID-19 pandemic moved some economies to the steep part of the Phillips curve in 2021, leading to a sharp but possibly short-lived increase in inflation (Gagnon 2022).

### Downward rigidity reduces output and employment

Another implication of the bending of the Phillips curve is that the equilibrium rate of unemployment, U*, will increase as inflation declines (Akerlof, Dickens, and Perry 1996; Gagnon and Collins 2019a). This is because achieving a sustained inflation rate closer to zero requires having more individual wage and price changes equal to zero, which in turn requires more unemployed workers. Akerlof, Dickens, and Perry argue that this effect is likely to be important mainly when trend inflation is below 2 percent, but this conclusion is based on a rough calibration of their theoretical model rather than direct evidence.

Two new theoretical macroeconomic studies suggest that the nonlinear Phillips curve created by downward wage rigidity gives rise to asymmetric business cycles, that is, economies spend more time below potential[6] than above (Aiyar and Voigts 2019; Dupraz, Nakamura, and Steinsson 2022). The latter study reaches two striking conclusions: First, for a given rate of inflation, central banks can reduce average unemployment by adjusting monetary policy more aggressively to offset demand shocks. Second, raising the inflation target from 2 to 4 percent reduces average unemployment by almost 2 percentage points in their calibrated theoretical model.

### Published estimates of output and employment gaps are too high

Conventional methods of modeling business cycles lead to estimates of output and employment gaps that are higher than their true values when wages and prices are downwardly rigid (Aiyar and Voigts 2019). **The output gap is defined as the level of real GDP minus its estimated potential level and is expressed in percent of the potential level. The employment gap is defined as the employment rate minus its estimated potential level and is expressed in percent of the labor force. Both gaps have the property that a positive value reflects a cyclical boom and a negative value a cyclical slump. *Note that the employment gap equals -1 times the unemployment gap defined above*.**

6 Potential output is the maximum level of output that can be sustained with constant inflation. Economists use "potential" interchangeably with "equilibrium."

The key difficulty in estimating output and employment gaps is estimating the level of potential. One common approach is to take the trend or smoothed value of output or employment. The Hodrick-Prescott filter, commonly used for calculating trends in economic data, has the property that the average value of the trend in any sample equals the average value of the underlying series. As suggested by the theoretical studies discussed above, the presence of downward wage and price rigidity may cause output and employment to be below their true potential levels more often than above. Thus, the average level of output may be less than the average level of its true potential. As a result, the gap calculated by subtracting a Hodrick-Prescott trend from actual output would be too high.

Other methods of estimating potential levels of output and employment do not necessarily set the average value of potential equal to the average of the underlying series, but they have the statistical property that the average value of potential comes closer to the average value of the underlying series as the sample size increases.[7] Consequently, estimated gaps between actual and potential will usually be too high when wages and prices are downwardly rigid. This property is true for the multivariate filter used by the International Monetary Fund (IMF).[8] It is also true for the methodology used by the Organization for Economic Cooperation and Development (OECD) to create employment gaps and key components of its output gaps (Chalaux and Guillemette 2019).[9]

Because estimates of potential stay close to the values of the underlying data on average over time, published gaps between output and employment and their estimated potentials always display periods of both positive and negative values in any sample over which they are estimated. The possibility of experiencing 20 consecutive years of negative gaps is essentially ruled out by design.[10]

The next section provides evidence to support the claim that inflation targets around 2 percent have led to widespread and sustained excess unemployment (negative output and employment gaps) in the advanced economies.

## EMPIRICAL SUPPORT

### The transition to ultra-low inflation

We focus on the 11 largest economies that were classified as advanced (or industrial) by the IMF as of 1990. Figure 2 shows a three-year moving average of inflation in these economies between 1970 and 2019. The years of the COVID-19

7 This result holds in any framework in which (1) actual output equals potential output at the steady state without shocks, (2) equations are linear, and (3) shocks are symmetric around 0. Most macroeconomic models used at central banks have these properties.

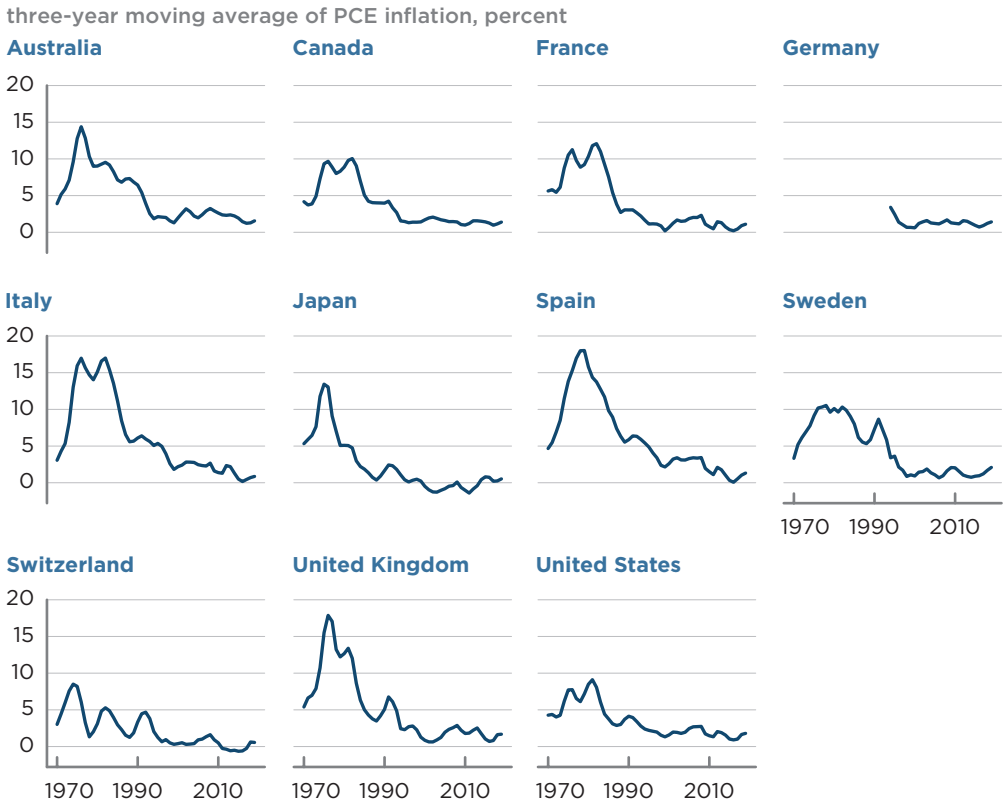
8 Aiyar and Voigts (2019) show that the IMF's methodology results in an estimated mean output gap less than 0.1 percentage point below zero when confronted with artificial data generated by a model with downward rigidities that has a true mean 1 percentage point below zero.

9 The OECD jointly estimates potential and cyclical components of unemployment. The cyclical component, or gap, is modeled as a second-order autoregressive process with mean zero. Thus, the average unemployment gap is close to zero in large samples and the average level of U* is close to the average of actual unemployment.

10 Methods of separating trend and cyclical output or unemployment using information from inflation via a Phillips curve can find prolonged cyclical gaps when inflation has a prolonged deviation from its expected value, such as during a trend increase or decrease in inflation. As shown below, inflation had little trend in most advanced economies over the years 1995-2019, providing little scope for such methods to identify prolonged cyclical gaps.

pandemic are discussed separately below. Inflation is based on the price index for personal consumption expenditures (PCE) obtained from the OECD. A three-year average of inflation helps to smooth away temporary ups and downs from volatile commodity prices.

Figure 2
**The shift to ultra-low inflation in 11 large advanced economies, 1970-2019**




PCE = personal consumption expenditures

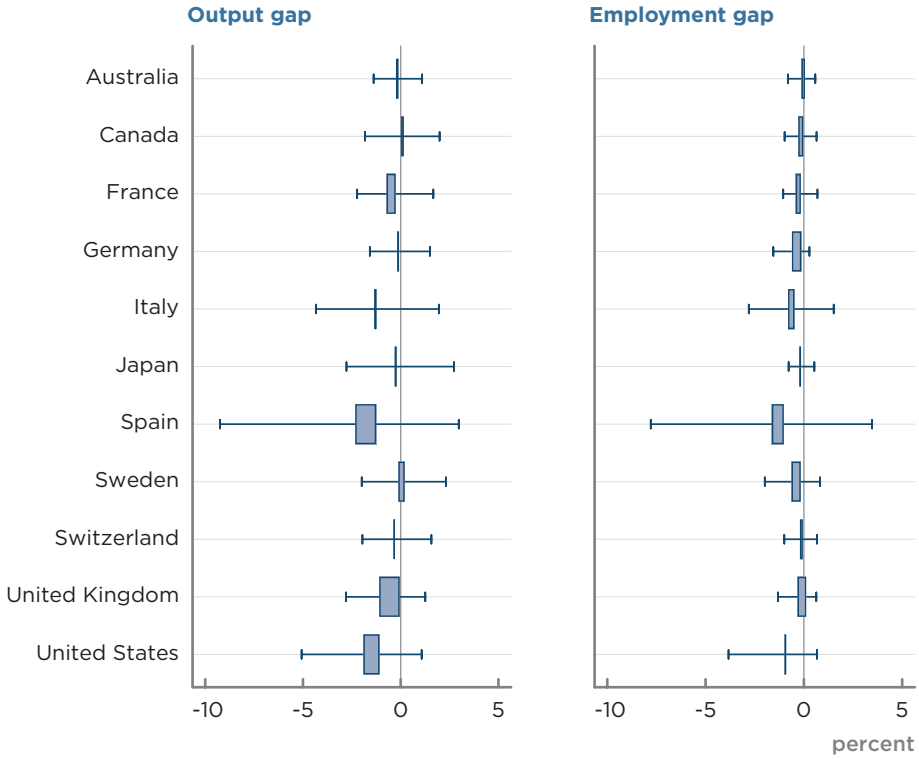
*Source:* Organization for Economic Cooperation and Development, *Economic Outlook* database, No. 110, December 2021.

