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21-16 Dollar Not So Dominant

Dollar Invoicing Has Only a Small Effect on Trade Prices

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ABSTRACT

This paper estimates and tests four models of the effects of exchange rate changes on export prices. It supports the Goldberg and Knetter (1997) canonical result that exporters adjust their prices by about half of any movement in exchange rates. A new twist is that exchange rate movements against importing countries account for only three-fifths of this price adjustment, while exchange rate movements against a dominant currency account for the other two-fifths. The dominant currency is the euro in Europe and Africa and the US dollar in Asia and the Western Hemisphere. The recent claim that the dollar is the most important driver of export prices (Gopinath et al. 2020) is shown to be valid only for the smallest exporting economies. For the bulk of international trade, the extra effects of the dollar (or the euro) beyond their effects as exporter or importer currencies are relatively modest.

JEL Codes: F14, F32, F41

Keywords: Exchange rate pass-through, pricing to market, dominant currency paradigm, local currency pricing, producer currency pricing

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INTRODUCTION

Many exporters around the world quote prices and accept payment in dollars or euros, even when neither the exporting country nor the importing country uses the dollar or the euro for domestic transactions. For exporters that maintain prices fixed in dollars or euros, a broad appreciation of the dollar or the euro would raise export prices when converted into the currencies of both exporters and importers, potentially reducing international trade and dragging down global growth. Indeed, a recent study argues that "the US dollar plays an outsized role in driving international trade prices and quantities" (Gopinath et al. 2020, 695).

This paper shows that most of any outsized role for the dollar is limited to the smallest exporting economies; for the bulk of international trade, the effect of dollar invoicing diminishes after a few months. Instead, this paper supports the older conventional wisdom that export prices tend to move halfway between domestic prices and foreign prices when exchange rates move. The new twist is that only about three-fifths of the foreign price impact comes from prices in importing countries, whereas two-fifths are tied to either the dollar or the euro depending on the geographic location of the exporter.

BACKGROUND

For many years, economic textbooks employed the simple assumption that the prices of a country's exports are identical to the prices of similar goods in its domestic markets. This model of export pricing is known as producer currency pricing (PCP). Although it was widely accepted that exporters in a large country such as the United States would follow domestic prices, it was less clear that exporters in smaller countries would do so. However, Sven Grassman (1973) reported that Swedish exporters typically invoice prices and accept payment in Swedish krona, whereas Swedish importers typically pay for imports in foreign currencies. These findings are consistent with the PCP model, although it should be noted that invoicing in exporter currency does not preclude export prices from moving independently of domestic prices (see box 1). When inflation rates are low and stable at home and abroad, PCP implies that a currency appreciation will cause a country's exports to become more expensive in terms of the currencies of its foreign buyers, while a depreciation will make its exports cheaper.

Peter Hooper and Catherine Mann (1989) observed that the pronounced appreciation of most foreign currencies against the US dollar in the late 1980s did not lead to a comparable increase in the prices of US imports, contrary to the predictions of the PCP model. Subsequently, an outpouring of research found that export prices sometimes follow prices in the importing markets and that this behavior can lead to different prices being charged for the same product in different destinations. This phenomenon is called local currency pricing (LCP).

Pinelopi Goldberg and Michael Knetter (1997) surveyed studies on different countries and products at varying levels of aggregation and found a canonical result for manufactured exports[1] that prices tend to split the difference between the predictions of the PCP and LCP models. In other words, an exchange rate

1 Prices of primary commodities are roughly equal across exporters and are determined by global supply and demand conditions.

appreciation of, say, 10 percent would raise prices in importer currency by 5 percent and lower prices in exporter currency by 5 percent.[2]

Box 1 Does currency of invoice matter?

It is generally accepted that prices of goods and services are slow to adjust to changing circumstances in modern industrial economies. Broad price aggregates, such as the producer price index, are "sticky" when expressed in terms of domestic currency. Exchange rates between currencies, however, move rapidly, as do prices of other financial assets such as stocks and bonds. Thus, a producer who wishes to keep her export prices close to the prices of her domestic sales would find it more convenient to invoice in domestic currency because prices invoiced in foreign currency would need to be adjusted frequently as exchange rates move. For this reason, researchers typically assume that export prices are sticky in the currency in which they are invoiced.

However, some of the forces behind sticky domestic prices operate differently in international trade. An exporter's major input costs, such as wages and rents, may be sticky in domestic currency, but the prices her competitors charge in foreign markets may be sticky in foreign currency. In a world of volatile exchange rates, producers have an incentive to adjust their export prices more frequently and by larger amounts than their domestic prices in order to stabilize foreign sales.

In their overview of trade invoicing and exchange rate effects on trade prices, Linda Goldberg and Cedric Tille (2006) find that prices tend to be relatively more stable in the currency of invoice but that there is still considerable adjustment of invoice prices to exchange rates. For example, they report that 93 percent of US imports were invoiced in dollars in 2003. (No other country has such a high share of its imports invoiced in its own currency.) If invoice prices do not respond to exchange rates, that would imply that only 7 percent of any change in exporter currency against the dollar would show up in US import prices. Yet the authors summarize studies as showing that US import prices move by 25 to 40 percent of any change in exporter currency. Gita Gopinath, Oleg Itskhoki, and Roberto Rigobon (2010, figure 1) show that prices of US imports invoiced in foreign currencies move roughly 100 percent of any change in the value of the invoice currency. They also show that prices of imports invoiced in dollars respond gradually to any change in exporter currency, rising to about 17 percent of the exchange rate change after 12 months. Although exchange rates affect dollar-invoiced prices much less than other import prices, the effect is significantly greater than zero.

Gita Gopinath and colleagues (2020) proposed a new model of export pricing that they label the dominant currency paradigm (DCP). The DCP is motivated by the fact that many exports of smaller countries are invoiced in US dollars or euros, even when neither the exporter nor the importer uses the dollar or the euro as its domestic currency. Gopinath et al. run regressions that nest the PCP, LCP, and DCP models. They regress bilateral import prices on exporter producer price indexes (PPIs), the bilateral exporter-importer exchange rate, and the bilateral importer–United States exchange rate (all variables are

2 Other studies have found somewhat lower pass-through of exchange rates to import prices in the United States than in other countries, which may be related to the relatively high share of US imports invoiced in US currency, as discussed in box 1.

expressed as rates of change).[3] They do not report coefficients on exporter PPI, but they do show that the DCP effect (US exchange rate coefficient) is notably larger than the effect of the exporter exchange rate, which they implicitly interpret as a measure of the PCP effect. They do not report an estimate of the LCP effect, but their results imply that it is very small.

Yet another potential model of export pricing might be called global currency pricing (GCP), in which exporters charge a common global price for their products. GCP describes primary commodity trade well, but it does not work on its own as a simple model for manufactures. However, it is an open question as to whether GCP has a role as part of a more complicated model that combines elements of PCP, LCP, and DCP behavior.

This paper examines evidence on the four export pricing models—PCP, LCP, DCP, and GCP—in a sample of 33 countries over the period 1983–2019. Table 1 lists and briefly defines the four models. They are not mutually exclusive; it is rather a question of gauging the relative importance of each.

