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DOMINANT CURRENCY PARADIGM:
A REVIEW

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ABSTRACT

A handful of currencies, especially the US dollar, play a dominant role in international trade. We survey the active theoretical and empirical literature that documents patterns of currency use in global trade, the implications of dominant currencies for international transmission of shocks, exchange rate pass-through, expenditure switching, and optimal monetary policy. We describe advances in the endogenous currency choice literature including conditions for the emergence and persistence of dominant currency equilibria.

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1 Introduction

There are around 180 currencies in the world, but a very small number of *dominant currencies* play an outsized role in international trade, finance, and central bank foreign exchange reserves. Figure 1 shows that in the modern era the US dollar has a dominant international presence, followed to a much lesser extent by the euro. Some other currencies such as the yen and renminbi also play a minor role. The figure further shows that the dollar is dominant across multiple dimensions of trade invoicing, international debt and loans, foreign exchange reserves and transactions, consistent with complementarities in the many functions of a currency.

The phenomenon of dominant currencies is not new. The British pound was the dominant currency for decades before World War I.[1] Despite this being the norm, the workhorse models in international macroeconomics have mostly treated the phenomenon of dominant currencies as more the exception than the rule, in part due to the lack of adequate data. This has however changed over the last decade as more granular data has become available and led to a resurgence in work on dominant currencies and their implications for international macroeconomics and finance. In this chapter we survey the empirical and theoretical work on dominant currencies with a focus on the trade channel. Other chapters in this Handbook, including by Miranda-Agrappino and Rey (2021), Maggiori (2021), Ilzetzki, Reinhart, and Rogoff (2021), Du and Schregger (2021) delve into the financial channel.

The importance of currencies is never more evident than in global trade. Currency exchange rates are often at the center of fierce economic and political debates, including on the architecture of the international monetary system and on the ability of flexible exchange rates to enhance welfare. To this day countries accuse each other of engaging in currency wars and unfair trade competition.[2]

The basis for many of these arguments is the first generation paradigm in international macroeconomics developed by Mundell (1963) and Fleming (1962) who appeal to evidence of sticky wages, which in turn make export prices sticky in the exporters currency. Micro-founded versions of this "producer

[1] There were periods such as the inter-war years when the pound and the dollar shared equal presence, but again these were only two of many possible currencies.

[2] The adoption by the United States in 2019 of the policy of countervailing duties on countries judged to have unfairly undervalued their exchange rates is one example.

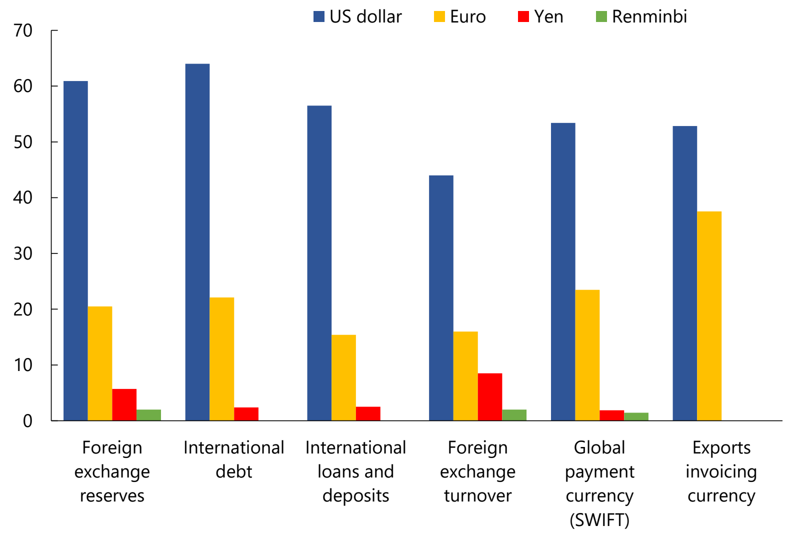

Figure 1: The International Monetary System

currency pricing" (PCP) paradigm were developed by Svensson and van Wijnbergen (1989) and Obstfeld and Rogoff (1995) as open-economy versions of macroeconomic models being developed at the time with prices of domestically produced goods assumed sticky in domestic currency.[3] With export prices sticky in the currency of the exporting country the depreciation of a country's currency makes its goods cheaper internationally and rest-of-the-world (ROW) goods more expensive for its residents, thus shifting demand towards its own goods and away from ROW. This expenditure switching channel is at the core of arguments in favor of flexible exchange rates (Friedman, 1953) and concerns about beggar-thy-neighbor policies.

An implication of PCP is that exchange rate pass-through (ERPT) into import prices should be high and the law-of-one price (LOP) should hold, that is, a good should sell at the same price (converted in the same currency) in all markets.[4] A second generation of New Keynesian open economy models grew out of the observation that ERPT into advanced economy import prices was incomplete — an often cited number was 50% from Goldberg and Knetter (1997), despite considerable heterogeneity — and LOP

[3]Dornbusch (1976) overshooting model is a reduced-form model where output is increasing in the real exchange rate, consistent with PCP. Galí and Monacelli (2005) develop a micro-founded small open economy version for the PCP paradigm.

[4]The strict LOP holds under constant mark-ups. If mark-ups are variable, firms can price differentiate across markets, but it must still be the case that LOP holds in changes in the short-run when prices are sticky. Marston (1990) documents variation in the relative price at which Japanese firms export relative to the price at which they sell domestically. Mann (1986) documents low pass-through into US import prices. As will become evident later, both these findings are consistent with the Dominant Currency Paradigm.

seldom holds. To match these features Betts and Devereux (2000), Devereux and Engel (2003), Bacchetta and van Wincoop (2000) and Chari, Kehoe, and McGrattan (2002) developed the "local currency pricing" (LCP) paradigm where prices are assumed to be sticky in the currency of the destination market. This assumption delivers the other extreme of no expenditure switching because a nominal depreciation does not make a country's goods cheaper internationally or ROW goods more expensive for domestic residents in the short term. Both the first and second generation paradigms have been extensively studied in the literature and are surveyed most recently in a handbook chapter by Corsetti, Dedola, and Leduc (2010).

Another classic open economy model for developing countries is the Salter-Swan model developed by Salter (1959) and Swan (1963), among others. Schmitt-Grohé and Uribe (2020) provide a microfounded version of this model. In this model, unlike in Galí and Monacelli (2005), the small open economy faces exogenous world prices in a foreign currency and demand is perfectly elastic at these prices. In this case, when a country's exchange rate depreciates it cannot affect the relative prices of its exports in world markets, but it raises the relative price of imported goods to non-traded goods as the latter are sticky in domestic currency. The response of quantities is, however, similar to what happens under PCP. Following a depreciation, exports increase to the ROW because domestic production costs decline in the foreign currency and exporters face a perfectly elastic demand for their goods, and imports from the ROW decline as they become relatively more expensive.

In the next sections, we describe empirical and theoretical advances in recent years that highlight the limitations of PCP and LCP paradigms. The evidence instead is consistent with a world where trade is denominated in a few dominant currencies, the "Dominant Currency Paradigm" (DCP), which is consequential for global trade, cross-border spillovers, and welfare. Prices in international trade are denominated in very few currencies and this asymmetry in the role of currencies has real implications. Expenditure switching takes place mainly through reduced imports for most countries and increased exports for the dominant currency issuer. Prices of traded goods at the retail level are less sensitive to exchange rates than at the dock because of a non-traded retail sector; nevertheless, expenditure switching still occurs unlike under LCP.[5] Invoice currency weighted exchange rates tend to be more consequential for inflation and expenditure switching as opposed to trade weighted exchange rates.

In standard models where the only friction is sticky prices, optimal monetary policy under DCP calls for producer price inflation targeting, but unlike under PCP the output gap cannot be closed because policy cannot bring about the desired adjustment in the terms of trade. Conditional on stabilizing producer price inflation, the optimal monetary policy allows for a floating nominal exchange rate without directly targeting its movements. Unlike in the Salter-Swan model, exports do not increase significantly for many countries, including developing countries, in the near term following exchange rate depreciations, consistent with the predictions of DCP. The Salter-Swan assumption of price taking behavior seems appropriate for some commodity exporters, but not for exporters in general. Even though the terms of trade are exogenous in the Salter-Swan model, like under DCP, there is no distortion associated with it and optimal policy can close output gaps, unlike under DCP.

In this chapter, we also survey recent advances in our understanding of how firms endogenously choose their invoicing currency, which is usually treated as exogenous in macro frameworks, and implications of these choices for international macroeconomic outcomes. While the assumption of exogenous currency choice is reasonable for most analyses, it is more restrictive for analyzing secular changes in the international monetary system driven by large shifts in macroeconomic fundamentals and policy (Mukhin, 2021). Furthermore, the mere fact that dominant currencies emerge as an equilibrium outcome imposes an important discipline on the set and calibration of essential building blocks for the international macroeconomic framework, with important consequences for both positive and normative analyses.

In particular, given the large body of evidence, the macro-model that best fits the facts would include the following features: (i) DCP at-the-dock, matching invoice currency shares from publicly available data at the country level, as well as the relative stability of the terms of trade (Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl, and Nguyen, 2020); (ii) a non-traded retail (or intermediate) sector that reduces partially the pass-through from prices at the border to retail prices (or into producer costs for

[5] In addition, fluctuations in dominant currency exchange rates lead to fluctuations in profit margins of importing firms that can have real consequences beyond the direct effect on sales in the short term.

imported intermediate inputs; Burstein, Neves, and Rebelo, 2003); (iii) a large share of non-tradables and home bias in tradables, calibrated to match the share of the imported goods in the consumption bundle, which allows for volatile and persistent deviations from PPP (Itskhoki, 2021); (iv) strategic complementarities in pricing and imported intermediate inputs in production, which give rise to DCP equilibrium at the dock (Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller, 2020; Amiti, Itskhoki, and Konings, 2020; Mukhin, 2021).[6]

The rest of this chapter includes the following: Section 2 covers the empirical evidence on DCP. Sections 3 and 4 examine the asymmetry in transmission of exchange rate shocks and optimal monetary policy under DCP. Section 5 reviews theoretical and empirical work on endogenous currency choice. And Section 6 concludes and discusses directions for future research.