In each of these economies, inflation underwent a marked transition from high and variable rates to sustained low rates. In each economy, the smoothed inflation rate fell below 3.5 percent between 1983 (Japan) and 1998 (Italy) and never exceeded that level afterwards. The median transition date among these economies was 1994. Only in Australia and Spain did smoothed inflation exceed 3 (but not 3.5) percent in any year after 1997. In Germany, Japan, and Switzerland it never exceeded 2 percent after 1995. As of the beginning of the COVID-19 pandemic in 2020, each of these economies had experienced more than 20 years of ultra-low inflation. Thus, they were all especially vulnerable to the harmful effects of downward wage and price rigidity.

### Published output gaps are usually negative

Figure 3 uses box and whisker plots to summarize the properties of two published output (GDP) gaps and two published employment gaps for each of these economies over the period 1995-2019.[11] The boxes span the distance between the mean values of each of the two gap measures. For example, the left edge of the US output gap box is the mean value of the IMF's output gap (-1.9) and the right edge is the mean value of the OECD's output gap (-1.1). For every economy, the mean values of these gaps are either near zero or notably below zero. In no country is a mean value notably above zero.

Figure 3
**Published cyclical gaps in advanced economies are usually negative (output and employment gaps, 1995-2019)**




Note: Boxes on the left panel span the distance between mean values of output (GDP) gaps retrieved from the IMF and OECD Fall 2021 databases. Boxes on the right panel span the distance between mean values of the employment gaps calculated from the OECD Fall 2020 and Fall 2021 databases. The IMF does not estimate an output gap for Switzerland. Whiskers display averages across two gap measures of the 10th percentile (left whisker) and 90th percentile (right whisker) values.

*Sources:* International Monetary Fund, *World Economic Outlook* database, October 2021; and Organization for Economic Cooperation and Development, *Economic Outlook* database, No. 110 (December 2021) and No. 108 (December 2020).

11 The output gaps are from the Fall 2021 forecasts of the IMF and the OECD. The employment gaps are from the Fall 2020 and Fall 2021 forecasts of the OECD. (The IMF does not publish employment gaps.) Output and employment gaps from the Fall 2019 OECD forecast had nearly identical properties as the 2021 output gaps and 2020 employment gaps, suggesting that past gaps were not noticeably revised in light of the 2020 recession. In 2021, the OECD changed the basis of its employment gap from labor force to working age population, making it difficult to compare to earlier vintages.

The whiskers display averages across the two gap measures of the 10th percentile and 90th percentile values. The 10th percentile levels are often more than twice as far below zero as the 90th percentile levels are above zero. In other words, recessions are far deeper than booms.

The published gap measures thus support the theoretical prediction of business cycles that are asymmetrically tilted toward recessions and excess unemployment in the presence of downward wage and price rigidity when inflation is very low and stable. As discussed above, the methodologies used to construct these gaps are biased toward finding gaps with means of zero.[12] Thus, there are strong grounds to suspect that true output and employment gaps are even more tilted in a negative direction than published measures.

## True output gaps are more negative than published gaps

### *Large positive published gaps have no effect on inflation*

Not only are large positive published gaps less frequent than large negative gaps, evidence suggests that the largest positive gaps are overstated. We define episodes of large positive gaps as events with two or more consecutive years of output gaps above 2 percent or employment gaps above 1 percent.[13] Only two such episodes are identified by at least three of the four gap measures: Italy and Spain in the mid-2000s.[14] These episodes are both the longest and the largest cyclical booms identified for any of these 11 economies since 1995. According to the OECD's 2020 estimates, employment gaps exceeded 1 percent for five years in Italy (2004-08) and nine years in Spain (2000-08), with peaks in 2007 of 2.4 percent for Italy and nearly 6 percent for Spain.

Such large and prolonged economic booms would be expected to have noticeable impacts on inflation, even with a relatively flat Phillips curve. For example, Blanchard (2016) finds that the US Phillips curve slope has declined to about 0.2, so that an unemployment gap of 3 percent would raise inflation by 0.6 percentage point immediately with further increases over time as expectations of future inflation begin to rise.[15] Yet, there was no increase in the three-year average of inflation in either of these economies between 2002 and 2008, and inflation took a noticeable step down in 2009 at the end of these episodes (see figure 2).[16]

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12 Although negative mean values are not impossible in finite samples using standard methodologies, the systematic tendency for negative mean values shown in figure 3 may arise from the inclusion of years prior to 1995 in the estimation sample, which may have had positive gap values, or from judgmental adjustment of the estimated gaps downward.

13 Okun's Law in the United States says that a cyclical increase in GDP of 2 percent typically is associated with a decrease in the unemployment rate of 1 percent.

14 All four measures identify these episodes, but the starting and ending dates differ across measures.

15 Some researchers have found even smaller slopes in recent years (as noted in Forbes, Gagnon, and Collins 2022), which may appear to reconcile the estimated gaps and inflation in Italy and Spain. However, these ultra-low slope estimates are almost surely too low because they reflect estimation using biased gap data and an assumed linear Phillips curve when the true curve is nonlinear. See the discussion of table 2 below.

16 In Italy, smoothed inflation was 2.8 percent in 2002 and 2.7 percent in 2008 before stepping down to 1.6 percent in 2009. In Spain, smoothed inflation ticked up from 2.6 percent in 2000 to 3.4 percent in 2002 and was still at 3.4 percent in 2008 before stepping down to 2.0 percent in 2009.

Based largely on the lack of inflationary pressure, Brooks, Heimberger, and Tooze (2020) argue that widely cited estimates of output gaps in Italy, Spain, and other European economies have been chronically overstated, particularly for the years prior to the Great Recession. It is worth noting that OECD estimates of the 2007 output and employment gaps of Italy and Spain that were released in December 2007 are far smaller than those released in later years. The estimated employment gaps for Italy and Spain were 0.7 percent in December 2007 but they rose to 2.4 percent for Italy and 5.8 percent for Spain by December 2020. These upward revisions represent a powerful example of the bias introduced by detrending techniques that force estimates of potential to stay close to average values of output or employment over time. The large and prolonged declines in output and employment after 2007 pushed down conventional estimates of potential and thus pushed up the implied gaps. Based on real-time estimates of potential and the subsequent behavior of inflation, Italy and Spain were probably operating close to potential in 2007 and then fell far below potential in 2009.

The Italian and Spanish "booms" are the reason that the employment gap whiskers for these economies on the right side of figure 3 extend much further into positive territory than those of any other economy. Italy and Spain also have large positive output gap whiskers on the left side of figure 3, but so do Japan and Sweden (even though they did not meet our employment gap criterion). Japan had a three-year period (1995-97) in which the IMF published output gap exceeded 3 percent, peaking at nearly 5 percent in 1996. (The OECD output gap for Japan never exceeded 2 percent over the same years.) Sweden had two years (2006-07) with an output gap of around 3 to 4 percent according to both published estimates.

These large published gaps in Japan and Sweden are likely overstated. Inflation in Japan was stable near zero in the late 1990s except for a temporary rise to 1 percent in 1997 when the value added tax was raised 2 percentage points. Inflation in Sweden was far below the 2 percent target in 2006-07. It did jump above 2 percent in 2008 because of a spike in global energy prices, but it fell back to roughly 2 percent the next year.[17] In both of these episodes, the positive gaps were small enough and short-lived enough that one might not expect a notable increase in inflation under the assumption of a flat linear Phillips curve. But, with a nonlinear Phillips curve with a steep segment when output is above potential as shown on the left side of figure 1, these episodes should have pushed inflation noticeably upward.[18]

Although the United States does not meet the criteria for an episode of large positive output or employment gaps defined above, it did come close in 1998-2000, for which the IMF estimates a peak output gap of 2.1 percent and the OECD's 2020 and 2021 estimated employment gaps both exceed 0.9 percent. Box 1 introduces a widely cited employment gap published by the Congressional Budget Office (CBO) for the United States, which peaked at 1.2 percent in 2000. The evidence from various measures of inflation suggests that the true US employment gap in 2000 was close to zero.

17 These statements are based on annual (not smoothed) PCE inflation in Japan and Sweden from the OECD.

18 Figure 1 is based on the unemployment gap, which has the opposite sign of the employment gap, so that a positive employment gap is on the left side of the curve.