Table 1
Models of export pricing

Producer currency pricing (PCP)	Export prices move with exporter PPI
Local currency pricing (LCP)	Export prices move with importer PPI
Dominant currency paradigm (DCP)	Export prices move with US (or euro area) PPI
Global currency pricing (GCP)	Export prices move with global (GDP-weighted) PPI

PPI = producer price index

REGRESSION SPECIFICATION AND DATA

We consider a regression specification of the following form:[4]

$$\Delta PX_{it} = \beta_1 \Delta PCP_{it} + \beta_2 \Delta PCP_{it-1} + \gamma_1 \Delta LCP_{it} + \gamma_2 \Delta LCP_{it-1}$$
$$+ \mu_1 \Delta DCP_{it} + \mu_2 \Delta DCP_{it-1} + \lambda_1 \Delta GCP_{it} + \lambda_2 \Delta GCP_{it-1} + \alpha_i + \tau_t,$$

where PX is the price of goods and services exports from the national income accounts and subscripts *i* and *t* denote countries and years, respectively. Greek letters (except Δ) denote parameters to be estimated, including full sets of country and time effects; Δ denotes the year-over-year logarithmic percent change in a variable. PCP is the exporter's PPI. LCP is the average PPI of all importing countries converted into exporter currency and weighted by the share of exports to each country.[5] DCP is the PPI of either the United States or the euro area converted into

3 They do not include US and importer PPIs in their main regressions. This omission may bias their results against the LCP model, especially if some importers have high inflation, as discussed later in this paper.

4 Feenstra, Gagnon, and Knetter (1996) derive a similar export pricing equation (minus the DCP and GCP terms) in a framework of imperfect competition with segmented markets.

5 LCP and GCP are calculated based on data for the 33 exporting countries in the sample plus the United States and the euro area.

exporter currency.[6] GCP is the PPI of every country in the dataset converted into exporter currency and weighted by its share of world GDP in US dollars.

In our baseline model, DCP is calculated using US PPI for Asian and Western Hemisphere countries (including Israel and Jordan) and euro area PPI for African and European countries (including Turkey). This specification fit uniformly better than DCP based solely on either the United States or the euro area. The effects of exchange rates on export prices show up in the coefficients on LCP, DCP, and GCP because these variables are foreign prices converted into exporter currency using the relevant exchange rates.

The sample includes all countries with available data and 2019 nominal GDP greater than $10 billion, except the following: the United States, countries that use the US dollar as their main currency, euro area countries, and economies with primary commodity exports higher than one third of their merchandise exports. The latter economies are excluded because primary commodity prices are determined in global markets and do not differ significantly across exporters. Concerns about data quality led us to drop data from formerly socialist economies (except China and Hungary) before 1999; the first rates of change for these countries are in 2000.

There are 33 countries in our dataset covering the period from 1983 to 2019. Appendix A provides details on country coverage, data sources, and the construction of the variables.

RESULTS

Column 1 of table 2 displays the baseline results. The reported effects are the sums of the estimated coefficients on the current and lagged values of the independent variables. Thus, the table reports the cumulative effects of the independent variables after a year has gone by. Standard errors are clustered by country. Standard errors on the sums of coefficients are based on the estimated covariance matrix of the coefficients. Neither a lagged dependent variable nor additional lags of the independent variables are statistically significant at the 5 percent level.

Export prices are most strongly influenced by domestic prices (PCP coefficient of 0.52) but importer prices also have an important effect (LCP coefficient of 0.28). The effect of a dominant currency (over and above its role as an element of importer prices) is moderate (DCP coefficient of 0.20) and statistically significant. These coefficients imply that a 1 percentage point increase in exporter PPI raises export prices 0.52 percent, the same increase in exchange-rate-adjusted importer PPIs raises these prices 0.28 percent, and in the exchange-rate-adjusted US or euro area PPI raises export prices 0.20 percent. Adding the LCP and DCP coefficients together to get an estimate of the overall effect of exchange rates on export prices of 0.48 leads to a conclusion remarkably close to the canonical finding of Goldberg and Knetter (1997) that half of an exchange rate change is passed through to importers, with exporters absorbing the other half.

6 The euro was not created until 1999, but the German mark may have played the role of a dominant currency—the currencies of the initial members of the euro area were linked increasingly tightly to the mark from 1979 through 1998.

Column 2 shows that the GCP effect is small (0.07) and not statistically significant. Because LCP and GCP are highly correlated with each other, neither coefficient on its own is statistically significant. However, replacing LCP or DCP with GCP in column 1 leads to a slightly poorer fit (lower R^2) and a smaller coefficient on GCP than on LCP or DCP. Although we cannot rule out some role for GCP, the principle of parsimony leads to keeping LCP and DCP and dropping GCP.

Table 2
Export pricing models, full sample

Variable	**Baseline**	**With GCP**	**No outliers**	**No lags**	**No time effects**	**US PPI**
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
ΔPCP	0.52** 0.05	0.52** 0.05	0.52** 0.07	0.45** 0.05	0.51** 0.05	0.54** 0.05
ΔLCP	0.28** 0.09	0.19 0.17	0.23** 0.08	0.36** 0.07	0.25** 0.09	0.50** 0.11
ΔDCP	0.20* 0.08	0.22* 0.09	0.20** 0.07	0.17* 0.06	0.24** 0.07	
ΔGCP		0.07 0.11				
ΔDCPUS						-0.04 0.11
Observations	891	891	855	922	891	891
Within R^2	0.904	0.905	0.632	0.900	0.888	0.903

* $p < 0.05$, ** $p < 0.01$

Note: Estimates, except in column 4, are the sums of coefficients on the current value and one lag of the independent variables. Standard errors (in blue) are clustered by country. For coefficient sums, standard errors are computed from the estimated coefficient covariance matrix. Within R^2s refer to the percent of variation explained after removing country effects.

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

Column 3 displays a regression that excludes high-inflation outliers, defined as observations in which any one of the five price variables increases or decreases by more than 40 percent. Relative to baseline, this reduces the coefficient on LCP by a small amount with little effect on the other coefficients.[7]

Column 4 shows that removing the lagged variables reduces the PCP effect slightly and raises the LCP effect slightly, but neither change is statistically

7 We also tried excluding even more outliers, by dropping any observation with a price change of more than +/− 20 percent. The resulting coefficient for LCP is little changed from that shown in column 3, but the coefficients on PCP and DCP decline by about one standard deviation each.

significant.[8] Other studies find that the speed of adjustment of trade prices to exchange rates is rapid, with full adjustment occurring in three to six months (Goldberg and Knetter 1997; Vigfusson, Sheets, and Gagnon 2007).

Column 5 shows that the results are robust to dropping the time effects, with only a small and not statistically significant increase in the coefficient on DCP.

Finally, column 6 shows that defining the DCP variable entirely in terms of dollars and US PPI leads to a statistically insignificant DCP coefficient close to zero. The R^2 declines by a tiny amount. Defining DCP entirely in terms of euros also leads to a lower R^2 and yields a negative coefficient on DCP (not shown).

Table 3 displays results for the baseline model in different subsamples. Column 1 shows that the coefficients for the advanced economies are broadly similar to those for the full sample, with a larger LCP coefficient and a smaller DCP coefficient. This result is robust to dropping time effects (not shown). When outliers are dropped, the PCP and DCP coefficients decline and the LCP coefficient rises (column 2).

Table 3
Baseline export pricing model, restricted samples

Variable	Advanced economies		Developing economies			2000-19	
	Baseline	No outliers	Baseline	No time effects	No outliers	Baseline	Coefficients sum to 1
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
ΔPCP	0.54** 0.05	0.41** 0.10	0.44** 0.06	0.48** 0.07	0.44** 0.08	0.37** 0.05	0.46** 0.04
ΔLCP	0.35* 0.12	0.40** 0.12	0.35 0.17	0.23* 0.11	0.20 0.11	0.36** 0.09	0.36** 0.08
ΔDCP	0.10 0.11	0.05 0.10	0.20 0.15	0.31** 0.07	0.28** 0.08	0.14 0.07	0.18* 0.08
Observations	358	354	533	533	501	588	588
Within R^2	0.968	0.769	0.865	0.831	0.627	0.665	0.598

* $p < 0.05$, ** $p < 0.01$

Note: Estimates are the sums of coefficients on the current value and one lag of the independent variables. Standard errors (in blue) are clustered by country and for coefficient sums are computed from the estimated coefficient covariance matrix. Within R^2s refer to the percent of variation explained after removing country effects.