2 Empirical Evidence

In this section, we describe empirical evidence on trade prices and quantities. The evidence highlights asymmetry in the role of currencies in international trade with a few currencies dominating, especially the US dollar. Prices indeed behave as if they are sticky in the invoice currency, especially with regards to exchange rate movements, and these prices are allocative and affect quantities.

2.1 Invoicing shares in global trade

A common feature of both PCP and LCP is symmetry in the role of currencies. That is, a currency's use in world trade is closely tied to its country's share in world trade. In the case of PCP (LCP) it is tied to the share of a country's exports (imports) in world trade. One of the earliest evidence on currency use in trade transactions by Grassman (1973) provided some support for symmetry based on a survey of Swedish firms. The Grassman Law was cited as evidence that around 60% of a country's exports are priced in its own currency. Over time, however, there has been a steady accumulation of evidence

[6] Additional ingredients may include financial shocks resulting in exchange rate disconnect (Itskhoki and Mukhin, 2021), nominal wage stickiness, delayed import quantity adjustment (due to e.g. adjustment costs or search frictions), endogenous or exogenous choice by monetary authority between inflation targeting and pegging the exchange rate (Ilzetzki, Reinhart, and Rogoff, 2019; Egorov and Mukhin, 2020).

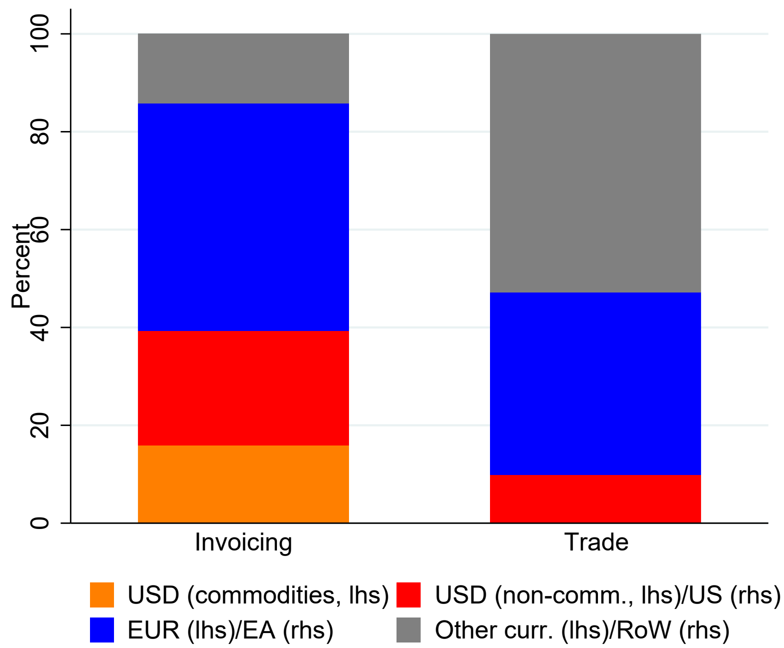

Figure 2: Dollar and Euro Shares in Global Trade

Note: From Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl, and Nguyen (2020).

on invoicing currencies with increasing country coverage and customs transactions data including by Tavlas and Ozeki (1991), Ilzkovitz (1994), Donnenfeld and Haug (2003), Kamps (2006), Goldberg and Tille (2008), Gopinath, Itskhoki, and Rigobon (2010), Ito and Chinn (2014), Gopinath (2015), Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl, and Nguyen (2020). This evidence demonstrates that, contrary to PCP and LCP, there is significant asymmetry in the role of currencies in trade. Most countries rely on *vehicle currencies*, that is a currency that is neither the currency of the exporter nor of the importer. Moreover, very few currencies act as vehicle currencies, with the dollar having a dominant role at the global level.

Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl, and Nguyen (2020) provide the most comprehensive panel data set of invoicing currencies in global trade covering over 100 countries since 1990. Figure 2 compares the share of the dollar, euro, and ROW currencies in global exports relative to the US, Euro area, ROW share in world exports. While PCP would imply that the dollar's share in export invoicing is equal to the US share in world exports, in reality the dollar use in export invoicing is multiple times the US share in world trade, even after excluding commodities. The euro is also used heavily in trade

Table 1: Regional Invoicing Patterns

	Simple average			Weighted average		
	USD	EUR	Home	USD	EUR	Home
Advanced economies (AE)	33.7	53.5	4.8	42.8	45.3	5.7
— United States	95.8	1.3	—	95.8	1.3	—
— Euro Area	19.4	74.4	—	17.4	77.6	—
— EU trade outside EU	32.3	50.8	—	—	—	—
— Non-Euro Europe	33.9	54.9	4.8	39.2	42.9	10.5
— AE excl. US and Euro Area	51.7	24.4	15.6	55	17.6	21.1
— Japan	50.1	7.1	38.3	50.1	7.1	38.3
Emerging Markets and Developing Economies	61.4	31.8	3.6	68.1	23.8	5.0
Central Asia	86.1	3.0	1.2	89.5	1.8	2.6
East and South East Asia	84.6	2.7	4.4	85.4	4.6	3.3
Latin America	96.7	2.3	0.4	95.9	3.0	0.6
Middle East + Gulf	91.8	6.9	7.0	91.8	6.9	7.0
North Africa	56.8	38.1	6.2	60	35.1	6.2
North America	95.8	1.3	0.0	95.8	1.3	0.0
Pacific	66.3	4.0	20.9	72.8	2.5	19.2
South Asia	90.1	6.2	0.0	90.1	6.2	0.0
Sub-Saharan Africa	78.5	10.3	6.9	74.4	9.1	11.3

Notes: The table is constructed using the invoicing shares for exports and Home refers to the currency of the exporter. If the exporter is the US or a euro area country, the share is assigned to USD or EUR, respectively, rather than Home. Averages are calculated using 2003-2019 data, except EU with extra-EU which uses data from 2010 to 2016. *Sources*: Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl, and Nguyen (2020) and Eurostat.

invoicing but mainly by European countries and therefore its share in export invoicing is close to the share of euro countries in world trade. It follows that there is similarly little evidence for LCP when import shares are considered. That is, the dollar share in import invoicing is multiples of the US share in world imports.

Table 1, using data from Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl, and Nguyen (2020), shows that the dollar has a strong global presence while the euro has an important regional role. In non-euro Europe the euro is more heavily used than the dollar in trade transactions (see also Appendix Figure A2 and the discussion in Section 5), and in North Africa the euro also has significant presence. Over time, the combined share of the dollar and the euro in trade invoicing has increased despite the declining shares of the US and the Euro Area in world trade.

Overall, evidence on invoicing currencies in global trade provides little *prima facie* support for PCP or LCP. Of course, the fact that trade transactions are invoiced in dollars need not necessarily imply a violation of PCP or LCP. It could be that the response of dollar prices to exchange rate shocks is such that ERPT, relative price movements, and expenditure switching are the same as what would follow from PCP or from LCP. This is the area where much progress has been made over the last decade with the availability of transaction-level data on trade prices and quantities alongside the currency of invoicing. As we describe below, the evidence is in line with the currency of invoicing having meaningful implications for trade prices and quantities.

A long standing practice has been to estimate the impact of changes in the *trade-weighted* exchange rate of a country on inflation, following theoretical predictions in a world with symmetric currency use under PCP or LCP. However, the relevant exchange rate should be the *invoice currency weighted*, in an asymmetric world for countries that rely on vehicle currencies. As an example, consider a country whose imports are denominated entirely in dollars regardless of where they originate from. In this case, a large weakening of its currency relative to the dollar would have a large impact on its inflation even if the value of its currency relative to its non-US trading partners and consequently the trade-weighted exchange rate remain unaffected. As described below, the evidence indeed demonstrates that invoice-based exchange rates do a better job in explaining inflation than trade-weighted exchange rates.

2.2 Currency of invoicing and ERPT

Burstein and Gopinath (2014) survey the literature on exchange rate pass-through (ERPT), including the standard regressions estimated and the interpretation of the coefficients. Given space constraints we will not repeat it here. Instead, we survey the evidence on the relation between currency of invoicing and ERPT.

If prices are sticky in their currency of invoicing (IC), then we expect differential pass-through of exchange rates across goods depending on which currency their prices are invoiced in, in the short-run, regardless of the source of fluctuation in the exchange rate. Suppose e_{ij} is the log bilateral exchange rate between country i and country j expressed as the price of currency i in terms of currency j; thus, an increase in e_{ij} is a depreciation of currency j relative to currency i. Similarly, suppose e_{vj} is the log exchange rate between the vehicle currency v and currency j. If the vehicle currency is the dollar, then an increase in e_{vj} is a depreciation of currency j relative to the dollar. If p_{ij} is the (log) domestic currency import price of a good imported from country i into country j, then all else equal:

$$\Delta p_{ij} = \begin{cases} 1 \cdot \Delta e_{ij} + 0 \cdot \Delta e_{vj}, & \text{if IC} = i, \\ 0 \cdot \Delta e_{ij} + 0 \cdot \Delta e_{vj}, & \text{if IC} = j, \\ 0 \cdot \Delta e_{ij} + 1 \cdot \Delta e_{vj}, & \text{if IC} = v. \end{cases}$$

That is, the domestic price moves one-to-one with the bilateral exchange rate if the price is sticky in the producer's currency, is disconnected from any exchange rate if price is sticky in local currency, and moves one-to-one with the vehicle currency exchange rate if prices are sticky in the vehicle currency.