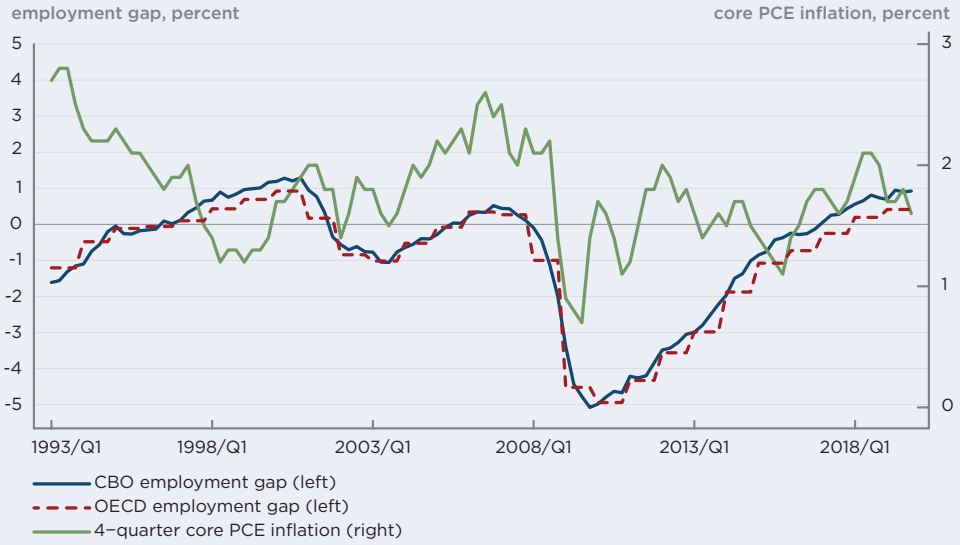
### Box 1 Overestimation of the US employment gap

The Congressional Budget Office (CBO) estimates U* for the United States based on a Phillips curve for married male unemployment over the period 1948-2004 and estimated relationships between U* for married males and U* for other demographic groups.[19] Married males are viewed as an important group with relatively high and constant attachment to the labor force and thus a relatively stable U*. The CBO estimates that the labor market was in equilibrium in 2005; changes in U* since then are limited to changes in the shares of demographic categories of the labor force that have different levels of U* (Brauer 2007; Shackleton 2018).

The CBO procedure likely has overestimated U* since the 1990s for a couple of reasons. First, the Phillips curve changed shape and became less persistent about 10 years before the end of the CBO estimation sample, calling into question the validity of the CBO estimates (Gagnon and Collins 2019a). Second, the average age of married males has increased with the general aging of the population.[20] Because older men are less likely to be unemployed, U* for this group should have been declining.

Figure B.1 displays the US employment gap based on the CBO estimate of U* along with the OECD's 2020 estimate of the employment gap. The two gaps are rather similar despite the different estimation methodologies. The largest positive gap occurred during the period from 1997 through 2001, with a peak around 1 percent.

Figure B.1
**Published employment gaps and core PCE inflation, United States, 1993Q1-2019Q4**




Note: Employment gaps are computed by subtracting the unemployment rate from the published equilibrium (noncyclical) unemployment rate (U*).
*Sources:* Organization for Economic Cooperation and Development, *Economic Outlook* database, No. 108, December 2020; and US Bureau of Economic Analysis, Bureau of Labor Statistics, and Congressional Budget Office via https://fred.stlouisfed.org.

19 The CBO allows for structural shifts in married male U* based on information about labor market efficiency derived from independent measures. The CBO notes that the Phillips curve approach does not work well after 2004.

20 Between 1990 and 2019, the proportion of married males who are 45 and older increased from 50 to 68 percent. *Source:* US Census Bureau.

Despite this sustained positive gap, core personal consumption expenditures (PCE) inflation (the solid green line) stepped down significantly in 1998, perhaps because of second-round effects from a drop in energy prices. Inflation bounced back in 2000 (when energy prices rose) but only to the rate that had prevailed in 1997. Core consumer price index (CPI) and trimmed mean PCE inflation also behave similarly. The rate of increase of hourly wages of production workers peaked at 4 percent in 1998 and stabilized near this level until after the recession of 2001. But, in light of steady productivity gains of more than 3 percent per year from 1998 through 2002, wages were, if anything, a disinflationary force.[21]

The evidence thus suggests that the US employment gap was close to zero in 1998-2000, about 1 percentage point below the CBO and OECD estimates. If the gap were to be shifted down 1 percentage point in the early years of figure B.1, it would be near -1 percent in 1995-96, which is more consistent with the declining rate of core PCE inflation in those years than the CBO's estimate of zero. Given the aging of the US labor force, it is likely that the error in the estimated gap has grown over time, suggesting a downward adjustment in 2019 somewhat greater than 1 percentage point, shifting the positive gap into negative territory, which is more consistent with the modest weakness of core inflation that year. The brief burst of inflation in 2006 might be taken as support of the CBO's estimated positive employment gap at that time. However, inflation returned to target in late 2007, before the gap turned negative, suggesting that the burst was simply part of the typical random noise in inflation.

### *Published employment gaps are not consistent with U* fundamentals*

Figure 4 displays unemployment rates and the OECD's 2020 estimates of U*.[22] In many economies there have been large movements in published U* both up and down since the mid-1990s. Yet, the most widely accepted fundamental drivers of U* have moved monotonically toward lower values of U* since 1995. This calls into question the published employment gaps derived from these estimates of U*.

Figure 5 displays three fundamental drivers of U*: (1) the ratio of the population aged 15-34 to the population aged 45-64, (2) the average number of years of schooling of the working-age population (ages 25 and above), and (3) the strictness of employment protection legislation.[23]

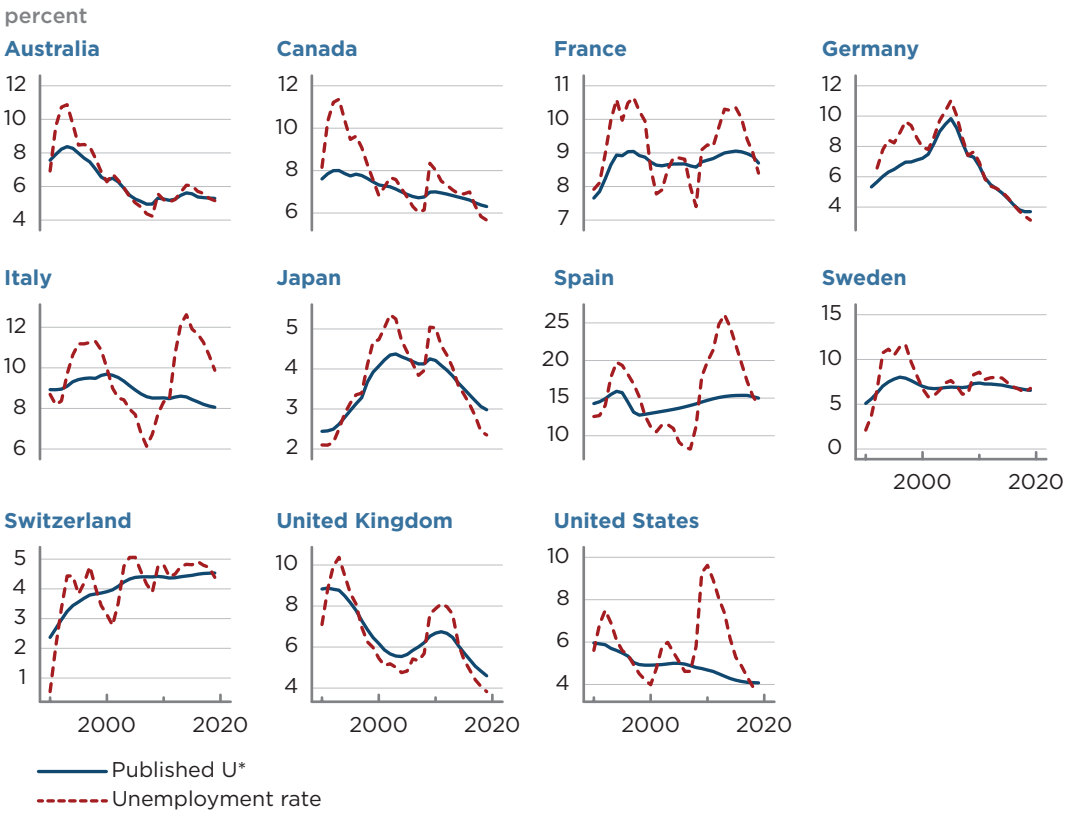
A younger workforce tends to increase U* because younger workers are more likely to be unemployed (Aaronson et al. 2015; Brauer 2007). The population has become older since the mid-1990s in all of these economies, which should push down U*.

21 Hourly earnings of production and nonsupervisory employees and labor productivity in the nonfarm business sector are from the Bureau of Labor Statistics via https://fred.stlouisfed.org.