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

For developing economies (column 3) the coefficients are again roughly similar to the full sample results, with a smaller PCP effect and a bit more LCP effect. Dropping the time effects (column 4) leads to a noticeably larger DCP effect at the expense of the LCP effect. Dropping outliers (column 5) also leads

8 A difference in coefficient values is considered to be statistically significant if it exceeds twice the standard error of the baseline coefficient value.

to a smaller LCP coefficient and a larger DCP coefficient. These differences are relatively minor, with the PCP effect remaining the largest coefficient across the various specifications.

Column 6 displays the baseline model estimated on the second half of the sample period. Compared to the full sample results (column 1 of table 2) the PCP and DCP effects decline and the LCP effect rises. However, the sum of the coefficients is smaller, 0.87 versus 1.00 in the full sample, and the t-statistic on this difference is statistically significant.

In principle, one would expect these coefficients to sum to one, so that a generalized increase in domestic and exchange-rate-adjusted foreign prices raises export prices proportionally. The smaller PCP coefficient in the second half of the sample may reflect the smaller variation in PCP after 2000, which leads to a downward-biased and less precise estimate of the PCP coefficient.[9] Exchange rates, on the other hand, are measured very precisely and have a great deal of variation, leading to less biased and more precise estimates of the LCP and DCP coefficients. Column 7 shows that imposing the restriction of summing to one moderately increases the PCP coefficient, slightly increases the DCP coefficient, and has little effect on the LCP coefficient.

The coefficient estimates in table 3 broadly support the Goldberg-Knetter result of a 50-50 split in the effect of exchange rates on trade prices, with just a bit more weight on domestic prices and a bit less weight on foreign prices in the advanced economies and vice versa in the developing economies and in the second half of the sample.

Table 4 shows results for the baseline regression run separately for each country in our sample.[10] The individual country results generally confirm conclusions derived from the panel regressions. The average values of the coefficients across the columns of table 4 are 0.36 for PCP, 0.19 for LCP, and 0.35 for DCP.[11] These values imply a bigger role for the DCP model than in the baseline panel results. However, we note that the DCP coefficients are imprecisely estimated with large standard errors. The sums of the PCP coefficients are positive and statistically significant in 14 of 33 regressions, whereas with the LCP coefficients this is the case in 7 regressions and with the DCP coefficients in only 5 regressions. Also, the country samples are relatively small to be estimating so many coefficients. Of 84 lag coefficients across the 28 countries with sufficient data to estimate lags, only 15 are significant at the 5 percent level. When regressions are run without lag terms, the weighted averages of the resulting coefficients are 0.40 for PCP, 0.35 for LCP, and 0.12 for DCP.

All the countries in table 4 that have a DCP coefficient greater than 0.30 (except Denmark and Israel) were developing economies at the midpoint of our sample, 2000. Nine of them are in the euro's sphere of influence and seven are in the dollar's. Nine other developing economies have a DCP coefficient less than 0.30.

9 The standard deviation of the change in PCP is 19 percent before 2000 and 6 percent afterward. This decline reflects the widespread stabilization of inflation around the world. If measurement error induced by the different commodity composition of PX relative to PPI remains constant over time while inflation has gotten less variable, then the signal-to-noise ratio would have declined after 2000, increasing the downward bias in the coefficient estimate.

10 Time effects are not identified in regressions on individual countries and are not included in table 4.

11 The averages are weighted by the number of available observations in each country.

Table 4

Baseline export pricing model, individual country samples, no time effects

Variable	Albania	Bosnia and Herzegovina	China	Croatia	Czech Republic	Denmark[A]	Dominican Republic	Hong Kong[A]	Hungary	India	Israel[A]
ΔPCP	-0.62 0.34	-0.10 0.07	0.17 0.18	0.30 0.29	0.07 0.09	-0.16 0.18	-0.41 0.78	0.99** 0.21	0.44* 0.18	0.04 0.44	0.21 0.10
ΔLCP	-4.66* 2.11	0.78 1.14	0.60 0.29	0.22 0.84	-0.23 0.39	0.55* 0.20	-0.09 0.67	-0.03 0.13	0.49 0.67	0.34 0.27	0.26 0.15
ΔDCP	5.49* 2.36	0.50 1.39	0.50 0.33	0.16 0.73	0.96* 0.40	0.64 0.38	1.41 1.76	0.03 0.16	0.33 0.63	0.27 0.22	0.52** 0.14
Constant	1.39 0.82	0.31 0.42	-1.39* 0.65	1.20** 0.26	-0.02 0.19	-0.06 0.31	-2.29 4.62	-0.33 0.42	-2.22** 0.63	1.75 1.28	-0.73 0.46
Observations	19	11	28	19	19	37	5	25	28	37	37
R^2	0.539	0.908	0.934	0.780	0.909	0.887	0.881	0.823	0.952	0.564	0.997
Variable	**Japan[A]**	**Jordan**	**Korea[A]**	**Malaysia**	**Mexico**	**Morocco**	**North Macedonia**	**Pakistan**	**Philippines**	**Poland**	**Romania**
ΔPCP	0.16 0.19	0.38** 0.04	-0.03 0.14	0.67* 0.27	0.46** 0.14	0.28 0.38	0.02 0.70	1.29** 0.20	0.44 0.25	0.58* 0.22	0.64** 0.12
ΔLCP	0.31* 0.11	-0.01 0.20	0.98** 0.11	0.04 0.39	0.03 1.04	0.03 1.42	-0.79 1.88	0.16 0.31	0.11 0.22	-0.15 0.69	0.18 1.03
ΔDCP	0.10 0.09	-0.62 0.32	-0.43** 0.11	0.47 0.26	0.53 1.03	0.60 0.98	2.21 2.18	0.13 0.30	0.63 0.34	0.51 0.63	0.19 0.94
Constant	-1.57** 0.21	3.91** 0.57	-0.75 0.57	-1.23 1.04	0.08 0.97	-0.01 0.69	0.49 1.30	-5.47** 1.74	-2.44* 0.95	0.89** 0.29	-0.07 0.83
Observations	37	16	37	34	37	21	19	37	37	19	19
R^2	0.943	0.915	0.881	0.746	0.963	0.703	0.584	0.679	0.748	0.895	0.954

Variable	Serbia	Singapore[A]	Sri Lanka	Sweden[A]	Switzerland[A]	Taiwan[A]	Tanzania	Thailand	Turkey	United Kingdom[A]	Vietnam
ΔPCP	0.33** 0.08	0.42** 0.09	0.89** 0.28	0.52** 0.12	0.95** 0.31	0.19 0.16	1.10 0.44	0.11 0.13	0.42** 0.13	0.09 0.13	0.34 0.30
ΔLCP	0.16 0.51	0.12 0.24	-0.37 0.34	0.20 0.14	0.36* 0.14	0.08 0.19	1.44 0.39	0.40** 0.14	1.66** 0.59	1.04** 0.27	-0.01 0.16
ΔDCP	0.48 0.49	-0.04 0.11	0.28 0.42	0.23 0.13	-0.28 0.15	0.26** 0.09	0.23 0.11	-0.03 0.12	-1.06 0.59	-0.42 0.27	1.67** 0.30
Constant	0.25 0.40	-0.76* 0.30	1.60 2.65	-1.08** 0.28	0.19 0.31	-1.11** 0.23	-7.43 4.15	1.40* 0.51	-1.00 0.87	0.02 0.49	-4.81** 1.02
Observations	11	37	37	37	37	37	6	37	32	37	10
R^2	0.969	0.808	0.534	0.835	0.608	0.743	0.901	0.668	0.986	0.757	0.985

"A" denotes advanced economy; * $p < 0.05$, ** $p < 0.01$

Note: Estimates are the sums of coefficients on the current value and one lag of the independent variables. Because of limited observations, regressions for Bosnia and Herzegovina, the Dominican Republic, Serbia, Tanzania, and Vietnam do not include lags. Robust standard errors (in blue) are computed from the estimated coefficient covariance matrix.