This simple relation was first tested by Gopinath, Itskhoki, and Rigobon (2010) using transaction-level import price data for the US. They document that indeed prices are sticky in their currency of invoicing with the median duration around 10-12 months, including for non-commodity imports. Because of this stickiness, goods imported into the US that were invoiced in dollars (94% of goods) had close to zero pass-through in the short-run, while those invoiced in a non-dollar currency had close to a 100% pass-through (see Appendix Figure A1). They also document that this divergence in pass-through persists (though is somewhat attenuated) even conditional on the prices being reset in their currency of invoicing. This is in line with endogenous currency choice because firms choose to price in currencies in which their desired price is least sensitive to the exchange rate. This is explained further in Section 5 where we discuss endogenous currency choice.

Following Gopinath, Itskhoki, and Rigobon (2010) several other transaction level studies for different countries, listed in Table 2, have confirmed that indeed pass-through varies by the currency of invoicing, and this is not a phenomenon specific to the US. Moreover, these other studies are able to test the vehicle currency channel (there is no vehicle currency use in US trade given the dominance of the dollar) and show that indeed prices denominated in the vehicle currency are sensitive to vehicle

Table 2: Studies of ERPT by currency of invoicing

Authors	Country	Type of prices	Granularity
Amiti, Itskhoki, and Konings (2020)	Belgium	Export prices	firm×HS8 product
Auer, Burstein, Erhardt, and Lein (2019)	Switzerland	Export prices	transaction level
Auer, Burstein, and Lein (2021)	Switzerland	Import and retail prices	UPC level
Barbiero (2020)	France	Export and import prices	firm×HS8 product
Chen, Chung, and Novy (2018)	UK	Import prices	firm×10-digit product
Corsetti, Crowley, and Han (2020)	UK	Export and import prices	firm×HS8 product
Crowley, Han, and Son (2020)	UK	Export and import prices	firm×HS8 product
Devereux, Dong, and Tomlin (2017)	Canada	Import prices	transaction level
Goldberg and Tille (2016)	Canada	Import prices	transaction level
Gopinath, Itskhoki, and Rigobon (2010)	US	Export and import prices	HS10 product
Gopinath et al. (2020)	Colombia	Export prices	firm×HS10 product
Cravino (2017)	Chile	Export prices	firm×HS8 product
Fitzgerald and Haller (2013)	Ireland	Producer prices	firm×8-digit product

currency exchange rates and not bilateral exchange rates.

This fact, combined with the evidence on invoicing shares in Section 2.1, implies that it is the invoice-currency-weighted exchange rate, rather than the trade-weighted exchange rate, that is relevant for ERPT. Moreover, given the dominant role of the dollar for most countries, it implies that import price inflation in many countries should depend mainly on movements in their exchange rate vis-à-vis the dollar regardless of the share of their trade with the US. Similarly, for non-euro Europe, the euro exchange rate should be the driving factor for inflation.

Chen, Chung, and Novy (2018) document using transaction-level data for the UK that previous estimates of low ERPT into import prices in the UK were a consequence of using bilateral exchange rates in place of vehicle currency exchange rates for goods priced in vehicle currencies (55% of UK imports from non-EU countries are priced in a vehicle currency of which 89% are in dollars). They estimate that once vehicle currency exchange rates are used, short-run pass-through into import unit values is 43.6% as compared to 17.9% when using only bilateral exchange rates.[7]

Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) and Boz, Casas, Georgiadis,

[7]They also conclude that once invoice currency exchange rates are used, this can explain why the pound depreciation during the Great Recession had a larger impact on inflation as compared to the weak impact of the pound appreciation during European Sovereign Debt crisis. This is because in the former episode the pound depreciated relative to the dollar, while during the latter even though the pound appreciated significantly relative to its trading partners, it did not change by much relative to the dollar.

Table 3: Exchange rate pass-through into prices

	Unweighted			Trade-weighted		
Dep. var: Δp_{ijt}	(1)	(2)	(3)	(4)	(5)	(6)
Δe_{ijt}	0.757***	0.164***	0.209***	0.765***	0.345***	0.445***
	(0.0132)	(0.0126)	(0.0169)	(0.0395)	(0.0449)	(0.0336)
$\Delta e_{ijt} \times S_j$			-0.0841***			-0.253***
			(0.0240)			(0.0482)
$\Delta e_{\$jt}$		0.781***	0.565***		0.582***	0.120*
		(0.0143)	(0.0283)		(0.0377)	(0.0622)
$\Delta e_{\$jt} \times S_j$			0.348***			0.756***
			(0.0326)			(0.0796)
R-squared	0.356	0.398	0.515	0.339	0.371	0.644
Observations	46,820	46,820	34,513	46,820	46,820	34,513
Dyads	2,647	2,647	1,900	2,647	2,647	1,900

Note: From Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020). The first (last) three columns use unweighted (trade-weighted) regressions. All regressions include two exchange rate lags (in log changes), exporter PPI and two lags (in log changes), and time fixed effects. Standard errors clustered by dyad. $^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$.

Gopinath, Le Mezo, Mehl, and Nguyen (2020) provide evidence for the importance of dominant currency exchange rates in pass-through using a global database of bilateral trade prices. They modify the standard pass-through regression as described in Burstein and Gopinath (2014) by including the dollar exchange rate, i.e. the log price $e_{\$j}$ of a US dollar in currency j, alongside the bilateral exchange rate:

$$\Delta p_{ijt} = \lambda_{ij} + \delta_t + \sum_{k=0}^{2} \beta_k \Delta e_{ij,t-k} + \sum_{k=0}^{2} \beta_k^{\$} \Delta e_{\$j,t-k} + \sum_{k=0}^{2} \eta_k \Delta e_{ij,t-k} \times S_j + \sum_{k=0}^{2} \eta_k^{\$} \Delta e_{\$j,t-k} \times S_j + \theta' X_{it} + \varepsilon_{ijt}, \quad (1)$$

where λ_{ij} and δ_t are bilateral country-pair and time fixed effects respectively, and X_{it} are other country i controls. They also interact the bilateral and dollar exchange rates with the importing country's dollar invoicing share S_j.[8]

[8]Inclusion of time fixed effects ensures that the apparent dominance of the dollar cannot be an artifact of special conditions that may apply in times when the dollar appreciates or depreciates against *all* other currencies, for example due to global recessions or flight to safety in asset markets.

As a benchmark, estimates from bilateral pass-through regressions on bilateral exchange rates (i.e., omitting the dollar exchange rates and interaction terms) are reported in columns 1 and 4 of Table 3. The two columns correspond to unweighted and trade-weighted regressions, respectively. According to the regression estimates, when country j's currency depreciates relative to country i by 10%, import prices in country j rise by 8%, suggestive of close to complete pass-through at the one year horizon.[9]

Columns 2 and 5 report estimates from regressions that include the dollar exchange rate in addition to the bilateral one. Including the dollar exchange rate sharply reduces the relevance of the bilateral exchange rate. It knocks the coefficient on the bilateral exchange rate from 0.76 to 0.16 in the unweighted regression, and from 0.77 to 0.34 in the weighted regression. Almost all of the effect is absorbed by the dollar exchange rate.[10]

The cross-dyad heterogeneity in pass-through coefficients is related to the propensity to invoice imports in dollars. Columns 3 and 6 interact the dollar and bilateral exchange rates with the share of invoicing in dollars at the importer country level, as in regression (1). The importer's country-level share is used as a proxy for bilateral invoicing shares. The import invoicing share plays an economically and statistically significant role for the dollar pass-through. Increasing the dollar invoicing share by 10 percentage points causes the contemporaneous dollar pass-through to increase by 3.5–7.6 percentage points. The R^2 values of the panel regressions are substantially improved by adding the invoicing share interaction terms.

Consumer Prices Most of the evidence on ERPT and currency of invoicing is with respect to import prices. This is because it is difficult to trace goods from the dock to the final buyer. Auer, Burstein, and Lein (2021) provide valuable evidence by matching detailed product categories at the import level, where they have invoicing information, to the retail level in Switzerland. They document that around the episode of a surprise large appreciation of the Swiss franc the differential pass-through at the dock across goods invoiced in Swiss franc versus those invoiced in Euros carried through to consumer prices,

[9] With year fixed effects, this should be interpreted as fluctuations in excess of world annual fluctuations.

[10] In the literature, *unilateral* exchange rate pass-through is sometimes estimated using a Vector Error Correction Model (VECM) that allows for cointegration between price levels and exchange rates. However, Burstein and Gopinath (2014, p. 403) find VECM results to be highly unstable across specifications, and this issue is likely to be compounded by measurement error in our bilateral data.

even though the gap was reduced as one would expect. In the first two quarters after the appreciation, retail import prices in product categories invoiced in foreign currency fell by roughly 7 percentage points more than in product categories invoiced in Swiss franc over a period when the Swiss franc appreciated by around 14%. Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) run country level CPI inflation regressions and document the average pass-through of the dollar into CPI (resp., PPI) to be 11% (resp., 28%) within the year, and pass-through is higher for countries with a higher share of dollar invoicing in imports.

2.3 Co-movement between terms of trade and exchange rates

A related test of the pricing paradigms is to examine the co-movement between exchange rates and the terms of trade, namely the relative price of imports and exports expressed in a common currency. Under PCP, the terms of trade should *depreciate* one-to-one with the exchange rate; under LCP, they should *appreciate* one-to-one; and under DCP or the Salter-Swan model, the two should be essentially *uncorrelated*.

The earliest implementation of this test goes back to Obstfeld and Rogoff (2000) who examine the correlation between country-level terms of trade and the trade-weighted exchange rate for 21 countries using quarterly data for 1982-1998. They report an average correlation of 0.26, which they interpret as a rejection of LCP which would have predicted a correlation close to -1. Even though the correlation is well less than 1, which would lend weak support for producer currency pricing, they conjectured that the low correlation could be because of the construction of the trade-weighted exchange rates and/or because their terms of trade measures include commodity prices. At this time, DCP was not even under consideration as an alternative description of the data.