22 The OECD's 2021 estimates of trend employment to population ratios are not comparable with estimates of U* because they commingle changes in unemployment and in labor force participation. Nevertheless, they too display large movements that are not consistent with the driving forces discussed here.

23 Another possible driver is changes in the power and prevalence of unions. Union coverage has been declining in the United States, which may be expected to reduce U* (Stansbury and Summers 2020).

Figure 4
**Unemployment rates and OECD's published U*, 1990-2019**




*Source:* Organization for Economic Cooperation and Development, *Economic Outlook* database, No. 108, December 2020.

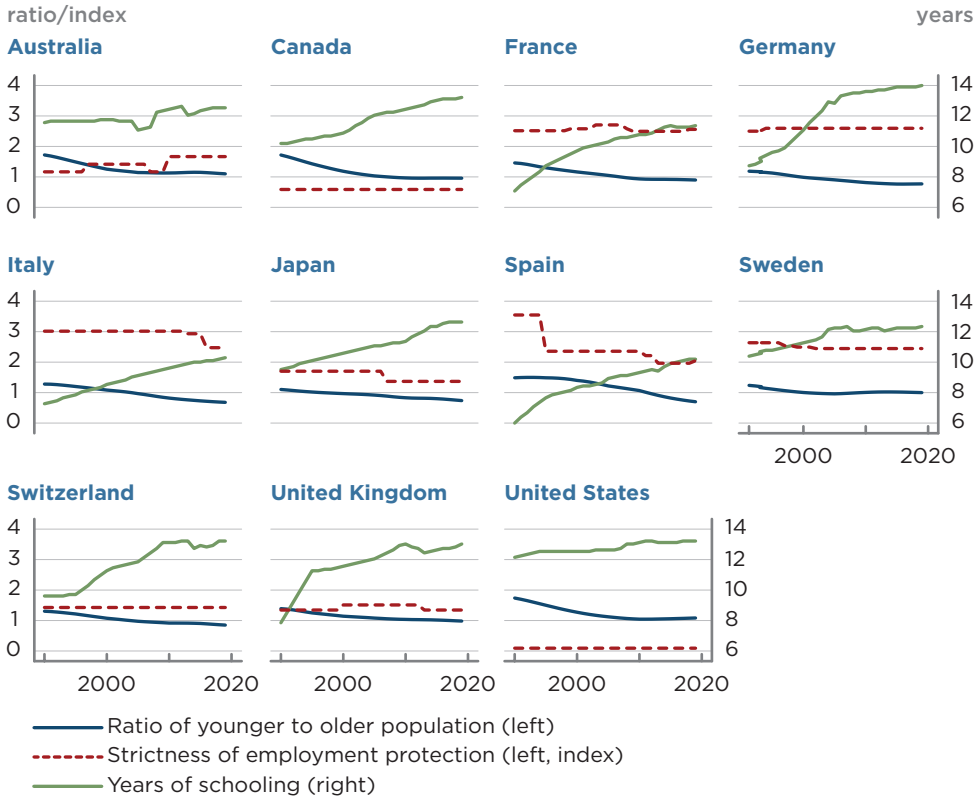
A more educated workforce tends to reduce U* because more educated workers are less likely to be unemployed (Aaronson et al. 2015; Brauer 2007). The population has become more educated since the mid-1990s in all of these economies, which should push down U*.

Stricter employment protection legislation tends to lengthen spells of unemployment and may increase the share of workers on temporary contracts who are more likely to lose their jobs in a recession (OECD 2020). The evidence that employment protection legislation increases U* is weak. Nevertheless, such legislation has mostly remained stable or become less strict since the 1990s, consistent with a stable, or slightly declining, value of U*.[24]

Figure 4 displays large increases in published U* in Germany in 1991-2005, Japan in 1993-2002, Switzerland in 1991-2009, and the United Kingdom in 2005-11. In none of these episodes does any of the fundamental drivers shown in figure 5 support a rising U*. These unsupported increases in published U* lead to excessively positive estimates of the employment gap, suggesting that true employment gaps are more negative than published gaps (and true *unemployment* gaps are more positive). Box 2 examines the case of Japan in more detail.

24 The Hartz employment reforms in Germany from 2003 to 2005 have no apparent effect on the OECD employment protections measure, but they may be partly responsible for the subsequent large decline in German unemployment and the OECD's published U* for Germany.

Figure 5
**Fundamental drivers of U*, 1990-2019**




Note: The figure displays (1) the ratio of the population aged 15-34 to the population aged 45-64, (2) the strictness of employment protection legislation (version 1, which has the longest available history of the four versions published by the OECD), and (3) the average number of years of education received by people ages 25 and older.

*Sources:* Organization for Economic Cooperation and Development, OECD Indicators of Employment Protection; United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects 2019, Online Edition, Rev. 1; and United Nations Development Programme, Human Development Data Center.

### *Revisions to published gaps suggest systematic overestimation*

Standard methods of estimating potential output and employment generate cyclical gaps that are revised in a predictable manner over time. Large shocks tend to cause estimates of potential output to be revised in the same direction as the shock (Coibion, Gorodnichenko, and Ulate 2018). Although interpreted by some observers as evidence of hysteresis,[25] this property is also predicted by asymmetric models of the business cycle based on downward rigidities (Aiyar and Voigts 2019).

A large negative demand shock in an economy with downward wage and price rigidity can lead to an extended period of a negative output gap, with little change to the true value of potential output. Standard methodologies, however,

25 Hysteresis is the property that shocks to employment and output have long-lasting effects on their equilibrium values. For example, a reduction in output reduces investment in productive capital, which reduces the level of potential output in the future.

are forced to revise down estimated potential to keep the average of the gap over time from becoming too negative. This appears to describe the behavior of published estimates of potential output and employment of several advanced economies since 2007, especially Italy and Spain.

### Box 2 The unexplained rise and fall of published U* in Japan

The 1990s were widely viewed as a lost decade for Japan's economy as equity and real estate prices deflated from their 1980s excesses. The unemployment rate, which had long hovered around 2.5 percent, began a steady rise to a peak of 5.4 percent in 2002. As shown in figure 4, the OECD's estimate of U* rises dramatically from 2.5 percent in 1992 to 4.4 percent in 2003. Inflation turned negative for the first time in the postwar era.

Figure 5 shows that the fundamental drivers of U* suggested a stable or declining level of U* throughout this sample. Another driver not shown in figure 5 is the adoption of policies after 2013 to encourage female participation in the labor force, which might be expected to raise U* at least temporarily because of the influx of new workers. But this cannot explain the rise of U* in the 1990s.

The OECD's *Economic Survey of Japan 2005* included a chapter on the labor market in which it estimated that U* had risen from 2.7 percent in 1990 to 4.0 percent in 2003. No specific reasons were given for this rise. The chapter focused on the damage caused by "increasing dualism" in the labor market, as part-time and temporary workers became more common. But the chapter's authors admitted that there is little evidence that dualism tends to increase U*. The chapter also noted the phenomenon of "hollowing out," as outsourcing is known in Japan, and an increase in the share of long-term unemployed workers in overall unemployment. The chapter did not link these developments to the rise in published U*.

The OECD's *Economic Survey of Japan 2019* again included a chapter on the labor market in which it noted that dualism, measured by the share of part-time and temporary workers relative to lifetime workers, had risen substantially further between 2006 and 2016. Most of the discussion focused on a perceived labor market shortage that should be addressed by increasing participation of the elderly, women, and immigrants. Despite the supposed labor shortage, inflation remained far below target albeit no longer in negative territory. No explanation was given for the decline in published U* from 4.0 percent in 2003 to 3.5 percent in 2019. In 2020, the OECD further reduced its published estimate of U* in 2019 to 2.9 percent.

A more plausible description of labor market slack in Japan over the past 30 years is that the employment gap was close to zero in 1993, it then fell dramatically to -3 percent in 2002, fluctuated between -2 and -3 percent for a decade, and then returned to near zero by 2018. In other words, the employment gap in Japan was negative (and the *unemployment* gap was positive) 24 years in a row from 1994 through 2017. It is during the years of the most negative output gap, from 2002 through 2012, that inflation was most frequently below zero.

In 2017-19, PCE inflation was between 0 and 1 percent, still below its 2 percent target but probably close to equilibrium given the many years of inflation at or below zero, which holds down expectations of future inflation. To generate sustained inflation near 2 percent, Japan may need many years of output above potential and unemployment below 2.5 percent to gradually raise long-term inflation expectations.

A large positive demand shock starting when the true gap is negative can push the gap toward zero, where it can remain indefinitely. However, a large positive demand shock starting when output is near true potential will cause a burst of inflation, which triggers tighter monetary policy that pushes output back down and closes the gap without requiring any revision in estimated potential. Since 1995, there have been few examples of large positive shocks that pushed up inflation and not estimates of potential output, suggesting that economies generally operated below potential when positive shocks occurred.