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

To check on our assumption that economies in Africa and Europe follow the euro whereas economies in Asia and the Western Hemisphere follow the dollar, we run two regressions for each country with DCP based on either the United States or the euro area and compare the resulting DCP coefficients. Of the 16 economies assumed to be in the euro's sphere of influence, only three (Switzerland, Turkey, and the United Kingdom) have higher DCP coefficients based on the dollar. Of the 17 economies assumed to be in the dollar's sphere of influence, only four (Jordan, Korea, Singapore, and Thailand) have higher DCP coefficients based on the euro.

COMPARISON WITH FINDINGS OF GOPINATH ET AL.

Gopinath et al. (2020, table 3) report considerably larger DCP coefficients than those presented here. Differences between the data and specification of table 2 in this paper and those of table 3 in Gopinath et al. include:

- Gopinath et al. use bilateral import prices covering over 2600 country pairs. This study uses aggregate export prices covering 33 countries.
- Gopinath et al. use annual data from 1992 through 2015. This study uses annual data from 1983 through 2019.
- Gopinath et al. construct aggregate import prices using unit value data for goods at the Harmonized Schedule 6-digit level, excluding primary commodities. This study uses national income accounts goods and services export deflators for countries with low levels of commodity exports.
- Gopinath et al. assume the US dollar is the dominant currency for all exporters in the regressions reported in their table 3, though they consider the possibility of the euro as a dominant currency elsewhere in their paper. This study allows the dominant currency to vary by exporter location.
- Gopinath et al. do not include importer or US PPIs in the control variables of their table 3, but they do have an online appendix that includes importer PPIs. This study includes importer and US (or euro area) PPIs converted by their respective exchange rates into exporter currency.
- Gopinath et al. include two lags of all variables in addition to their contemporaneous values. This study includes one lag of all variables in addition to their contemporaneous values.
- Gopinath et al. report only the contemporaneous coefficients, which represent the impact effect of exchange rates. This study reports the sums of the contemporaneous and lag coefficients, which represent the effects of exchange rates after one year.

Appendix B lays out a general model of export pricing within which the model of this paper and that of Gopinath et al. may be derived as special cases.[12] The general model enables us to translate the coefficients of Gopinath et al. into estimates of the PCP, LCP, and DCP effects reported here.

12 Gopinath et al. also display regressions that include interactions of exchange rate changes and the share of a country's imports invoiced in dollars. These regressions show that import prices are more responsive to the dollar when a larger fraction of imports is invoiced in dollars. However, the regressions are less useful for measuring the effects of different exchange rates on average import prices.

The first column of table 5 reports the baseline coefficients of this paper. Column 2 reports the coefficients obtained when the DCP variable is defined solely in terms of US prices and exchange rates, as is done in Gopinath et al. Column 3 reports estimates from Gopinath et al. in which all observations are given equal weight.[13] The DCPUS coefficient is very large at 0.78, with only a small PCP effect and almost no LCP effect. Unlike the approach presented in this paper, column 3 reports only the contemporaneous coefficients, a choice that can have important implications, as discussed below. Column 4 reports estimates from Gopinath et al. in which observations are weighted by bilateral import values. It is apparent that the DCPUS effect is notably smaller and the PCP effect notably larger in relationships that account for the bulk of international trade. Nevertheless, the DCPUS coefficient, at 0.58, remains larger than the PCP and LCP coefficients.

Table 5
Comparison with Gopinath et al. (2020)

Variable	**This paper**		**Gopinath et al. (2020) dataset**				
	Baseline	**US PPI**	**Unweighted regression**	**Trade-weighted regression**			
			As reported	**As reported**	**Sum of coefficients**	**Unrestricted sum of coefficients**	**Unrestricted sum without second lag**
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
ΔPCP	0.52** 0.05	0.54** 0.05	0.14** 0.02	0.31** 0.04	0.45** 0.06	0.40** 0.06	0.42** 0.06
ΔLCP	0.28** 0.09	0.50** 0.11	0.05** 0.01	0.07** 0.03	0.08** 0.02	0.41** 0.06	0.59** 0.19
ΔDCP	0.20* 0.08						
ΔDCPUS		-0.04 0.11	0.78** 0.01	0.58** 0.04	0.44** 0.07	0.16 0.10	-0.03 0.23
Observations	891	891	46,820	46,820	46,820	42,303	44,131
Within R^2	0.904	0.903	0.398	0.371	0.371	0.381	0.420

* $p < 0.05$, ** $p < 0.01$

Note: Estimates in columns 1, 2, and 7 are the sums of coefficients on the current value and one lag of the independent variables, while estimates in columns 5 and 6 additionally incorporate the second lag of the independent variables. Columns 3 and 4 report only contemporaneous coefficients. Standard errors (in blue) are clustered by country. For coefficient sums, standard errors are computed from the estimated coefficient covariance matrix. Within R^2s refer to the percent of variation explained after removing country effects.

Sources: Authors' calculations using data described in appendix A and data provided by Gopinath et al. (2020).

13 We use the underlying data and regression code from Gopinath et al. to replicate their results. The DCPUS coefficient is identical to that shown in column 2 of table 3 in Gopinath et al. The PCP (exporter PPI) coefficient is not reported by Gopinath et al. but is available in the underlying regression. The LCP coefficient is a translation of the coefficients reported by Gopinath et al. based on the model of appendix B.

Column 5 displays the sums of the contemporaneous and lagged coefficients from the regression shown in column 4. Whereas column 4 displays the impact effect of exchange rate changes, column 5 displays the cumulative effect after two years. The DCPUS effect declines and the PCP effect rises, so that the two are almost equal at around 0.45. The LCP effect remains small. The shift in PCP and DCPUS effects from column 4 to column 5 likely reflects a temporary effect of dollar invoicing. When the dollar rises late in the year, import prices invoiced in dollars rise in terms of importer currency, but some of this increase is removed the following year as import contracts are renegotiated.

Column 6 displays the cumulative effects when importer and US PPI are added to the regression with unrestricted coefficients. The LCP and DCPUS effects are taken from the exchange rate coefficients only, as is done in Gopinath et al. However, including importer PPIs in the regression has an important effect on the other coefficients, substantially raising the LCP effect and reducing the DCPUS effect to a value below that of both the PCP and LCP effects. The contemporaneous importer PPI is statistically significant, rejecting the Gopinath et al. assumption of zero coefficients.[14]

Exclusion of importer PPI likely biases the LCP coefficient downward because some importers have high domestic inflation (rising PPI) coupled with a depreciating exchange rate. In such a circumstance, an exporter following the LCP model would raise prices (in importer currency) in proportion to the rising importer PPI. When importer PPI is excluded from the regression, the coefficient on the importer-exporter exchange rate (or the importer-US exchange rate, both of which rise with a depreciation) will be biased upward to fill in the gap left by the missing PPI. As shown in appendix B, the LCP effect is negatively related to the coefficients on these exchange rates in the Gopinath et al. regressions, reflecting the translation from exporter currency to importer currency. The upshot is that excluding importer PPI likely biases the LCP effect downward.

None of the second lags in the regression of column 6 is statistically significant. Column 7 reports cumulative effects from a regression with only one lag.[15] The DCPUS coefficient is near 0 and almost equal to that of this paper, shown in column 2. The PCP coefficient is a bit smaller than that of column 2 and the LCP coefficient a bit larger.[16] This shift from PCP to LCP behavior likely reflects the greater proportion of developing economies and post-2000 data in the Gopinath et al. sample compared to the sample of this paper. As is shown in table 3 of this paper, developing economies tend to be associated with somewhat larger LCP effects and smaller PCP effects, as are years after 2000.

14 Gopinath et al. report results in an online appendix that relaxes the restriction of no importer PPIs. In their table 19, column 5 of the appendix, the contemporaneous DCPUS coefficient declines to 0.46 in the trade-weighted regression when importer PPI and importer GDP growth are included. The appendix does not report the sum of the DCPUS coefficients, which declines to 0.18.