Atkeson and Burstein (2008) have emphasized another property of terms of trade, namely their relative stability in comparison with the real exchange rate. Indeed, non-commodity terms of trade are about two-to-three times less volatile than the real (or nominal) exchange rate. While this pattern is at odds with model in which the law of one price holds, Atkeson and Burstein (2008) show that a model with variable markups and pricing to market can successfully mute the volatility of terms of trade to match the data. A drawback of such a model, nonetheless, is still a high positive correlation between the terms of trade and the real exchange rate.

In the data, however, both relative volatility and correlation of the terms of trade with the real exchange rate are low, resulting in a very low exchange rate pass-through coefficient into the terms of trade. Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) improve upon the implementation of the test by examining the bilateral terms of trade, excluding commodity prices, and estimate pass-through coefficients as opposed to correlations. Consistent with DCP, they find that bilateral exchange rates are virtually uncorrelated with bilateral terms of trade with the 95% confidence interval for the regression coefficient equal to $[0.02, 0.05]$ in the unweighted regression, and $[0.04, 0.13]$ in the trade-weighted regression.

The disconnect between the terms of trade and the exchange rate is also consistent with the Salter-Swan model where import and export prices are assumed to be exogenous to the country. While this is consistent for commodity prices for some countries, prices of non-commodity exports from developing countries display similar sticky price features as those from advanced economies. Moreover, a prediction of the Salter-Swan model is that a weaker currency reduces marginal costs of production and leads to an increase in exports because the firm faces an infinitely elastic demand for its goods at the world price. On the other hand, under DCP, because the firm faces a downward sloping demand curve, if the foreign currency price does not change then there is no increase in exports, while firms profits in home currency fluctuate. The next section provides evidence that for most countries (and for non-commodities) expenditure switching occurs mostly through cuts in imports and not increases in exports, unlike in the Salter-Swan model, where expenditure switching occurs both through a cut in imports and an increase in exports. Also, firm profits do fluctuate with invoice currency exchange rates.

2.4 Trade elasticity, expenditure switching, and currency of invoicing

The previous subsections focused on prices. As these prices are contracted between firms, a question arises about their allocative role. Furthermore, even if border prices have consequences for profit margins of importing firms, could it be the case that movements in terms of trade have little impact on quantities in the near term because final consumers face stable prices in their local currency? We now describe the evidence showing the differential response of import and export quantities as a function of the invoice currency, pointing to the real allocative consequences of currency of pricing. Border prices are consequential for quantities.

Demand for good i in country j can be approximated as:

$$\Delta y_{ijt} = -\sigma_{ij} \left(\Delta p_{ijt} - \Delta p_{jt} \right) + \Delta y^{d}_{jt},$$

where σ_{ij} is the elasticity of demand and y^{d}_{jt} is the log aggregate demand in country j and p_{jt} is the log price index in country j. When prices are fully rigid and pre-determined in their currency of invoicing, pass-through into import quantities from country i to country j is given by:

$$\Delta y_{ij,t} \quad = \quad -\sigma_{ij} \left(\theta^{i}_{ij} \Delta e_{ijt} + \theta^{\$}_{ij} \Delta e_{\$jt} \right) \tag{2}$$

where θ^{k}_{ij} captures the share of imports from country i to j that are invoiced in currency k. In the case of PCP, $\theta^{i}_{ij} = \theta^{j}_{ji} = 1$ and $\Delta y_{ijt} = -\sigma_{ij} \Delta e_{ijt}$. In the case of LCP, $\theta^{j}_{ij} = \theta^{i}_{ji} = 1$ and $\Delta y_{ijt} = 0$. In the case of DCP, $\theta^{\$}_{ij} = \theta^{\$}_{ji} = 1$ and $\Delta y_{ijt} = -\sigma_{ij} \Delta e_{\$jt}$.

The issue of endogeneity of the exchange rate is a bigger concern for the response of imports and exports to exchange rates than it is for prices. This is because quantity responses depend on the level of demand besides the relative price of imports and this can vary depending on the shock driving the exchange rate changes (see Section 3). That is, a decline in imports may reflect an overall decline in demand for certain goods in a country rather than an increase in the price of imports. Much progress has been made here with granular data and through instrumenting for the dollar exchange rate.

One of the cleanest pieces of evidence is from Auer, Burstein, and Lein (2021) using the rapid appreciation of the Swiss franc. They show that consumer expenditure shares on imported goods increased by more in product categories in which imports were invoiced in euro (foreign currency) than in those categories invoiced in Swiss franc (local currency). Hence, they conclude that differences in invoicing currency at the border matter also for consumer allocations.

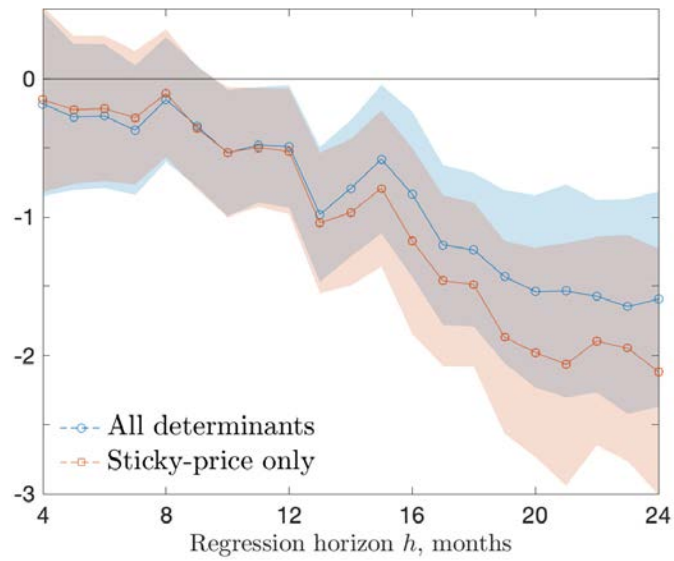

Figure 3: The dynamics of quantity elasticity

Note: This figure, from Amiti, Itskhoki, and Konings (2020), plots the non-parametric dynamic estimates of the quantity elasticity σ_h from a regression of h-month difference in export quantities on h-month difference in export prices; the price changes are projected in the first stage on changes in exchange rates interacted with firm-level determinants of pass-through and firm currency choice dummies (the red line uses only the currency choice dummy interactions)—see Eq. (14) in Section 5. The sample covers all differentiated product exports from Beligum to all extra-EU destinations.

Auer, Burstein, Erhardt, and Lein (2019) also document that differences in currency of invoicing at the border also carry over to allocations on the export side. In the context of the Swiss franc appreciation, they show that export growth in 2015 was larger in industries with higher euro invoicing of export border prices. Cravino (2017) uses data on Chilean exports to document the differential response of exports to exchange rate shocks according to the invoicing currency of the transaction. He shows that in a given destination, the relative prices and quantities exported of products invoiced in different currencies fluctuate with the nominal exchange rate, consistent with prices being sticky in the currency of invoicing and also with these prices being allocative for quantities.

Amiti, Itskhoki, and Konings (2020) study the differential response of Belgian export prices and quantities across firms invoicing in different currencies. While LCP implies relative stability of destination-currency prices, and thus quantities, export pricing in dollars (DCP) or euros (PCP) results in high pass-through of the respective exchange rates into prices and thus predicts corresponding responses of quantities. Specifically, appreciation of the dollar (euro) relative to the destination currency implies a relative increase in export prices and decline in export quantities for firms pricing in dollar (euro). If this is the case, the currency of pricing has direct allocative consequences in international trade and global production. Amiti, Itskhoki, and Konings (2020) find evidence of both stages of transmission — namely, differential pass-through into prices of respective exchange rates, in line with a sticky price model, and associated differential responses of quantities, albeit with a time lag suggestive of additional quantity adjustment frictions, as we illustrate in Figure 3. The implied elasticity of import demand in response to differential movement of sticky export prices invoiced in different currencies is low over short horizons, but gradually builds up to over 1.5 (in absolute value) a year after the shock, due to delayed quantity adjustment.[11]

Barbiero (2020) astutely observes that even if exports of goods invoiced in a foreign currency are slow to respond because of sticky prices, it must be that a firm's cashflow is sensitive to exchange rate fluctuations either because the firm's mark-up increases or its marginal cost fluctuates when its inputs are also priced in a foreign currency. He investigates the impact of currency mismatch generated by trade invoicing on cash flows of French firms. First, he shows that an invoice-weighted exchange rate index consistently outperforms any trade-weighted effective exchange rate index at explaining cash flows, investment, and employment effects of trading firms. Second, he shows that investment and payroll of small domestic-oriented firms are sensitive to the cash flow shocks that arise from exchange rate fluctuations. On the other hand, the real effects on large traders and small exporters are negligible because the former are liquid, and the latter partially hedge their dollar-priced imports with dollar-priced exports. The additional channel of adjustment may be entry and exit of firms in the aftermath of large persistent exchange rate movements.

Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) and Boz, Casas, Georgiadis, Gopinath, Le Mezo, Mehl, and Nguyen (2020) provide global evidence by estimating panel regressions of trade volumes on bilateral and dollar exchange rates. The volume regressions take the same form as in the price pass-through regressions, Eq. (1), except that the dependent variable is now the log growth

[11]The quantity elasticity of 1.5 is consistent with conventional calibrations in international macroeconomics (see e.g. Chari, Kehoe, and McGrattan, 2002) and other empirical estimates using time-series variation in prices and quantities (see e.g. Feenstra, Luck, Obstfeld, and Russ, 2018), yet is smaller than the estimates in the international trade literature, which use cross-sectional variation in prices and quantities (see e.g. Broda and Weinstein, 2006).