## Economies now operate on a very flat segment of the Phillips curve

### *Estimated Phillips curve slopes have flattened*

Table 1 displays estimated Phillips curves for the 11 economies before and after the transition to ultra-low inflation. For simplicity, we assume the transition occurred in 1995 for each economy. The first column displays results for a regression of the rate of PCE inflation from 1970 through 1994. The unemployment rate has a highly statistically significant negative effect.[26] A 1 percentage point decline in the unemployment rate is estimated to raise the PCE inflation rate 0.35 percentage point immediately and 0.89 percentage point in the long run (the bottom row of the table). The second column displays results over the same period for the rate of inflation of the GDP price index. The long-run impact of unemployment on GDP inflation is nearly identical to that on PCE inflation.

Columns three and four display results of regressions over the period 1995-2019. The Phillips curve is much flatter in this period. A 1 percentage point decline in the unemployment rate raises PCE inflation in the long run by only 0.12 percentage point and GDP inflation by only 0.18 percentage point.

The regressions include the ratio of the population that is 15 to 34 years old to those aged 45 to 64 years (youth ratio), which was displayed in figure 5. As previously discussed, this variable is widely believed to have an important influence on U*. The coefficient always has the correct sign, but it is statistically significant (at the 5 percent level) only for PCE inflation after 1995. Between 1994 and 2019, the youth ratio declined by an average of 0.4 in these economies, which would tend to reduce PCE inflation by about 1 percentage point in the long run.[27] The other variables displayed in figure 5, years of schooling and strictness of employment protection, are never statistically significant (at the 5 percent level) and are not included in the regressions of table 1.[28] Dropping the youth ratio has only a small effect on the remaining coefficients.

26 The regression does not include an employment or unemployment gap because we lack a reliable estimate of U*. However, the regression does include an important driver of U*, the ratio of younger to older people, which may control for shifts in U*.

27 The calculation is -0.4*1.36/(1-0.47) = -1.0.

28 Years of schooling data start in 1990 and cannot be included in the 1970-94 sample.

Table 1
**Panel Phillips curve regressions for 11 advanced economies, annual data**

| | 1970-1994 | | 1995-2019 | |
|---|---|---|---|---|
| *Variables* | *PCE inflation* | *GDP inflation* | *PCE inflation* | *GDP inflation* |
| Lagged inflation | 0.61**<br>0.06 | 0.50**<br>0.07 | 0.47**<br>0.06 | 0.29*<br>0.11 |
| Unemployment rate | -0.35**<br>0.05 | -0.44**<br>0.07 | -0.06*<br>0.02 | -0.13*<br>0.05 |
| Youth ratio | 1.97<br>1.00 | 2.06<br>1.23 | 1.36**<br>0.42 | 1.20<br>0.95 |
| Change in VAT | 0.42<br>0.24 | 0.69**<br>0.16 | 0.30<br>0.14 | 0.21<br>0.17 |
| Within $R^2$ | 0.87 | 0.83 | 0.64 | 0.45 |
| Observations | 236 | 236 | 275 | 275 |
| Long-run Phillips curve slope | -0.89**<br>0.17 | -0.88**<br>0.16 | -0.12**<br>0.04 | -0.18**<br>0.06 |

* p<0.05, ** p<0.01

Note: The long-run slope is calculated by dividing the unemployment rate coefficient by (1 minus the lagged inflation coefficient). Youth ratio is the ratio of the population aged 15 to 34 years relative to those aged 45 to 64 years. VAT is goods and services tax revenues as a percent of personal consumption expenditures. Standard errors (in blue) are clustered by country. All regressions include a full set of country and year fixed effects. Within $R^2$ excludes impact of country fixed effects. The 11 countries are Australia, Canada, France, Germany, Italy, Japan, Spain, Sweden, Switzerland, United Kingdom, United States.

*Sources:* Authors' calculations based on data from Organization for Economic Cooperation and Development, *Economic Outlook* database (No. 110, December 2021), Annual National Accounts database, and Revenue Statistics database; United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects 2019, Online Edition, Rev. 1; and Freund and Gagnon (2017).

The coefficient on the change in value-added and other indirect taxes (ΔVAT) always has the correct sign. It is highly significant for GDP inflation before 1995. It is weakly significant (10 percent level) for PCE inflation after 1995 and nearly so before 1995. Dropping this variable has little effect on the remaining coefficients.

All regressions include a full set of year effects to control for movements in global commodity prices. The year effects are jointly highly significant. Dropping the year effects (not shown) increases the magnitude of the estimated long-run effects of unemployment modestly in the post-1994 sample, from 0.12 to 0.18 percentage point for PCE inflation and similarly for GDP inflation. Dropping the year effects raises the estimated long-run effects more noticeably in the pre-1995 sample, from 0.89 to 1.61 percentage points for PCE inflation and similarly for GDP inflation.

Tests for a nonlinear Phillips curve did not find any significant evidence of nonlinearity. These tests were conducted by adding a variable that equals the difference between the unemployment rate and its economy-specific median when that difference is negative and zero when that difference is positive, similar

to the approach of Forbes, Gagnon, and Collins (2022).[29] (Similar tests were run using the difference between the unemployment rate and its economy-specific 25th percentile value, also yielding no significant evidence of nonlinearity.) We interpret the statistical insignificance of the nonlinear term as reflecting that (1) Phillips curves were predominantly linear in the high inflation sample of 1970-94 (see the right panel in figure 1), and (2) true unemployment gaps were almost exclusively above 0 in 1995-2019, thereby identifying only the flat (and thus linear) side of the curve (see the left panel in figure 1).

### *The bending of the Phillips curve can explain the apparent flattening*

The transition in the Phillips curve slope coefficients from the left side to the right side of table 1 may be caused by the shift to ultra-low inflation, which bent the Phillips curve, in addition to the greater frequency of periods of high unemployment. To show this, we run three sets of regressions on simulated data. First, we generate inflation using the linear equation 1. The coefficients on inflation and unemployment are based on the averages of the results in the first two columns of table 1 and the constant is chosen to yield average inflation of 2 percent.

$$\text{Inflation}_t = 0.90 + 0.55*\text{Inflation}_{t-1} - 0.40*(\text{Unemployment gap})_t + \text{Shock}_t \quad (1)$$

We take random draws on the shock to inflation (mean 0, standard deviation 1) and the unemployment gap (mean 0, standard deviation 2.5) and generate 1,000 samples of 100 observations each of inflation.[30] We regress inflation on lagged inflation and the unemployment gap. The averages of the 1,000 regression coefficients, coefficient standard errors, and regression $R^2$s are shown in column 1 of table 2. Each of the 1,000 regressions has 99 observations because the first observation is needed for lagged inflation. The average coefficient on the unemployment gap is -0.40, equal to its expected value.

We then generate inflation with a nonlinear, or bent, Phillips curve, similar to that on the left side of figure 1 and described in equation 2.

$$\text{Inflation}_t = 0.90 + 0.55*\text{Inflation}_{t-1} - \{0.40*(\text{Unemployment gap})_t \text{ if gap}<0\} - \{0.02*(\text{Unemployment gap})_t \text{ if gap}>0\} + \text{Shock}_t \quad (2)$$

Column 2 of table 2 shows that the average coefficient of a linear regression (equation 1) on these simulated data is -0.21, about halfway between the slope for a gap below 0 (-0.40) and the slope for a gap above 0 (-0.02).

29 The sample of Forbes, Gagnon, and Collins includes many countries that did not have continuous ultra-low inflation, which increases the occurrence of true positive employment gaps (negative unemployment gaps) so that the steep part of the curve may be identified.

30 The ratio of the standard deviations in the simulation, 1 to 2.5, is the average of the ratios of the standard deviation of the inflation residual to the standard deviation of unemployment in the data associated with the first two columns of table 1. The results of table 2 are not qualitatively affected by allowing for a positively autocorrelated unemployment gap.

Table 2
**Phillips curve regressions based on simulated data (averages of coefficients and standard errors)**
*Dependent variable is inflation*

| | Linear model | Nonlinear model | |
|---|---|---|---|
| | *Mean of unemployment gap* | | |
| *Variables* | *0* | *0* | *2.5* |
| Lagged inflation | 0.54**<br>0.06 | 0.53**<br>0.08 | 0.53**<br>0.09 |
| Unemployment gap | -0.40**<br>0.04 | -0.21**<br>0.04 | -0.08<br>0.04 |
| Constant | 0.93**<br>0.16 | 1.33**<br>0.24 | 1.17**<br>0.23 |
| $R^2$ | 0.64 | 0.43 | 0.31 |
| Observations | 99 | 99 | 99 |

* p<0.05, ** p<0.01

Note: Simulated data are generated by taking random draws on unemployment gap (mean 0 in columns 1 and 2, mean 2.5 in column 3, standard deviation 2.5 in all columns) and shock to inflation (mean 0, standard deviation 1). Refer to the text for linear and nonlinear equations used to generate inflation. Each column presents average results from 1,000 linear regressions run on a sample of 99 observations. Standard errors are in blue.

*Source:* Authors' calculations based on simulated data.

Finally, we changed the mean of the unemployment gap from 0 to 2.5.[31] With a standard deviation of 2.5, 84 percent of the observations of the gap are above 0. For these observations, the slope of the Phillips curve is very flat at -0.02. Only 16 percent of the unemployment gap observations are below 0, where the Phillips curve is steeper. Column 3 shows that the average coefficient of a linear regression on these simulated data is -0.08, close to the value estimated in recent data for advanced economies (column 3 of table 1) and implying a relatively flat Phillips curve.