15 Further restrictions that each PPI coefficient equal the coefficient on the associated exchange rate (implied by the baseline model of this paper) are rejected in only one of four cases (the restriction on the contemporaneous US PPI coefficient). These restrictions have essentially no effect on the sums of the coefficients or on the R^2 reported in column 7.

16 When the regression of column 7 is run without trade weights, the coefficients are 0.22 on PCP, 0.27 on LCP, and 0.50 on DCPUS. This reflects a considerable decline in the DCPUS coefficient from that in column 3 but a much larger coefficient than that in column 7, suggesting that the smallest exporters are more inclined toward stabilizing prices in US dollars.

Altogether then, different results on the export pricing models arise from differences in samples and in econometric specification but not from differences in data definition. The DCP model appears to be relevant mainly for the smallest exporters. When observations are weighted by the value of trade so that larger exporters get greater weight, the DCPUS coefficient declines from 0.78 to 0.58. The DCPUS effect declines further to 0.44 when expressed in terms of the cumulative effect instead of the impact effect. When US and importer PPIs are added as control variables, the cumulative effect declines further to 0.16. Finally, when insignificant second lags are dropped, the DCPUS effect declines to near 0, as is found in this paper.

CASE STUDIES

This section presents graphical analysis of episodes when there was a substantial and sustained movement in exchange rates. These episodes reveal starkly different paths of domestic and foreign prices, enabling a clearer view of how export prices respond. There are a few episodes that seem most consistent with the DCP model, but more often export prices stay close to domestic prices (PCP model), importer prices (LCP model), or else split the difference between the PCP and LCP models, as suggested by the regression results.

The figures display export, domestic, importer, and US or euro area prices, all expressed in terms of exporter currency. The figures display levels as opposed to percent changes, which were the focus of the regression analysis, because they make the figures visually clearer and more intuitive.

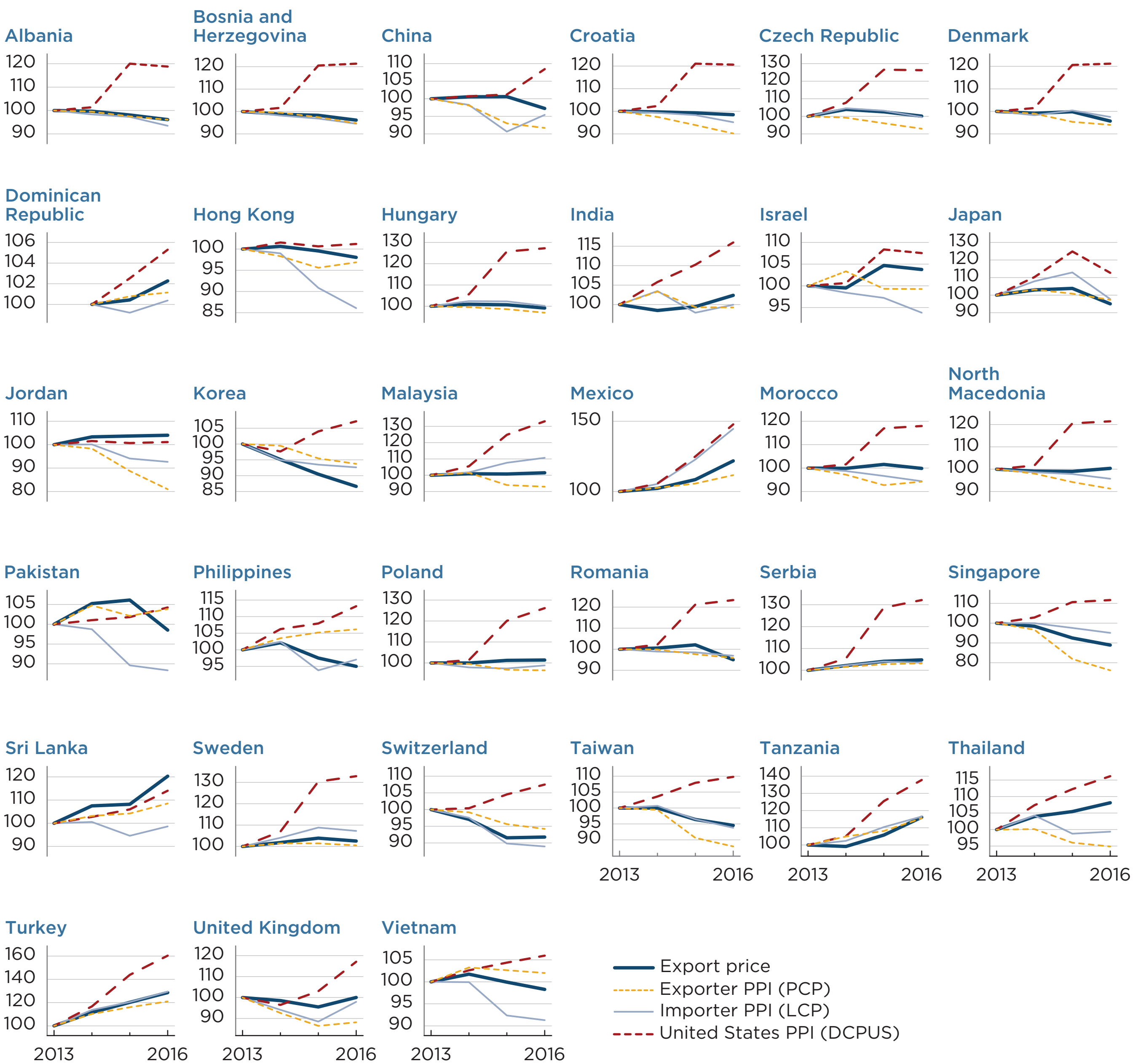
Figure 1 displays data for all countries in the sample for the period from 2013 to 2016, during which the US dollar appreciated against almost all currencies by an average of around 20 percent owing to developments unique to the United States which are plausibly viewed as exogenous to the 33 noncommodity exporters examined here.[17] The dollar's appreciation started in late 2014 and ended in mid-2015. Such an almost uniform and considerable strengthening of the US dollar makes this time frame a natural experiment to test whether the dollar has any effect on export prices over and above its role as the currency of a major importer. All price indexes are normalized at 100 in 2013, the year before the dollar appreciation.

The most common outcome in these episodes is that US prices rise distinctly higher than the other prices, which generally remain stable. This effect appears in Albania, Bosnia and Herzegovina, Denmark, Hungary, India, Japan, Korea, Morocco, Poland, Romania, Serbia, and Tanzania. The second most common outcome is for export prices to move closely with importer prices (LCP), as is the case in China, Croatia, Czech Republic, North Macedonia, the Philippines, Taiwan, Turkey, and the United Kingdom. (We focus mainly on the cumulative effects of the dollar as of 2016, by which time lagged adjustments should have been completed.) The third most common outcome is for export prices to move between domestic prices (PCP) and importer prices (LCP): Malaysia, Mexico,

17 The dollar appreciation is widely attributed to relatively strong US growth which raised expectations for monetary tightening. A contributing factor may have been the rise in domestic petroleum production from oil shale, which reduced oil imports and the supply of dollars to pay for them.

Pakistan, Singapore, Switzerland, and Vietnam. There are two cases of each of the following outcomes: export prices follow domestic prices most closely (PCP) in Hong Kong and Sweden; export prices follow US prices most closely (DCPUS) in Jordan and Sri Lanka; and export prices move between domestic prices (PCP) and US prices (DCPUS) in the Dominican Republic and Israel. Finally, in Thailand, export prices move between importer prices (LCP) and US prices (DCPUS).