Table 4: Trade elasticity with respect to exchange rate

	Unweighted			Trade-weighted		
Dep. var: Δy_{ijt}	(1)	(2)	(3)	(4)	(5)	(6)
Δe_{ijt}	-0.119***	-0.0310*	-0.0765*	-0.0901***	-0.0163	-0.0971**
	(0.0139)	(0.0160)	(0.0403)	(0.0182)	(0.0236)	(0.0380)
$\Delta e_{ijt} \times S_j$			0.118*			0.124**
			(0.0684)			(0.0519)
$\Delta e_{\$jt}$		-0.186***	-0.140**		-0.155***	-0.131**
		(0.0250)	(0.0600)		(0.0277)	(0.0658)
$\Delta e_{\$jt} \times S_j$			-0.0903			-0.00581
			(0.0871)			(0.0846)
R-squared	0.069	0.071	0.074	0.172	0.179	0.215
Observations	52,272	52,272	38,582	52,272	52,272	38,582
Dyads	2,807	2,807	2,014	2,807	2,807	2,014

Note: From Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020). The first (last) three columns use unweighted (trade-weighted) regressions. All regressions include two exchange rate lags (in log changes), import GDP growth and two lags, and time fixed effects. Standard errors clustered by dyad. $^{***}p$ <0.01, $^{**}p < 0.05$, $^{*}p < 0.1$.

rate of bilateral trade volumes Δy_{ijt}, and the extra controls X_{jt} include the growth rate of real GDP (and two lags) for the importing country j. These regressions do not capture structural demand elasticity parameters, as they do not attempt to control for all relevant relative prices and the importer's GDP growth is an imperfect proxy for the level of import demand. These regressions should be viewed as predictive relationships that may inform potential structural estimation exercises.

The volume regressions underline the dominant role played by the US dollar. As in the case of the price pass-through regressions, adding the dollar exchange rate to the volume regressions knocks down the coefficient on the bilateral exchange rate by a substantial amount. The contemporaneous elasticity for the dollar exchange rate is about -0.19 to -0.13 across specifications, while the elasticity for the bilateral exchange rate is an order of magnitude smaller. Unlike the price pass-through regressions, the interactions of exchange rate changes with the importer's dollar invoicing share are mostly imprecisely estimated here.

Adler, Casas, Cubeddu, Gopinath, Li, Meleshchuk, Buitron, Puy, and Timmer (2020) demonstrate that in the short term (within a year), following a currency depreciation imports decline noticeably

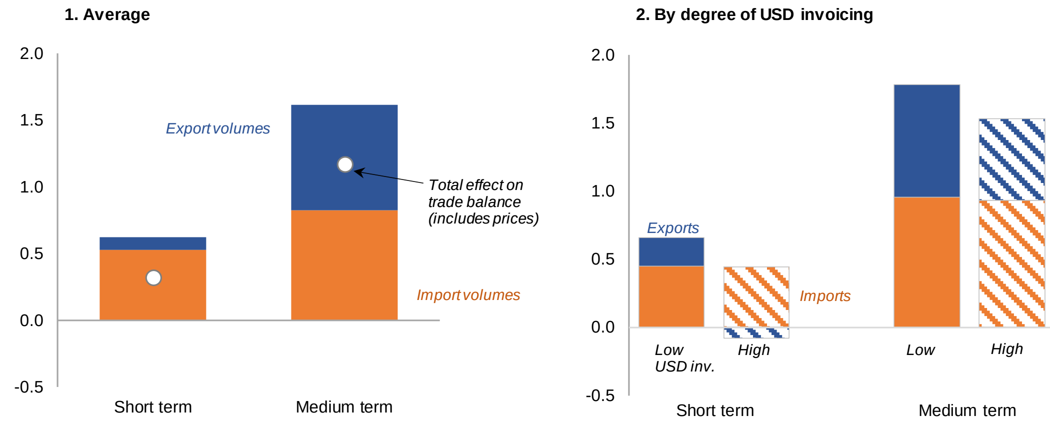

Figure 4: Role of Exports and Imports in Expenditure Switching

Note: From Adler, Casas, Cubeddu, Gopinath, Li, Meleshchuk, Buitron, Puy, and Timmer (2020)

while exports barely change. Over the medium term (3 years), exports increase in line with the decline in imports. This is depicted in Figure 4 using estimates from weighted regressions. When regressions are unweighted, so that smaller economies that are more dollar dependent get a greater weight, the gap between exports and imports persists.

Ma, Schmidt-Eisenlohr, and Zhang (2020) re-estimate the regressions in Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) and deal with the endogeneity of the dollar exchange rate by instrumenting it using domestic housing activity in the US, which has been shown by Ma and Zhang (2019) to predict dollar exchange rate movements one year ahead. They focus on trade flows between third countries that are unlikely to be directly affected by changes to domestic demand and supply for U.S. housing. Using this instrument they find strong support for DCP, with larger coefficient estimates for the dollar's impact on prices and quantities relative to the OLS regressions in Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020). They estimate that a dollar appreciation of 1 percent lowers import quantities by 1.5 percent for countries that fully invoice in dollars.

Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) also demonstrate that because of the asymmetric importance of the dollar, under DCP, *ceteris paribus*, a uniform depreciation relative to the dollar, $\Delta e_{\$t} > 0$, leads to a decline in non-commodity trade in the rest of the world ($\mathbb{R}$):

$$\Delta y_{\mathbb{R}t} = \sum_{\mathbb{R}} \omega_{ij} \Delta y_{ijt} = -\left(\sum_{\mathbb{R}} \omega_{ij} \sigma_{ijt} \right) \Delta e_{\$t} < 0. \tag{3}$$

Under both PCP and LCP, the growth of the rest-of-the-world trade is instead $\Delta y_{\mathbb{R}t} = 0$, because bilateral non-dollar exchange rates are unchanged (PCP) and there is no bilateral pass-through (LCP).

Consequently, under DCP, the dollar has substantial predictive power for aggregate trade among countries in the rest of the world. That is, the dollar is important for predicting global trade, even when excluding direct trade with the U.S. Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) measure the elasticity of the rest-of-world trade volume to the dollar by aggregating up from a bilateral panel regression specification and report that a 1% U.S. dollar appreciation against all other currencies in the world predicts a 0.6% decline within a year in the volume of total trade between countries in the rest of the world, holding constant various proxies for the global business cycle. They show that the large negative predictive effect of a dollar appreciation on world trade is robust to controlling for the exchange rates of the Swiss franc and Japanese yen. Hence, the finding is not an artifact of conflating periods of overall dollar appreciation with periods of global flight to safety.

3 Asymmetry in the Transmission of Shocks

Asymmetry in invoicing currencies in global trade translates into an asymmetric impacts of shocks originating in the dominant currency issuer versus in other countries. To illustrate these effects, we use a simple general equilibrium framework with stark modeling assumptions. Nonetheless, the qualitative insights from this analysis remain largely robust in a fully general quantitative international business cycle model, as studied in Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020). We focus on a non-dominant open economy (home) trading with the rest of the world (ROW), which may include a dominant country, under different pricing paradigms. We consider various shocks that lead to a home currency depreciation, and study their impact on trade prices and quantities, inflation and output.

Equilibrium environment We consider a static three-equation general equilibrium model with endogenous exchange rate determination, following Corsetti and Pesenti (2007) and Farhi, Gopinath, and Itskhoki (2014), which allows us to study the response of various macroeconomic quantities to shocks.

Aggregate demand of the economy is given by a conventional cash-in-advance condition:

$$PC = M, \tag{4}$$

where M is money supply, C is aggregate consumption. P is the price level given by:

$$P = P_H^{1-\gamma} P_F^{\gamma},$$

where P_H and P_F are the home-currency prices of the home and imported goods, respectively, with γ characterizing the expenditure share on foreign goods. Similarly, in the rest of the world, we have $P^*C^* = M^*$ and $P^* = (P_F^*)^{1-\gamma^*}(P_H^*)^{\gamma^*}$ in foreign currency, where γ^* is the ROW's expenditure share on home goods. Note that $\gamma^* < \gamma$ captures the fact that home is small relatively to the rest of the world with $\gamma^* \to 0$ in the limit when home is a small open economy.

Home expenditure on foreign products (home imports) is given by $P_F C_F = \gamma PC = \gamma M$, with the complementary share spent on the domestic goods, arising from a Cobb-Douglas (unit-elastic) demand system. In turn, the rest of the world's expenditure on home products is given by $P_H^* C_H^* = \gamma^* M^*$, in foreign currency. As a result, goods market clearing requires that total domestic output satisfies:

$$Y = C_H + C_H^* = (1-\gamma)\frac{M}{P_H} + \gamma^* \frac{M^*}{P_H^*}. \tag{5}$$

Similarly, the output in the rest of the world satisfies $Y^* = (1-\gamma^*)\frac{M^*}{P_F^*} + \gamma \frac{M}{P_F}$.

Finally, we denote with B the net foreign assets of the home country (inclusive of interest payments and valuation effects). As a result, the budget constraint of the country is given by $B + NX = 0$ with net exports given by:

$$NX = \mathcal{E} P_H^* C_H^* - P_F C_F = \gamma^* M^* \mathcal{E} - \gamma M,$$

where $\mathcal{E}$ is the nominal exchange rate: an increase in $\mathcal{E}$ corresponds to a home currency depreciation.

This immediately allows us to characterize the equilibrium exchange rate:

$$\mathcal{E} = \frac{\gamma M - B}{\gamma^* M^*}, \tag{6}$$

which holds independently of the price setting in the economy. Therefore, home depreciation ($\mathcal{E}\uparrow$) may be triggered by a monetary expansion at home ($M\uparrow$), a monetary contraction in the rest of the world ($M^*\downarrow$), or a shift in net wealth from home to the rest of the world ($B\downarrow$). Shocks to M and M^* have a simultaneous direct effect on aggregate demand via Eq. (4), and thus the general equilibrium comovement with exchange rates is in a large part shaped by these direct effects. In contrast, shocks to B have no direct macroeconomic effect on consumption, inflation, or output, with all macroeconomic consequences arising as a result of international transmission via exchange rates and prices. These shocks, in particular, capture the financial determinants of the exchange rate, such as shifts in demand between home- and foreign-currency bonds, as in Itskhoki and Mukhin (2021).