These results show that the observed flattening of the estimated linear Phillips curve may indeed reflect a combination of a bending of the curve with ultra-low inflation and a preponderance of observations with a true unemployment gap above 0.

31 A more realistic regression would be based on an estimated unemployment gap constructed as the actual unemployment rate minus its sample mean, so that the preponderance of positive gaps would not be recognized. However, using this estimated gap changes only the intercept in column 3 and not the coefficient on the gap.

### *It is difficult to estimate U* in the flat region of a Phillips curve model*

A key implication of operating on a very flat region of the Phillips curve is that negative employment gaps (positive unemployment gaps), no matter how large, have very little impact on inflation. The simulated regressions discussed above assumed that unemployment gaps are known with certainty. But, in practice, U* is often estimated along with a Phillips curve model of inflation (Chalaux and Guillemette 2019).

When the economy is on a flat segment of the curve, the effects of unemployment on inflation are hard to detect because the unexplained variation in inflation is much larger than the estimated effect of a typical change in the unemployment rate. For example, in 1995-2019 the typical unexplained, or surprise, movement in PCE inflation in a given year is 0.6 percentage point, which is more than ten times larger than the short-run effect of the typical 0.9 percentage point year-on-year change in the unemployment rate and more than five times larger than the long-run effect.[32] Even the largest employment gaps, such as the roughly 10 percentage point negative gaps estimated by the OECD in 2020 for Spain in 2012-13 would affect inflation only by an amount about equal to that of the typical random shocks.[33] This low signal-to-noise ratio makes it extremely difficult for central banks to have confidence in their estimates of U*.

### *Hysteresis is at most a secondary feature of labor markets*

Estimating potential output and employment is generally viewed as an exercise in distinguishing between permanent and temporary (albeit possibly persistent) surprises in observed output and employment. The hysteresis hypothesis, in its simplest form, argues that all surprises are essentially permanent. Even a seemingly temporary shock such as military spending in a war or a monetary policy tightening causes changes in output and employment that tend to last because firms and workers quickly get used to the new environment and expect it to continue.

The case for hysteresis is strongest for potential output because increases in output tend to drive higher investment and innovation while improving labor skills, all of which support higher future output (Cerra, Fatas, and Saxena 2020). The case is weaker for potential employment, given the presumption that most of the working-age population desires employment. The secular and near monotonic runup in European unemployment rates in the 1970s and early 1980s was initially attributed to hysteresis driven by insider-outsider dynamics in labor markets (Blanchard and Summers 1986). However, as shown in figure 4, unemployment rates in many advanced economies have displayed pronounced swings with little secular trend since 1990, suggesting that the earlier European experience is not a generalized property of advanced-economy labor markets.

32 These figures are based on the data associated with column 3 of table 1.

33 Given the enormous variability of Spanish unemployment, it is likely that inflation is less sensitive to employment gaps in Spain than in the other advanced economies. The next largest negative employment gaps in these economies occurred in Italy and the United States at around -5 percent.

Tests for hysteresis in U* find only weak support in our data. The strict hysteresis hypothesis is that last year's rate of unemployment is this year's natural rate. The unemployment gap then is defined as the change in the unemployment rate (Gali 2020). A less strict version allows for both a constant long-run natural rate of unemployment and a short-run natural rate equal to last year's unemployment rate. Accordingly, we added the change in the unemployment rate alongside the level of the unemployment rate in each of the regressions in table 1. The coefficient on the change in unemployment is statistically significant (at the 5 percent level) with the correct (negative) sign only for GDP inflation after 1994. The coefficient is near zero and not significant for PCE inflation after 1994 and for GDP inflation before 1995. It has the wrong sign and is nearly significant for PCE inflation before 1995. Adding the change in the unemployment rate never changes the coefficient on the level of unemployment significantly, contrary to the predictions of the hysteresis model. Hysteresis may be present to a modest extent in labor markets, but it does not appear to be a dominant characteristic.

### Monetary policy has been excessively tight for many years

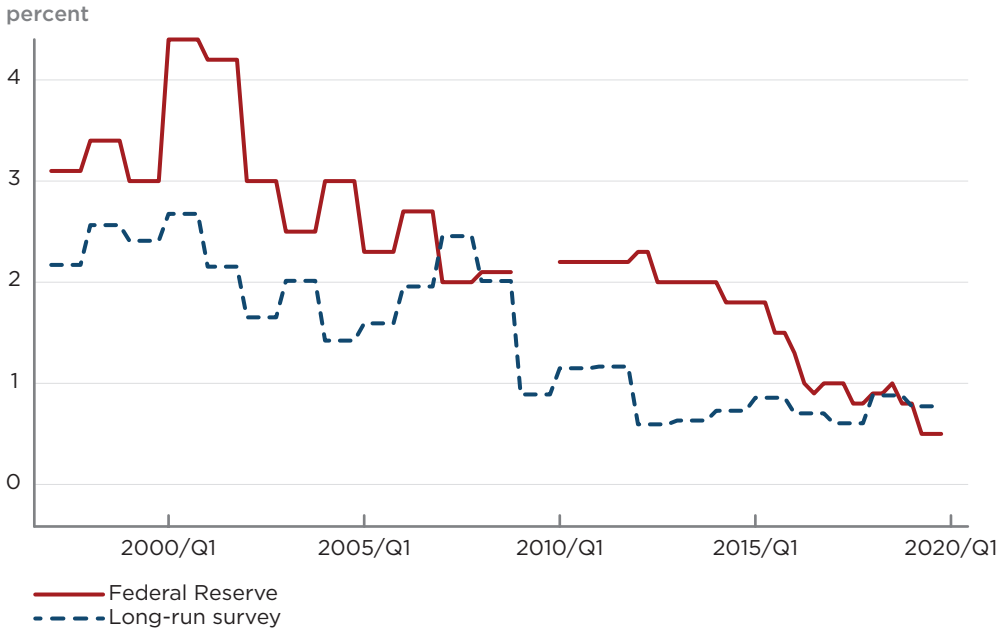
The evidence suggests that output and employment have been below potential in most, perhaps all, years in the major advanced economies since the mid-1990s. Moreover, conventional estimates of these gaps have been systematically biased upward toward zero, so that central banks were not fully aware of the sustained underperformance.

It also appears that central banks have systematically misjudged the effects of their policy stances because they did not understand that the equilibrium real interest rate had declined. Numerous studies have pointed to a secular decline in the equilibrium real rate of interest in the United States and other advanced economies since the 1980s (Laubach and Williams 2003; Holston, Laubach, and Williams 2017; Brand, Bielecki, and Penalver 2018; Rachel and Summers 2018; and Platzer and Peruffo 2022). The factors behind this downward trend may include declining rates of population growth, increasing longevity, slower rates of productivity growth, shifts in demand toward less capital-intensive services, greater saving rates by developing-economy and resource-exporting governments, and regulatory changes that increase demand for government-backed debt.

Figure 6 displays an estimate of the equilibrium natural real rate of interest derived from long-run projections of professional forecasters. It is based on 10-year forecasts of PCE inflation and Treasury bill rates after removing the influence of the 1-year ahead inflation forecast and the current bill rate.[34] Prior to 2009, the long-run forward real rate fluctuated around 2 percent. Since then, it has been below 1 percent.

34 The figure thus displays the 9-year real short-term interest rate projected to hold one year ahead. There likely remains residual cyclicality to the extent that deviations from long-run equilibrium are expected to last longer than one year.

Figure 6
**Declining estimates of the equilibrium real interest rate, R*, United States, 1997Q1-2019Q4**




Note: The long-run survey estimates are the difference between 10-year forecasts of Treasury bill rates and PCE inflation after removing the influence of the current bill rate and the 1-year ahead inflation forecast, taken from the Survey of Professional Forecasters. Thus, the figure displays the implied 9-year real bill rate one year forward. Prior to 2007, forecasts of CPI inflation are used, adjusted for the average difference between forecasts of CPI and PCE inflation in later years. Before 2012, the Federal Reserve estimates are taken from the furthest future value of the baseline optimal control real federal funds rate in the January Bluebook of each year. When only a nominal funds rate is available, the real rate is estimated by subtracting 2 percent. Since 2012, the estimates are the median long-run projection of the federal funds rate minus the 2 percent inflation target taken from the quarterly Summary of Economic Projections of FOMC participants. In 2009, the optimal control solution did not extend to a period of full economic recovery and thus it is not possible to calculate a long-run natural rate.

*Sources:* Survey data come from the Federal Reserve Bank of Philadelphia Survey of Professional Forecasters. Federal Reserve natural rates are taken from www.federalreserve.gov and https://fred.stlouisfed.org.