Figure 1
Export price responses to US dollar appreciation, 2013–16 (index, 2013 = 100)

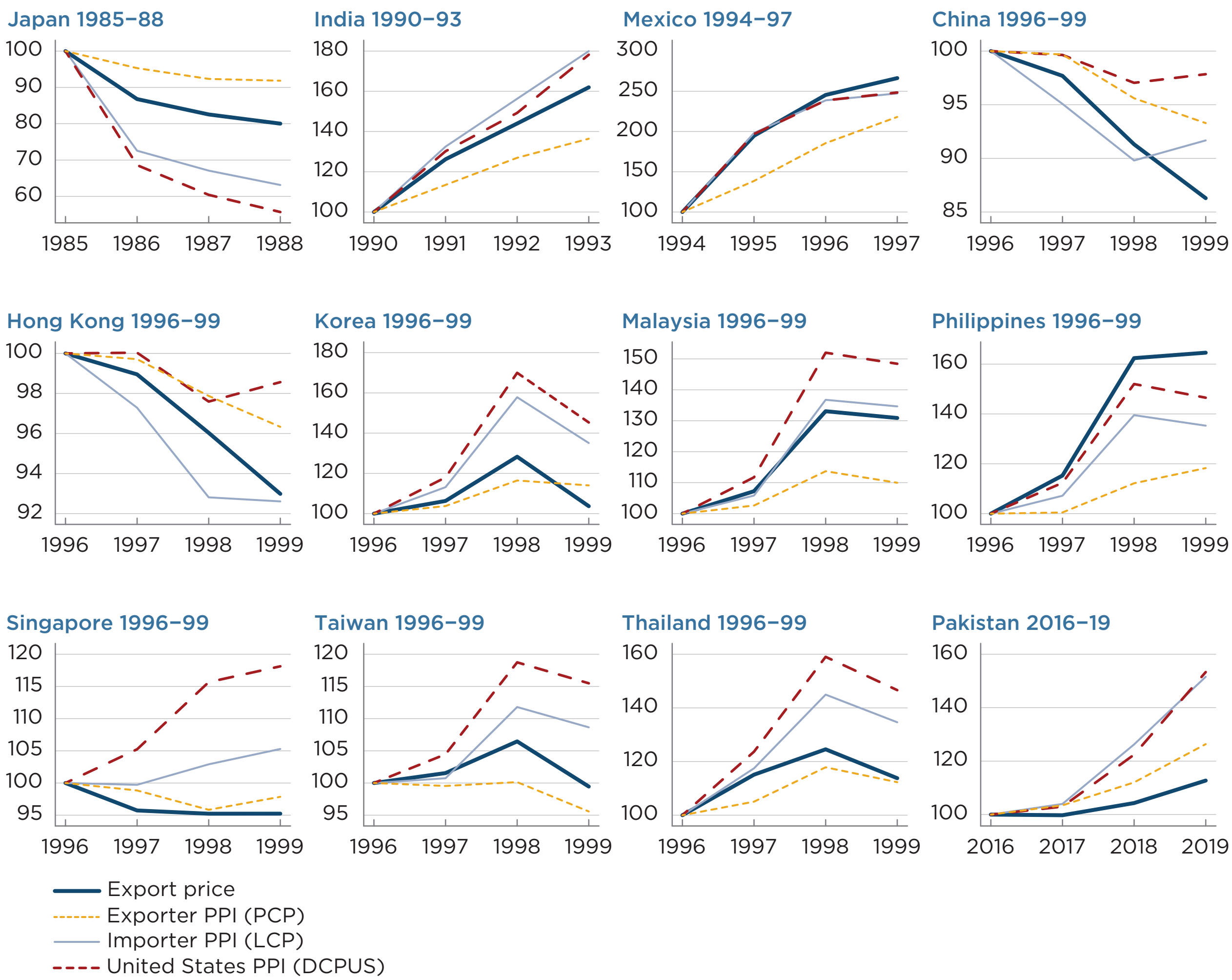


Source: Authors' calculations using data described in appendix A.

It should be noted that neither US PPI nor importer PPI seems to have an outsized effect on Mexico's export prices, despite the country's close trade links with the United States. Mexico's export prices rise slightly above domestic PPI, but still lag substantially behind US and importer PPI.

Figure 2 displays other episodes when an exporter's currency moved sharply against the US dollar, with all series included in the figure normalized at 100 at the beginning of each episode. The upper left panel presents data for Japan from 1985 to 1988, when the dollar depreciated by more than 40 percent against the Japanese yen. The figure shows that Japan's export prices also moved down but not by as much as the US and importer PPI did.

Figure 2
Export price responses to selected currency movements against the dollar (index, beginning of each episode = 100)



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

The next panel displays the rapid appreciation of the US dollar against the Indian rupee in the wake of India's 1991 balance of payments crisis. The rupee depreciates roughly equally against the dollar and the other currencies of India's export markets, so that the LCP and DCPUS lines are nearly identical. Indian export prices rise by more than domestic prices (PCP) but less than foreign prices (LCP, DCPUS).

The third panel displays price dynamics in Mexico following the 1994–95 Mexican financial crisis, when the country's currency suffered a sizable depreciation. As in the case of India, the Mexican peso depreciates roughly equally against the dollar and the other currencies of its export markets. Mexican export prices move up slightly more than foreign prices (LCP, DCPUS) and far more than domestic prices (PCP).

The next eight panels show effects of the 1997 Asian financial crisis on the behavior of prices in selected East Asian economies. Both China and Hong Kong experienced mild appreciations, while currencies of the other countries saw substantial depreciations. Export prices follow domestic prices most closely (PCP) in Korea, Singapore, Taiwan, and Thailand. Export prices follow importer prices (LCP) most closely in China, Hong Kong, and Malaysia. Only in the Philippines do export prices move most closely with US PPI (DCPUS).

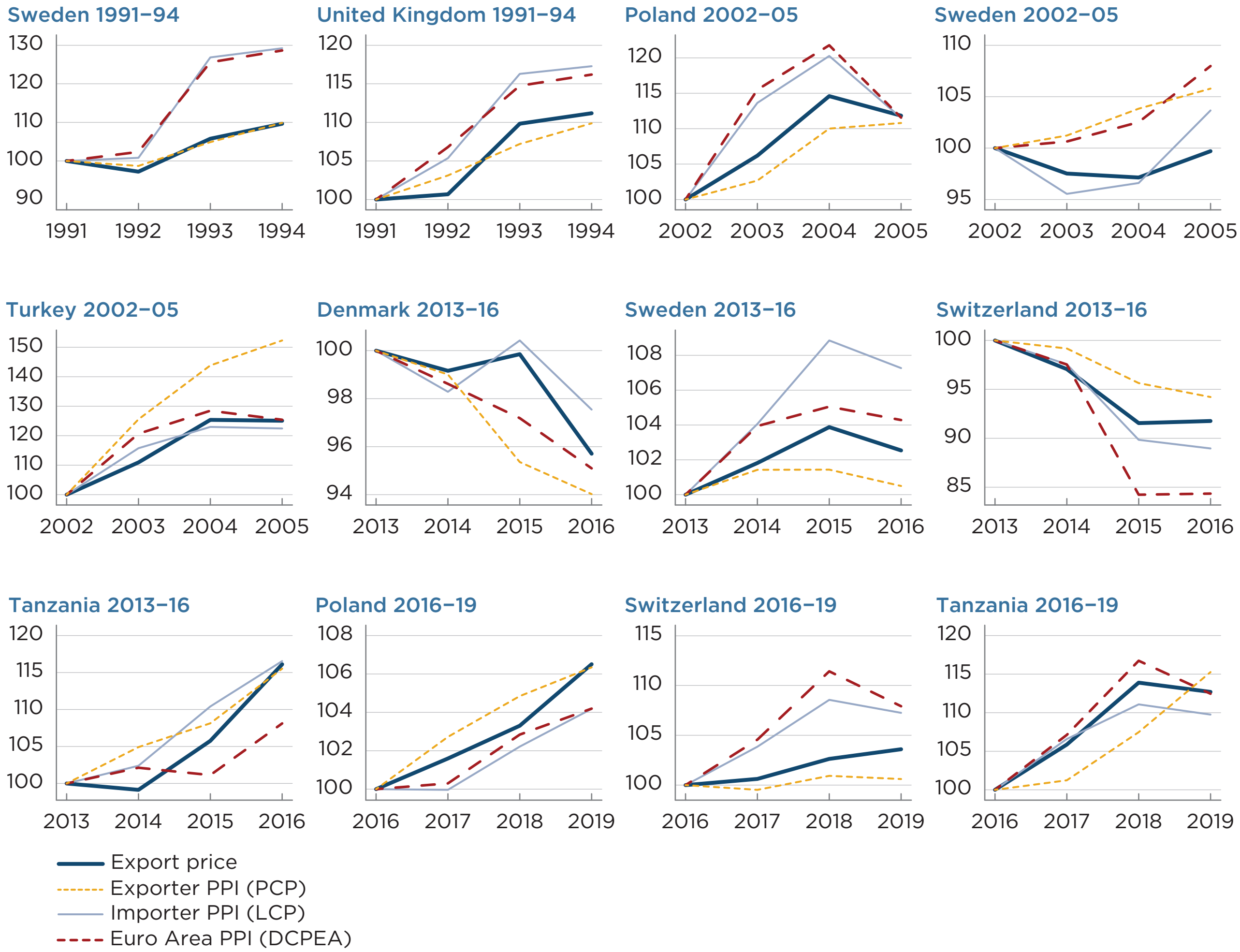
The last panel displays a steady depreciation of the Pakistani rupee that began at the end of 2017 in response to a persistent large current account deficit. Not only did export prices not follow US or importer prices, but they even lagged behind substantial domestic inflation. This episode is more consistent with the PCP model than any of the others.