For simplicity, we consider the limiting case of fully sticky prices, thus focusing on the short-run response. The domestic prices are sticky in the domestic currency, while the international prices follow either PCP, LCP or DCP paradigms. In particular, under PCP, the producer currency prices P_H and P_F^* are preset and the international prices satisfy the law of one price with $P_H^* = P_H/\mathcal{E}$ and $P_F = P_F^*\mathcal{E}$. Under LCP, all local prices, including import prices P_H^* and P_F, are preset in the local currency, and thus consumer prices are not affected by the exchange rate. Finally, under DCP, all trade prices are preset in the dominant currency, and only the exchange rate with the dominant currency, rather than the bilateral exchange rate between trading countries, matters for consumer prices.

International transmission of shocks We consider a home currency depreciation ($\mathcal{E}\uparrow$) driven by either domestic monetary expansion ($M\uparrow$), foreign monetary tightening ($M^*\downarrow$), or an international wealth transfer to the ROW ($B\downarrow$), as characterized in Eq. (6). The effect of the depreciation on trade prices and terms of trade, as studied in the previous section, as well as on consumer price inflation does not depend on the nature of the shock that moves the exchange rate. We summarize these effects in Table 5. The three pricing paradigms have the most stark differential implications for the transmission

Table 5: Transmission of a depreciation into aggregate prices

	PCP	LCP	DCP
Nominal exchange rate, $\mathcal{E}$	$+1$	$+1$	$+1$
Terms of trade, $\mathcal{S} = P_F/(P_H^*\mathcal{E})$	$+1$	-1	0
— Home import price, P_F	$+1$	0	$+1$
— Foreign import price, P_H^*	-1	0	0
Home CPI inflation, P	$+\gamma$	0	$+\gamma$
Foreign CPI inflation, P^*	$-\gamma^*$	0	0

Note: The table shows proportional changes in aggregate prices in response to a unitary home depreciation ($\mathcal{E}\uparrow$).

of a depreciation into the terms of trade, which deteriorate under PCP, improve under LCP and stay stable under DCP.[12] This is driven by the differential response, or the lack thereof, of import prices to exchange rates.

The response of import prices predicts, in turn, the response of consumer price inflation. Home CPI inflation increases with home currency depreciation, in proportion with the openness of the economy γ, under both PCP and DCP, while it stays stable under LCP. In contrast, the foreign CPI inflation is sensitive to the domestic-currency depreciation only under PCP, and this effect is proportional to the foreign expenditure share on domestically-produced goods, γ^*. This emphasizes the first asymmetry of dominant currency pricing in that the home-currency depreciation results in inflationary pressures at home, yet no deflationary pressures abroad. Furthermore, the inflationary pressures at home are strongest under DCP, as depreciation against the dominant currency affects import prices from all countries at once, while under PCP it is the trade-weighted exchange rate that is relevant for the home inflation (see Gopinath, 2015).

Next we consider the international transmission into trade and aggregate quantities, namely the real quantities of exports, imports, output and consumption, as we summarize in Table 6. In this analysis, unlike with prices, the nature of the shock matters for the resulting outcome, as the presence or absence of the direct aggregate demand effect matters for quantities independently of the transmission via prices. We start with a wealth transfer shock to the ROW ($B\downarrow$), which results in a home

[12] Despite this stark difference for the terms of trade, the real exchange rate $\mathcal{Q} = P^*\mathcal{E}/P$ comoves in all cases closely with the nominal exchange rate, as long as economies are sufficiently closed (γ and γ^* are small), limiting the effect of the exchange rate on consumer price levels.

Table 6: Transmission of a depreciation into aggregate quantities

	International wealth transfer shock ($B\downarrow$)			Dominant monetary contraction shock ($M^{\$}\downarrow$)	
	PCP	LCP	DCP	PCP & LCP	DCP
Home exports, C_H^*	$+1$	0	0	0	-1
Home imports, C_F	-1	0	-1	0	-1
Home output, Y	$+\gamma^*$	0	0	0	$-\gamma^*$
Foreign output, Y^*	$-\gamma$	0	$-\gamma$	0	$-\gamma$

Note: The table shows changes in real trade quantities and output in response to a unitary home depreciation, caused by a wealth transfer to the ROW in the left panel and by a monetary tightening in the dominant country in the right panel (in this case, all currencies depreciate against the dominant currency). The effects on home (foreign) consumption have the same signs as the effects on foreign (home) output. The effect on home and foreign output is proportional to $\gamma^* M^*/(P_H^* Y)$ and $\gamma M/(P_F Y^*)$, respectively (see Eq. (5)).

currency depreciation ($\mathcal{E}\uparrow$) without any additional shifts in aggregate demand, thus isolating the pure expenditure switching effect from the exchange rate. In particular, a home depreciation generally shifts expenditure towards home goods and away from foreign products. However, these expenditure switching effects are only fully present under PCP, and they are entirely absent under LCP, whereby stable local currency prices eliminate all expenditure switching in the short run. DCP offers an interim case where expenditure switching operates on the import side, resulting in a decline in imports as under PCP, while there is no effect on the export side, akin to LCP.[13]

The differential response of imports and exports under different pricing paradigms translates into the differential response of quantities produced and consumed, in proportion with the openness of the economies. Thus, domestic output expands in response to a domestic depreciation only under PCP, but not under DCP or LCP as these pricing paradigms do not result in expenditure switching towards domestically produced goods.[14] In contrast, foreign output and domestic consumption contract under both PCP and DCP as these two pricing regimes feature expenditure switching away from imported goods that become more expensive with a home depreciation.

[13] While all these effect are still present under other shocks, such as domestic monetary expansion ($M\uparrow$) or foreign monetary contraction ($M^*\downarrow$), the direct aggregate demand effects in those cases can partially or fully undo the expenditure switching effect from the exchange rate depreciation. For example, a depreciation driven by home monetary expansion stimulates exports under PCP, but does not curb imports under either PCP or DCP, as the expansion of home demand fully compensates for the expenditure switching away from imported goods.

[14] This stark result is partially modified in an economy with imported intermediate inputs, where the expenditure switching effects can operate entirely in the domestic market, as we discuss below.

Finally, we consider separately a dominant currency appreciation triggered by a monetary tightening in the dominant country, without any monetary accommodation at home or in the rest of the world. In this case, all currencies depreciate against the dominant currency. For simplicity, we focus on the special case where the home country only trades with the non-dominant ROW, but not with the dominant country directly.[15] In this limiting case, both the PCP and LCP paradigms uniformly imply no change in export or import quantities, consumption or output at home, as a shock in the dominant country does not affect bilateral exchange rates in the rest of the world, and hence leads to no transmission, as we show in the right panel of Table 6.

Matters are starkly different under dominant currency pricing, as in this case all international trade prices increase proportionally with the dominant currency exchange rate. Indeed, this leads to a decline in both domestic export and import quantities, as well as a worldwide decline in consumption and output (see also Goldberg and Tille, 2009; Mukhin, 2021). Furthermore, in this case the aggregate effects are proportional to the full expenditure share of all economies on all internationally-sourced goods. This is, perhaps, the most consequential differential prediction of the DCP paradigm relative to the symmetric pricing paradigms (PCP and LCP), where exchange rate movements typically involve an international redistribution of production and consumption rather than lead to a simultaneous macroeconomic slowdown across all countries.

Dynamic impulse responses We finish this section with an illustration of dynamic impulse responses of aggregate prices and quantities in a full quantitative model from Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020), which features Calvo staggered price and wage setting, Kimball variable markups, imported intermediate inputs, incomplete international asset markets, and Taylor interest rate rules, as well as models explicitly three regions of the world — the small home economy, the dominant country, and the non-dominant ROW.

Importantly, the qualitative stylized insights from the analysis above still hold in a rich quantitative

[15]Formally, we consider a reduction in money supply in the dominant country ($M^{\$}\downarrow$), while holding constatn M, M^* and B in Eq. (6). Therefore, the exchange rate between home and the non-dominant ROW remains unchanged, while all exchange rates depreciate proportionally against the dominant currency, thus raising proportionally all DCP-set trade prices.