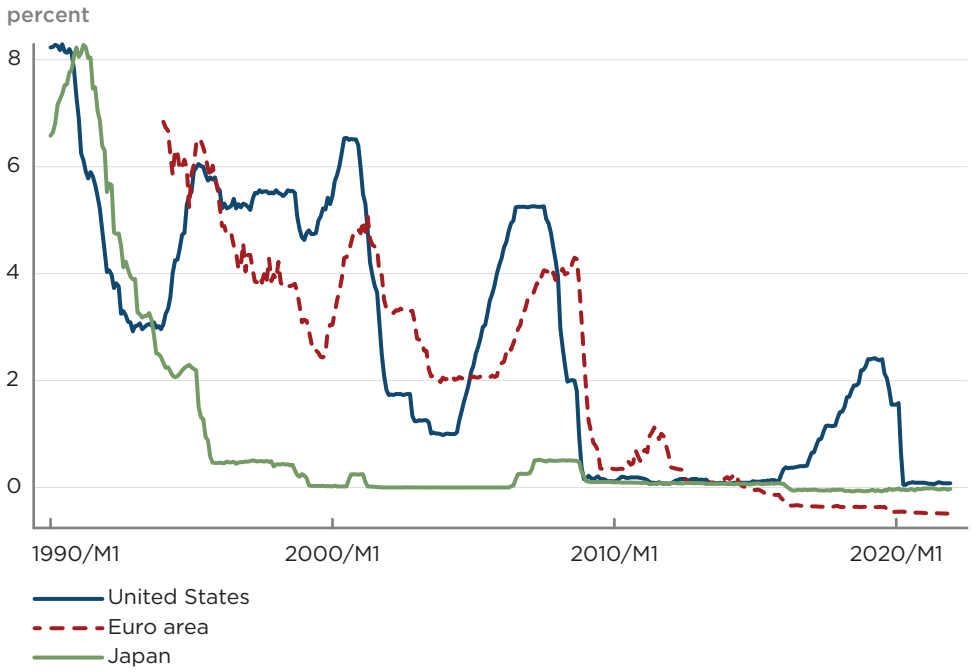
Figure 6 also displays estimates of the equilibrium real interest rate derived from published projections of the Federal Open Market Committee (FOMC) (since 2012) and the Federal Reserve Board staff's Bluebooks (before 2012). Prior to 1997, the FOMC did not have a clear inflation goal and it is difficult to interpret the Bluebook simulations as providing information on the equilibrium real rate. Since at least 1997, the Fed's estimated equilibrium real interest rate has been higher than that projected by professional forecasters in most years. The Fed's estimate is also higher than those estimated by Holston, Laubach, and Williams (2017), Rachel and Summers (2019), and others over the same period.[35] These

35 Buncic (2022) claims that the Holston, Laubach, and Williams estimates are about 1 percentage point too low, but even his alternative estimate is lower than the Federal Reserve estimate in most of these years. Buncic also argues that underestimating the natural rate may have caused central banks to set policy rates too low, thereby reinforcing the underestimation. However, sustained policy rates below the natural rate would have caused an inflationary boom that did not in fact occur in the decades before the COVID shock. As argued here, the evidence instead suggests that central banks overestimated the natural rate and allowed excessive economic slack at least until 2021.

data suggest that the Fed set monetary policy tighter relative to a neutral stance than it intended for more than 20 years prior to 2020. Chair Powell was right to question the Fed's estimate of R*.

Another reason central banks have been too tight on average is the zero lower bound on interest rates. Figure 7 displays policy interest rates for the United States, Japan, and the euro area since 1990. The constraint on lowering rates below zero has bound with increased frequency, starting with Japan in the 1990s and moving to the United States and the euro area since the Great Recession.[36] Central banks have used forward guidance and quantitative easing to relax this constraint, but it seems likely that such measures moved policy only partway to its optimal level (Gagnon and Collins 2019b).

Figure 7
**Overnight interest rates hit the zero bound, January 1990-December 2021**




Note: The figure shows the effective federal funds rate for the United States, the EONIA rate for the euro area, and the call money/interbank rate for Japan.

*Sources:* Board of Governors of the Federal Reserve System, European Central Bank, and Organization for Economic Cooperation and Development (Main Economic Indicators database), accessed via Macrobond.

Because central banks overestimated U* and R*, they inadvertently set monetary policy too tight on average over roughly the past 25 years. In addition, the zero lower bound on interest rates kept them from loosening more even when they wanted to do so. Altogether, this excess tightness has kept true output and employment gaps negative in most years. Because the Phillips curve slope is very

36 The European Central Bank was able to implement a modestly negative interest rate in the euro area, which the Bank of Japan and the Federal Reserve have chosen not to follow. But it is widely accepted that rates cannot be pushed much further below zero.

flat in this region, central banks did not observe noticeable downward pressure on inflation, which would have alerted them to their errors. Inflation tended to fall below target, but only to a modest and relatively steady extent.

### *An improved measure of unemployment gaps*

There is a strong case that unemployment rates in the advanced economies never fell significantly below their natural rates between the early 1990s and the COVID-19 pandemic. It is possible that unemployment was always significantly above its natural rate in some of these economies, but in many economies it is arguable that unemployment came close to its natural rate in the strongest cyclical upturns—most commonly in 2000, 2007, and 2019.

Figure 8 plots indicative unemployment gaps on the assumption that each economy had at least one episode of a near-zero unemployment gap from 1992 through 2018. The natural rate of unemployment, U*, is estimated by the centered three-year moving average rate of unemployment in the identified base year.[37] U* is then extrapolated forwards and backwards allowing for modest changes over time in proportion to changes in the ratio of young to old people in each economy.[38] There are thus trend declines in the natural rate from 1990 to 2019 of no more than, and typically less than, 1.6 percentage points. Except for Spain, most of these declines occur in the 1990s.

The unemployment gaps shown in figure 8 are the differences between the actual unemployment rates and the natural rates we construct. By construction, in each economy there is at least one episode with an unemployment gap close to zero. In Japan, it occurs near the beginning of the sample. In Australia, Italy, and Spain it occurs just before the Great Recession. In Germany, it occurs at the end of the sample. In the other economies, there are two or more episodes of near-zero gaps. Since 2000, Australia, Canada, and Sweden have had the best outcomes in terms of keeping the unemployment gap mostly below 2 percentage points. Spain has by far the most excessive unemployment. Overall, the figure shows significant room for improvement in all of these advanced economies.

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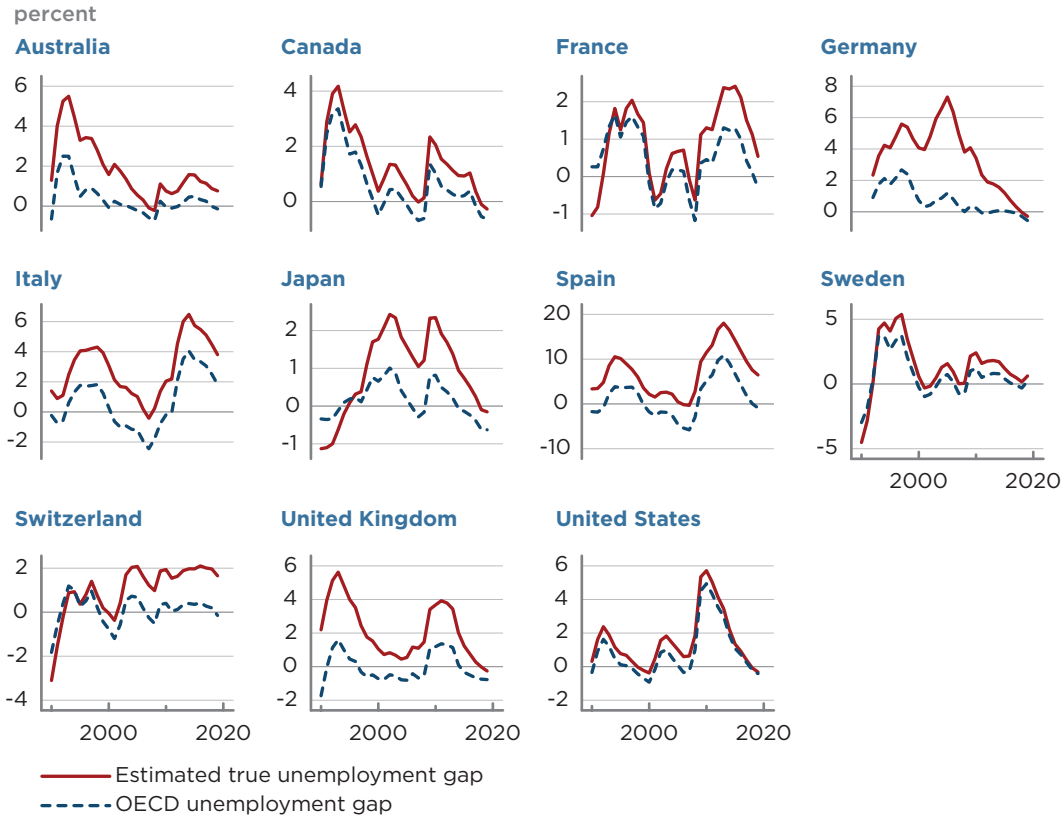
37 The base year is set when a 3-year centered moving average of age-adjusted unemployment reaches its low point. We start in 1992 because there is evidence of inflationary pressure in 1990-1991 in a few of these economies. We end in 2018 because the large and unprecedented pandemic shock affects the centered moving average in 2019. The age adjustment is described below.