Figure 3 focuses on substantial movements of exporter currency against the euro. The first two panels display the large drops in the values of the Swedish kronor and the UK pound in the wake of the 1992–93 European Exchange Rate Mechanism crisis. As can be seen from the panels, export prices move with domestic prices (PCP).

The remaining panels display three broad waves associated with changes in the value of the euro. The euro appreciates in 2002–05, depreciates in 2013–16, and appreciates in 2016–19. During 2002–05, Swedish and Turkish export prices closely follow importer prices (LCP), whereas Polish export prices lie between exporter (PCP) and importer (LCP) prices. During 2013–16, Swedish export prices most closely follow the euro (DCPEA) and Danish export prices lie between importer prices (LCP) and the euro (DCPEA), but Swiss and Tanzanian export prices move between domestic (PCP) and importer (LCP) prices (albeit with a lag in the case of Tanzania). In 2016–19, Polish and Swiss export prices follow domestic prices most closely (PCP), although Swiss export prices exhibit some effect of importer prices (LCP). Tanzanian export prices follow euro area prices most closely (DCPEA).

Altogether then, export prices in these episodes of significant exchange rate movements tend to follow domestic prices (PCP), importer prices (LCP), or some path between domestic and importer prices. Only rarely do export prices follow prices in a dominant currency such as the dollar or the euro more closely than domestic or importer prices.

Figure 3
Export price responses to selected currency movements against the euro (index, beginning of each episode = 100)



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

CONCLUSION

This paper examines the behavior of aggregate export prices in a sample of 33 advanced and developing economies from 1983 through 2019. It finds strong support for the Goldberg and Knetter (1997) canonical result that exporters adjust their prices by about half of any movement in exchange rates. The new twist is that exchange rate movements against importing countries account for only three-fifths of this price adjustment, while exchange rate movements against a dominant currency account for the other two-fifths. The dominant currency is generally the euro in Europe and Africa and the US dollar in Asia and the Western Hemisphere.

This paper does not support the claim that the dollar is the most important driver of export prices (Gopinath et al. 2020). The large coefficient (0.78) on the US dollar in Gopinath et al. declines to zero as (1) larger trade flows are given more weight in the regression, (2) results are reported in terms of cumulative rather than impact effect, (3) importer PPIs are included as control variables, and (4) insignificant second-year lags are excluded from the regression.

By finding only a small role for the DCP model and a larger role for the PCP model, this paper supports the conventional wisdom that exchange rate changes can have important effects on a country's export competitiveness and that a depreciating currency can boost a country's exports.

APPENDIX A

DESCRIPTION OF DATA AND LIST OF COUNTRIES IN THE PAPER'S SAMPLE

The primary sources of data are the International Monetary Fund's (IMF) Direction of Trade Statistics (DOTS), International Financial Statistics (IFS), and World Economic Outlook (WEO) databases; the World Bank's World Development Indicators (WDI) database; and several other sources accessed either via Macrobond or directly. All data are annual and were downloaded in June–August 2021, except as noted below.

The sample includes all countries with available data and 2019 nominal GDP greater than $10 billion, except the following: the United States, countries that use the US dollar as their main currency, euro area member countries, and economies with primary commodity exports higher than one third of their merchandise exports. The countries are listed in table A1.

Table A1
List of countries included in regression sample

Countries for which ΔDCP takes values of ΔDCPUS		Countries for which ΔDCP takes values of ΔDCPEA	
1	China	18	Albania
2	Dominican Republic	19	Bosnia and Herzegovina
3	Hong Kong[A]	20	Croatia
4	India	21	Czech Republic
5	Israel[A]	22	Denmark[A]
6	Japan[A]	23	Hungary
7	Jordan	24	Morocco
8	Korea[A]	25	North Macedonia
9	Malaysia	26	Poland
10	Mexico	27	Romania
11	Pakistan	28	Serbia
12	Philippines	29	Sweden[A]
13	Singapore[A]	30	Switzerland[A]
14	Sri Lanka	31	Tanzania
15	Taiwan[A]	32	Turkey
16	Thailand	33	United Kingdom[A]
17	Vietnam		

"A" = advanced economy; DCP = dominant currency paradigm

Note: Transition economies (with IMF country codes above 900), except China and Hungary, are excluded from the regression sample before 2000. Data for the United States and the euro area are used to construct some variables.

Commodity exports are the sum of exports of agricultural raw materials, food, fuel, and ores and metals (all expressed as a percentage of merchandise exports) in 2019 or, in the case of missing data, the most recent year with available data in 2015–18. GDP and commodity exports data used in determining the country sample were downloaded in February 2021 from the WEO and WDI databases, respectively. Transition economies (with IMF country codes above 900), except China and Hungary, are excluded from the regression sample before 2000. Otherwise, our baseline regression covers the period from 1983 to 2019.

Change in export prices (ΔPX) is the logarithmic percent annual increase in export prices of an exporting country. Export prices are goods and services export deflators, calculated by dividing nominal exports by real exports in exporter currency. Both series come from WDI. For China, export deflator data are obtained from the Organization for Economic Cooperation and Development's (OECD) Economic Outlook database via Macrobond. For Taiwan, nominal and real export series are accessed via Macrobond from the Taiwan Directorate General of Budget, Accounting and Statistics.

Change in exporter's producer price index (denoted ΔPCP since it is used to test the importance of the producer currency pricing hypothesis) is the logarithmic percent annual increase in the producer price index (PPI) of an exporting country. A wholesale price index (WPI) is used for the following countries, where either PPI data are not available or have fewer observations than the WPI series: India, Israel, Pakistan, the Philippines, Singapore, Sri Lanka, and Taiwan. The principal source for both PPI and WPI series is the IFS database. However, for a few countries with missing information data are obtained from national sources via Macrobond. In particular, the PPI statistics for China come from the China National Bureau of Statistics; data for Tanzania are from the Tanzania National Bureau of Statistics; and WPI data for Taiwan are from the country's Directorate General of Budget, Accounting and Statistics. For the Dominican Republic, manufacturing PPI (from the National Statistics Office) is used as industrywide PPI or WPI data are not available.