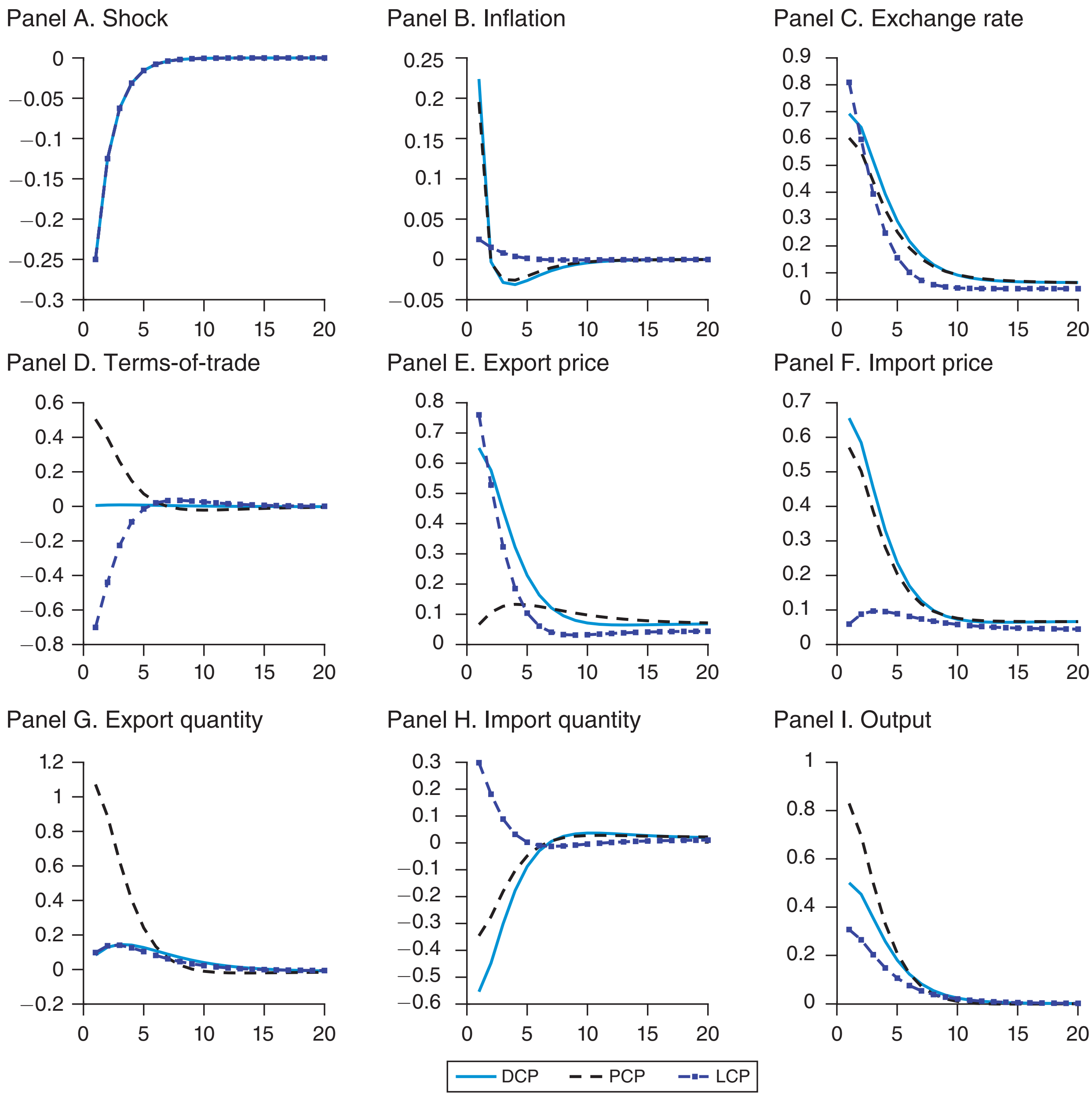

Figure 5: Dynamic response to a monetary expansion in a small open economy

Note: Impulse responses to a monetary shock from the quantitative small open economy model in Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020).

macroeconomic environment, as we show in Figure 5. In particular, a depreciation of the home currency, in this case triggered by a monetary expansion at home, results in domestic inflation under PCP and DCP, which is in turn largely muted under LCP. The export and import prices and terms of trade have a starkly different behavior in the first year after the shock, depending on the pricing paradigm.

Consequently, exports are stimulated by the expenditure switching under PCP, but not under LCP or DCP, while imports contract under both PCP and DCP.[16]

Lastly, the strong expenditure switching effect towards domestically produced goods under PCP results in a strong domestic output response in this case. This effect is largely absent under LCP, which features no expenditure switching in the short run. DCP corresponds to an interim case, where expenditure switching operates on the import side, but not on the export side, which limits the effect on output. Domestic output still expands in this case, as home producers substitute away from foreign and towards domestically-produced intermediate inputs. As a result, the inflation–output trade-off in response to expansionary monetary policy worsens under DCP relative to both PCP (which features a stronger output response) and LCP (which features nearly no inflation response).[17]

4 Optimal Monetary Policy

This section reviews the insights from the recent literature on optimal monetary policy under dominant currency pricing for the case of a small open economy.[18] This literature finds that the optimal policy under DCP calls for producer price inflation targeting and flexible exchange rates, similar to the case of PCP. However, unlike in the PCP case, output gaps cannot be closed under DCP and consequently the benefits of flexible exchange rates are muted.

The intuition for this result is as follows: under DCP, because of the failure of the law of one price, there are two inefficient sticky prices — the domestic price which is sticky in the home currency and the export price which is sticky in the dominant currency. As a result, shocks give rise to a domestic output gap and an export output gap. Monetary policy is a single instrument that cannot close both gaps. Interestingly, however, the optimal response is not to partially close each gap but instead to fully close the domestic output gap. This is because policy is unable to influence the export output gap

[16] Note that the presence of imported intermediate inputs in production causes imports to actually increase under LCP, due to the stimulating effect of the monetary shock on domestic output.

[17] See Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller (2020) for a further discussion of the asymmetries in the transmission of shocks originating in different countries, with and without a dominant currency status.

[18] Earlier literature on monetary policy under DCP includes Devereux, Shi, and Xu (2007), Corsetti and Pesenti (2007) and Goldberg and Tille (2009).

when it cannot influence the relative price of home exports in international markets and the foreign demand for domestic goods. It therefore focuses solely on closing the domestic output gap by stabilizing domestic producer prices.

The inability to influence the relative price of exports follows straightforwardly when export prices are assumed to be perfectly sticky in the dominant currency. Less trivially, it is also the case when prices adjust à la Calvo under the additional assumptions that international asset markets are complete, wages are flexible, and utility is log-linear in consumption and labor, $U = \ln C - L$. In this case, the wage rate is $W_t = P_t C_t$, and under complete markets it is also proportional to $\mathcal{E}_t P_t^* C_t^*$, where as before $\mathcal{E}_t$ is the nominal exchange rate.[19] Therefore, the marginal cost of domestic firms, $MC_t = W_t/A_t$, when expressed in the foreign currency is exogenous to domestic monetary policy, $MC_t/\mathcal{E}_t = P_t^* C_t^*/A_t$. As a result, the domestic policymaker lacks an instrument to affect either preset or newly set prices in foreign markets, and hence influence the export output gap.

More formally, in this case, Casas, Díez, Gopinath, and Gourinchas (2016) derive the second-order approximation to the welfare loss function:

$$\mathbb{W} \approx \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{2} y_t^2 + \frac{\sigma(1-\gamma)}{2\lambda} \pi_{Ht}^2 + \frac{\gamma(1-\gamma)}{2} m_t^2 \right], \tag{7}$$

where γ is a measure of openness, $\lambda = (1-\delta)(1-\beta\delta)/\delta$ where δ is the Calvo probability of price non-adjustment, β is the discount factor, and σ is the elasticity of substitution across product varieties. The output gap y_t and producer price inflation π_{Ht}, both in log deviations from the flexible-price allocation, jointly satisfy the dynamic New Keynesian Phillips curve representing the supply side of the economy:

$$\pi_{Ht} = \frac{\lambda}{1-\gamma} \big(y_t - \gamma s_t \big) + \beta \mathbb{E}_t \pi_{H,t+1} \tag{8}$$

where s_t is the terms of trade. Lastly, the term m_t in the welfare loss function (7) captures deviations from the law of one price (LOP) between domestic and export prices, and in equilibrium is given by

[19] This is a consequence of the equilibrium international risk sharing, which under the log utility implies $P_t C_t = \mathcal{E}_t P_t^* C_t$ as a special case of the Backus-Smith condition ($C_t/C_t^* = \mathcal{Q}_t$, where the real exchange rate $\mathcal{Q}_t \equiv \mathcal{E}_t P_t^*/P_t$).

(*cf.* the misalignment term in Engel, 2011, under LCP):

$$m_t = \frac{1}{1-\gamma}\left(y_t - s_t\right). \tag{9}$$

The domestic planner minimizes the welfare loss function in (7) subject to the Phillips curve (8) and the equilibrium law of one price deviations (9).[20] This problem generalizes the case under PCP, considered in Galí and Monacelli (2005), which features no LOP deviations, and thus $m_t \equiv 0$ both in (9) and in the objective function (7). Furthermore, under PCP, the planner can use monetary policy to control the equilibrium terms of trade s_t, which depreciate together with the exchange rate. As a result, the planner can ensure that y_t, s_t and π_{Ht} are all stabilized simultaneously, reproducing the "divine coincidence" in an open economy under producer currency pricing.[21]

In contrast, the equations above make it clear that there is no divine coincidence in the case of DCP: it is generally impossible to attain simultaneously zero inflation and a zero output gap. Indeed, in this case, even if the output gap is closed, inflation fluctuates with the terms of trade. This is because, under DCP, the terms of trade evolve exogenously and independently from monetary policy, acting like a closed-economy markup shock in the Phillips curve (8) and breaking the divine coincidence. Another way to see this is that LOP deviations under DCP, which give rise to exogenous terms of trade s_t fluctuations and misalignment m_t, result in the domestic and export output gaps being out of sync, thus making it difficult for the policymaker to stabilize both of them at once.

Note that, under DCP, even when a country exports to multiple locations, there is only one misaligment term and the only policy relevant exchange rate is the dominant currency exchange rate. This differs from the case of LCP where the law of one price also fails but it is the bilateral exchange rates with trading partners that impact the misaligment between good prices in the domestic market and in the destination markets. Furthermore, in the case of DCP it is the terms of trade that cannot be influenced by monetary policy, while under LCP it is the relative price of imports to home produced goods

[20]Equilibrium dynamics in this economy must additionally satisfy the IS curve, which can be used as a side equation to recover the equilibrium interest rate as a function of output gap, inflation, and LOP deviations.

[21]Indeed, $m_t = 0$ implies that the output gap is proportional to the terms of trade deviations, $y_t = s_t$, which can be substituted into the Phillips curve (8) to obtain $\pi_{Ht} = \lambda y_t + \beta \mathbb{E}_t \pi_{H,t+1}$ featuring no trade-off between inflation and output gap stabilization, just like in the closed economy.

that is independent of monetary policy.