38 Based on Canadian and US data, we assume that each unit decline in the youth population ratio reduces U* 2 percentage points. The OECD 2020 estimates of U* in Canada and the United States decline 1.3 and 1.9 percentage points from 1990 to 2019, a period over which the ratio of young to old in the population declines 0.76 and 0.65, respectively. Our estimated aging effect is conservative to the extent that the OECD's procedure is not based on demographic data and may understate the effect of aging on the natural rate in Canada and the United States. (The US Congressional Budget Office does incorporate demographic data in its U* estimate, which is broadly similar to that of the OECD.) On the other hand, it is possible that the effect of aging on the natural rate could be larger or smaller in other advanced economies relative to its effect in Canada and the United States.

The estimated effects of changes in the youth ratio and changes in unemployment on inflation in table 1 can be used to back out an implied change in unemployment needed to offset the declining youth rate for a given constant rate of inflation. But the resulting trends in the rate of unemployment are implausibly large, probably because the slope of the Phillips curve is mis-specified as linear and thus not well estimated.

The period with the lowest moving average unemployment rate is identified using an unemployment rate adjusted by the same youth ratio effect described here. In other words, an unemployment rate of 5 percent in 2019 reflects a labor market that is less tight than the same unemployment rate would imply in 1991.

Figure 8
**Estimated true unemployment gaps, 1990-2019**




Note: Estimates of the true unemployment gap are based on the difference between actual unemployment and an estimate of the natural rate, U*, that is constant over time except for a moderate decline in proportion to the aging of the population. U* is set equal to a centered three-year moving average of actual unemployment in the year in which a centered three-year moving average of age-adjusted unemployment reached its lowest level over the period 1992-2018. From this year, U* is adjusted backwards and forwards by two times the change in the ratio of the population aged 15-34 to the population aged 45-64 relative to its value in the base year. The OECD unemployment gaps are the December 2020 published values.

*Sources:* Authors' calculations based on data from Organization for Economic Cooperation and Development, *Economic Outlook* database, No. 110 (December 2021) and No. 108 (December 2020), and data from United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects 2019, Online Edition, Rev. 1.

### Economies with lower inflation had worse employment outcomes

As discussed above, there are theoretical grounds to believe that ultra-low inflation can persistently raise unemployment and possibly raise U* when downward wage and price rigidity is important. As argued by Akerlof, Dickens, and Perry (1996), this effect is likely to be particularly important when inflation falls below 2 percent.

The experience of the past 25 years provides some support for this conclusion. Economies that had lower inflation on average since 1995 had worse outcomes for employment. In particular, Japan and Switzerland had the lowest average rates of inflation over the period 1995-2019, around -0.3 percent for Japan and 0.4 percent for Switzerland. These economies experienced large increases in average unemployment rates over the period 1995-2019 compared

with their 1985-94 averages. Australia and Spain had the highest average inflation rates since 1995, 2.2 percent, and Australia's average unemployment rate decreased 2.6 percentage points in 1995-2019 compared with the 1985-94 average, while Spain's average unemployment rate was about unchanged across the two periods.

The correlation across these 11 economies between the average rate of inflation in 1995-2019 and the change in the average rate of unemployment between 1985-94 and 1995-2019 is -0.55, which is significantly different from zero at the 10 percent level. In other words, the evidence shows that economies with lower rates of inflation had worse employment outcomes relative to their averages prior to the shift to ultra-low inflation.

An alternative explanation for these results is that inflation expectations take a long time to adjust to persistent shifts in inflation. In the standard expectations-augmented Phillips curve, a persistently high unemployment gap is required to reduce inflation persistently below its expected value. Survey evidence supports a persistent excess of long-run inflation expectations over actual inflation in Japan and Switzerland.[39]

## THE COVID-19 PANDEMIC AND ITS AFTERMATH

On the eve of the COVID-19 pandemic in late 2019, the US Federal Reserve was cutting its policy rate below the level consistent with its contemporaneous estimate of R* despite having pushed unemployment below its contemporaneous estimate of U*. This move was a response to modest weakness in core inflation.

Pandemic-induced lockdowns in early 2020 pushed the US economy into a sharp recession. Unemployment soared and inflation ticked down further. Other advanced economies also experienced recessions and reductions in inflation.

Multiple large-scale fiscal spending packages in 2020 and 2021 enabled US households to maintain and even increase consumption spending. Unemployment plummeted. But many workers were either afraid or unable to return to work, raising U*. At the same time, household spending shifted dramatically away from in-person services to goods, putting the goods sector on the steep segment of the Phillips curve while services languished on the flat segment. The net effect was an increase in aggregate inflation as the higher goods inflation far exceeded slightly lower services inflation (Gagnon 2022).

US inflation soared in late 2021 and early 2022 to levels not seen in 40 years. Other advanced economies also have experienced relatively rapid recoveries with upward pressure on inflation. The fact that large positive employment gaps (negative unemployment gaps) are able to raise inflation significantly is strong evidence for a nonlinear Phillips curve of the type shown in figure 1.

39 Professional forecasts of average inflation over the next 10 years in Japan and Switzerland have been almost continuously above actual inflation since 2009, by an average of 0.8 percentage point in Japan and 1.3 percentage points in Switzerland. Forecasts in 2009-11 were above the averages of actual inflation over the subsequent 10 years by an average of 0.3 percentage point in Japan and 1.5 percentage points in Switzerland. Forecasts in 2012-16 for average inflation over the next five years were above the averages of actual inflation over the subsequent 5 years by an average of 0.6 percentage point in Japan and 0.9 percentage point in Switzerland. *Source:* October issues of *Consensus Forecasts*, 2009-2019 (April issue for 2011) and OECD *Economic Outlook* database, December 2021.

It would be a mistake to conclude that the problem of ultra-low inflation and excessive unemployment is permanently behind us. Rather, the situation is the result of a once-in-a-century shock and the policy response to that shock. The Russian invasion of Ukraine and subsequent rise in food and energy prices is another important contributor to high inflation in 2022 that may not persist in future years.

Over time, workers will return to their jobs. Spending will shift away from goods back to in-person services. In the United States, where the labor shock was most pronounced, U* will decline toward its original level. Fiscal deficits will shrink, allowing growth to cool off. Inflation will decline.

If fiscal policy returns to its pre-pandemic pattern and central banks retain their 2 percent inflation targets, the old problem of excess unemployment is likely to gradually return.

## POLICY CONCLUSIONS

Events in 2019 demonstrated the prescience of Chair Powell's 2018 speech. But the COVID-19 pandemic prevented the lesson from sinking in. Right now, central banks are focused on controlling inflation, a battle for which they have long prepared. But it would be a mistake to believe that a temporary shock, no matter how large, has rendered the experience of the previous 25 years irrelevant.

Central banks should incorporate downward wage and price rigidity and nonlinear Phillips curves into their models. They should not interpret a stable inflation rate as evidence that unemployment is equal to U*. They must recognize that stable inflation is also consistent with unemployment above U*, and thus a singular focus on stabilizing inflation is not sufficient to obtain the best economic outcomes. Moreover, they must actively learn about U* by pushing unemployment down until inflation pressure from an overheated labor market becomes apparent.[40] Only then should they tighten policy to relieve excess demand. They should also monitor the fundamental demographic and institutional drivers of U* to stay ahead of future changes.

Central banks should conduct research on the extent to which downward nominal rigidities interact with ultra-low inflation to raise U*. Such an effect has theoretical support. Although it has not been the subject of rigorous empirical study, differences in the behavior of average unemployment rates across advanced economies are consistent with the view that pushing inflation close to zero does raise U* to a meaningful extent. However, another interpretation is that U* did not rise and that Japan and Switzerland, in particular, had excessively tight macroeconomic policy that pushed output and employment gaps into negative territory and caused inflation to fall below target.

Most importantly and most controversially, central banks should raise their inflation targets to at least 3 percent or as much as 4 percent. The most widely accepted reason to raise the inflation target is to avoid lost employment and output by having policy constrained by the zero bound on interest rates.[41]

40 Volker Wieland (2003, Abstract) concludes that uncertainty about U* "motivates an element of experimentation in policy."

41 Gagnon and Collins (2019b) show that the policy space added from even a small increase in the inflation target is considerably higher than is commonly understood.

Andrade et al. (2019) argue that the optimal inflation target rises nearly 1 percentage point for each percentage point decline in the equilibrium real rate of interest. Given the observed decline in the equilibrium real interest rate, they recommend an increase of the inflation target of about 1 percentage point.

In addition, the Phillips curve would be more linear and U* easier to estimate if inflation averaged higher than 2 percent. Finally, if careful study shows that downward wage rigidity causes ultra-low inflation to raise U*, the case for a higher inflation target would be practically unassailable.

If inflation does not return quickly to the 2 percent target, central banks should not deliberately push their economies below potential and risk recessions in order to return to 2 percent. Instead, they should take the opportunity to correct the mistake of 25 years ago and raise their targets moderately above 2 percent.

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