Missing PPI observations for some years are filled in based on country data from the Bank of Japan, Jordan's and Malaysia's Department of Statistics, the Mexican National Institute of Statistics and Geography, and the Vietnamese General Statistics Office. Central bank data are used to fill in missing WPI observations for Sri Lanka. These data are accessed via Macrobond.

For Israel, the WPI series provided in the IFS database appears to have been rebased in 1985 as the index suddenly drops after 1984. Thus, 1985 producer price inflation from the World Bank's Global Database of Inflation (June 2021 version; Ha, Kose, and Ohnsorge 2021) is used to readjust Israel's WPI series from 1985 onward.

Change in importer producer price index (denoted ΔLCP since it is used to test the importance of the local currency pricing hypothesis) is the trade-weighted logarithmic percent annual increase in PPIs in importing countries converted to exporter currency and calculated as follows:

$$\Delta LCP_{it} = \left(\sum_{j \neq i} (\log (PPI_{jt} * ER_{jit}) - \log (PPI_{jt-1} * ER_{jit-1}))w_{ijt} \right) *100,$$

where PPI_{jt} is the producer price index of an importing country, ER_{jit} is the bilateral exchange rate between the exporter (*i*) and importer (*j*) country (expressed as exporter currency per unit of importer currency), w_{ijt} is the weight representing the share of exporting country *i*'s total exports flowing to importer *j*. In addition to all 33 exporting countries in our sample, calculations include the United States and the euro area as importers.

For the euro area, various PPI series are merged to construct a single index since no series is long enough to cover the entire period analyzed in this paper. Thus, the total output price index for industry (except construction, sewerage, waste management, and remediation activities) normalized at 100 in 2015 is used for 2000–19. From 1995 to 1999, this index is spliced with an analogous index normalized at 100 in 2010. Both series are downloaded from Eurostat. IFS data are used to extrapolate euro area PPI for all remaining years prior to 1995 (Eurostat presents PPI data for the current 19 euro area countries, whereas the IFS does so for only the original 11 euro area members).

Bilateral exchange rates are computed by dividing exporter's exchange rate by importer's exchange rate, both expressed vis-à-vis the US dollar (specifically, as domestic currency per US dollar). All exchange rates are annual averages and come from the IFS database, except the euro area exchange rate, which is obtained from OECD's Main Economic Indicators database via Macrobond.

Computations of weights use US dollar–denominated value of goods flowing from an exporting to importing country, which is reported on a free on board (FOB) basis. Because of data availability issues, Taiwanese bilateral exports are based on bilateral imports reported by its trading partners on a cost, insurance, and freight (CIF) basis. Because euro area PPI data cover only the original 11 member countries before 1995, export weights before that are limited to the same 11 countries. All trade data come from the DOTS database.

Change in global producer price index (denoted ΔGCP since it is used to test the importance of the global currency pricing hypothesis) is the logarithmic percent annual increase in GDP-weighted PPIs converted to exporter currency. It is calculated as follows:

$$\Delta GCP_{it} = \left(\sum_{j}\left(\log\left(\frac{PPI_{jt}}{ER_{jt}}\right) - \log\left(\frac{PPI_{jt-1}}{ER_{jt-1}}\right)\right) w_{jt} + \log\left(\frac{ER_{it}}{ER_{it-1}}\right)\right) * 100,$$

where GCP_{it} is the global PPI in country *i*'s currency, PPI_{jt} is country *j*'s producer price index, ER_{jt} is country *j*'s exchange rate vis-à-vis the US dollar, and w_{jt} is country *j*'s share of global GDP in US dollars.[18] In addition to all 33 exporting countries in our sample, calculations include the United States and the euro area to allow for a construction of a broader global PPI inflation measure. GDP data are from the WEO database.

Change in US producer price index (ΔDCPUS) is the logarithmic percent annual increase in US PPI converted into exporter currency. Data are from IFS.

18 The sum over countries indexed by *j* includes the exporting country *i* to get a true world price. In the definition of ΔLCP the sum over countries indexed by *j* does not include the exporting country because LCP refers to prices in importers only.

Change in euro area producer price index (ΔDCPEA) is the logarithmic percent annual increase in euro area PPI converted into exporter currency. Data sources are described above under importer PPI.

Change in dominant currency producer price index (denoted ΔDCP since it is used to test the importance of the dominant currency paradigm) takes values of ΔDCPUS for Asian and Western Hemisphere countries (including Israel and Jordan) and values of ΔDCPEA for African and European countries (including Turkey).

APPENDIX B
A GENERAL MODEL OF EXPORT PRICING

This appendix presents the simplest model of export pricing that nests both the baseline model estimated in this paper and the model of Gopinath et al. (2020). This enables a comparison of the coefficients reported by Gopinath et al. with those reported here. For simplicity of exposition, the model does not include lags, but it is easy to add lags.

$$\Delta PX_{ijt} = \beta \Delta PPI_{it} + \gamma \Delta PPI_{jt} + \lambda \Delta ER_{jit} + \mu \Delta PPI_{Dt} + \delta \Delta ER_{Dit} + u_{ijt} \quad \text{(B1)}$$

Subscript *i* refers to the exporting country, subscript *j* the importing country, subscript *D* the dominant currency country, and subscript *t* the year. The residual, u_{ijt}, includes country fixed effects, year effects, and any remaining unexplained variation. ER_{ab} is the exchange rate that converts values from currency *a* to currency *b*, that is, units of currency *b* per unit of currency *a*. The parameters (lower-case Greek letters) differ from those used in the main regression equation above. Here β refers to the PCP effect, γ and λ to the LCP effect, and μ and δ to the DCP effect.

The regressions of tables 2 through 4 are based on a version of equation B1 with the restrictions $\gamma = \lambda$ and $\mu = \delta$ imposed and lags added. The restrictions are based on the assumption that exporters respond to competitors' prices at home and abroad, with exchange rates entering only because they are needed to translate prices into a common currency. The restrictions take advantage of the property of logarithmic changes, for which $\Delta\log(ab) = \Delta\log(a) + \Delta\log(b)$.

Gopinath et al. (2020) use import prices in terms of importer currency. Equation B2 converts the general model into terms consistent with their regressions, where *i* continues to refer to the exporter and *j* to the importer. This conversion uses the identities: $\Delta PX_{ij} = \Delta PM_{ij} - \Delta ER_{ij}$ and $\Delta ER_{ij} = -\Delta ER_{ji} = \Delta ER_{iD} + \Delta ER_{Dj}$.

$$\Delta PM_{ijt} = \beta \Delta PPI_{it} + \gamma \Delta PPI_{jt} + (1 - \lambda - \delta)\Delta ER_{ijt} + \mu \Delta PPI_{Dt} + \delta \Delta ER_{Djt} + u_{ijt} \quad \text{(B2)}$$

Note that the exchange rates, ER_{ji} and ER_{Di}, have been replaced by ER_{ij} and ER_{Dj}. The coefficients on most terms are identical in B1 and B2. The exception is the coefficient on the exchange rate between the exporter and importer, which is affected by (1) the transition from exporter to importer currency and (2) the transition from dominant currency exchange rate against exporter to dominant currency exchange rate against importer. It is still possible, however, to calculate the LCP effect, λ, based on the estimated coefficients on the two exchange rates. In their table 3, Gopinath et al. impose the restrictions $\gamma = 0$ and $\mu = 0$.[19]

19 It may be argued that price stickiness in an invoicing currency that is different from the importer's currency gives rises to nonzero exchange rate coefficients without requiring any PPI coefficients. However, that argument is not consistent with allowing for a nonzero coefficient on the exporter's PPI, as Gopinath et al. do. Moreover, the restriction of a zero coefficient on importer PPI is rejected in the data. Other studies cast doubt on the assumption of extreme price stickiness in invoice currencies, finding that export prices adjust to shocks in considerably less than one year (Goldberg and Knetter 1997; Vigfusson, Sheets, and Gagnon 2007).

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