Optimal policy under discretion minimizes (7) subject to the implementation constraints (8) and (9), taking future inflation as given. Optimal discretionary policy thus satisfies:

$$y_t + \gamma m_t = -\sigma \pi_{Ht}, \tag{10}$$

which characterizes the open-economy tradeoff between inflation and output gap under DCP. Substituting (10) into the implementation constraints delivers the optimal policy under DCP: $\pi_{Ht} = 0$, $m_t = -s_t$ and $y_t = \gamma s_t$. That is, optimal policy calls for *producer price inflation targeting*. This is the same as under PCP, but unlike PCP where inflation targeting goes along with a zero output gap, in the case of DCP the output gap fluctuates with the terms of trade deviations and this is increasing in the level of openness of the economy γ. As demonstrated in Casas, Díez, Gopinath, and Gourinchas (2016), there are no gains to commitment in monetary policy (without cost-push shocks), despite the absence of divine coincidence. This is because under discretion optimal policy calls for zero inflation in each period. There are therefore no gains to being able to smooth inflation over time as is possible under commitment.

Even more surprisingly, Egorov and Mukhin (2020) demonstrate that the result on the optimality of producer price inflation targeting under DCP holds for a more general parametric case of the utility function and incomplete asset markets that lead to fluctuations in dollar marginal costs. Even though monetary policy can influence the prices of firms that get to adjust their prices, this action is not welfare improving, as the firm's price setting choices turn out to be socially optimal from the point of view of the country's policymaker. Unlike in the case of PCP where the policymaker can use the exchange rate to manipulate export prices without them being adjusted, under DCP there is no way around the sticky price friction — the planner faces the same tradeoff as the firms — and there is no policy tool to shift foreign demand towards the exporting firms.[22] As a result, the planner's best choice is still to eliminate

[22]This result breaks down if there are demand spillovers between adjusting and non-adjusting home exporters (e.g., nested demand structure with domestic products being closer substitutes for each other than for foreign varieties, so that home country as a whole can internalize demand cannibalization across its export products) or if multiple countries can form a currency or trade union and thus internalize export demand spillovers.

the domestic output gap by stabilizing producer price inflation at home.

A corollary of the optimality of producer price inflation targeting is that policy does not aim to manipulate the exchange rate but instead lets it adjust flexibly conditional on stabilizing producer prices. The implications for the dynamics of exchange rates, and whether exchange rates are more or less volatile under DCP relative to PCP, depend on the specifics of the shocks (e.g., productivity shocks, financial shocks) and parametric assumptions. Casas, Díez, Gopinath, and Gourinchas (2016) show that, under their parametric assumptions and DCP pricing, the exchange rate moves one-to-one with productivity shocks, as is also the case under PCP pricing even though the resulting allocation is different.

Egorov and Mukhin (2020) and Basu, Boz, Gopinath, Roch, and Unsal (2020) also show that capital controls are generally not helpful in alleviating the sticky-price inefficiency (export output gap) under dominant currency pricing, as domestic capital controls cannot affect foreign demand for home exports. This characterizes a departure from the general second-best logic, as for example formulated in Farhi and Werning (2016), providing an example where capital controls are not a substitute for missing monetary policy instruments.

This result changes when there are additional frictions. There is now a growing literature on policy making in the presence of multiple frictions, including financial frictions, and multiple policy instruments, including foreign exchange intervention, capital controls, and macro-prudential measures. The optimal mix of policy instruments is shown to depend, among other things, on the nature of the pricing frictions (see Basu, Boz, Gopinath, Roch, and Unsal, 2020). Bianchi and Lorenzoni (2021) in this handbook surveys this literature.

5 Currency Choice

Dominant currency use in international trade is a robust and persistent property of the data. This currency equilibrium is not exogenous, but is instead the consequence of firm-level decisions. While the US dollar accounts for a disproportionate share of international trade flows, as described in Section 2, there exists a small subset of currencies that are actively used in international trade alongside the US dollar, most notably the euro, but also to a smaller extent the Japanese yen, the British pound, the Swiss franc, and the Chinese yuan. Furthermore, in some bilateral trade flows these currencies play an equally important role as the US dollar, with considerable variation in currency use across individual firms even within narrowly defined industries.[23] The presence of this heterogeneity permits a study of the determinants of currency choice at the micro level, which can then be used for counterfactual analysis of changes in the currency choice equilibrium in response to large shifts in the global monetary system.

Main facts We emphasize three main facts that a model of currency choice should capture. First, there is considerable heterogeneity across firms in the use of a handful of global currencies, especially in trade among pairs of developed countries. The specific currency choice is also robustly associated with observable firm characteristics, as we discuss below. Therefore, currency choice is an active choice made at the micro level with allocative consequences at the macro level, as discussed in earlier sections.

Second, despite the presence of heterogeneity in the cross section, currency choice is remarkably stable in the time series with the status of dominant currencies remaining unchanged over decades. This suggests the presence of strategic complementarity forces that lock in currency equilibria at the micro level across firms as well as at the macro level for currency use in pricing, in financing and in monetary anchoring (see Mukhin, 2021; Gopinath and Stein, 2021; Gourinchas, 2019).

Third, the status of the dominant currency can shift occasionally, over centuries or half-centuries. The previous dominant currency, the British pound, lost its dominant status in the 1930s, long after the UK stopped being the leading world economy, and the pound kept its role as an important currency for pricing, anchoring and financing for even longer. There can be decisive shifts in the international monetary system over long time horizons, driven by secular shifts in macroeconomic fundamentals, in particular the relative economic size of countries and relative stability of currencies, even if with a

[23] For example, even in trade with the United States, where the US dollar accounts on average for over 90% of both imports and exports, the euro and Swiss franc account for nearly 40% of bilateral trade flows with Germany and Switzerland (see Gopinath, Itskhoki, and Rigobon, 2010, and Table 7 below). Furthermore, the euro is used at least as intensively as the dollar in trade of many European countries, even with trade partners outside European Union, while the Japanese yen accounts for the majority of exports from e.g. Belgium to Japan (see Amiti, Itskhoki, and Konings, 2020, and Appendix Figure A2). One can thus think of the dollar as the global dominant currency and of the euro as the regional dominant currency, all in existence of a handful of other currencies used in specific bilateral trade flows.

considerable time lag (see e.g. Krugman, 1980; Eichengreen, 2010).

Theories of currency choice Theories of currency choice can be classified based on the three conventional uses of money — the medium of exchange, the unit of account, and the store of value. The medium of exchange or transaction cost theories emphasize that a currency is adopted if it guarantees the lowest transaction costs (Krugman, 1980; Rey, 2001) or maximizes room for mutually beneficial exchange (e.g. due to market thickness in search-theoretic models, see Matsuyama, Kiyotaki, and Matsui, 1993; Devereux and Shi, 2013; Chahrour and Valchev, 2017). Large trade partners (like the US or China) and major currencies (like the dollar, the euro, the British pound or the Japanese yen) typically satisfy these requirements. In addition, such theories emphasize the likelihood of multiple coordination equilibria, which can elevate smaller currencies (like the Swiss franc) to the dominant status. These theories also emphasize macroeconomic factors, such as the overall inflation rate and inflation volatility or uncertainty, which could make certain currencies particularly costly to price in. In the modern world, transaction costs are likely not very large and spot exchange of currencies is mostly frictionless, at least for major currencies. In contrast, transaction costs are potentially large for many smaller currencies from developing countries, reinforcing the existence of only a small subset of global currencies.[24]

The unit of account or sticky price theories postulate that a price is set in a given currency and is not adjusted in the short run, and this forms the basis for the open economy Keynesian analysis. This is the framework for which both theory and empirical evidence is well developed, and it is the focus of our analysis next. 'Invoicing currency' can refer to either the transaction currency or the currency in which the price is preset, however, the two typically coincide, likely reinforcing each other's roles.

Finally, there are the store of value and financing theories, in which firms and financial institutions buy assets and issue liabilities denominated in various currencies. For example, the hedging motive is analyzed in Froot, Scharfstein, and Stein (1993), financing frictions in Gopinath and Stein (2021)

[24]In practice, we observe the use of only a handful of currencies — for example, even the Canadian or Australian dollars are rarely used in international transactions, let alone currencies of developing countries — likely owing to some fixed cost or coordination equilibrium, driven by macroeconomic or political fundamentals (e.g., macroeconomic or political risks associated with possible crises or inflation/devaluation). For evidence of the importance of macroeconomic fundamentals, such as the size of the country, inflation and exchange rate volatility, and income per capita, see e.g. Campa and Goldberg (2005); Goldberg and Tille (2008, 2009); Amiti, Itskhoki, and Konings (2020).

and Bahaj and Reis (2020), and costly default in Doepke and Schneider (2017) and Drenik, Perez, and Kirpalani (2021), where the latter theories share common themes with the transaction cost models. These theories are important on their own, explaining the role of the dollar in financial markets, yet they also predict complementarities with currency choice in international trade in goods and services.

5.1 Theory: how is invoicing currency chosen?

We now focus on the sticky price theory of currency choice, where invoicing currency is the currency in which prices are preset and stable until the next price adjustment. Consider a general profit function $\Pi(p_{it};\Omega_t)$ from exports of product i to a given destination, where p_{it} is the log realized price in producer currency and Ω_t is the state of the world, which includes in particular productivity, exchange rates and competitor prices. Consider a one-period choice of pre-setting the price in the producer currency at $\bar{p}_{it}$ (in logs) or in any other currency ℓ at $\bar{p}^{\ell}_{it}$, including the destination (local) currency which we denote with $\bar{p}^{*}_{it}$. The realized consumer price is then:

$$p^*_{it} = p_{it} + e_t = \begin{cases} \bar{p}_{it} + e_t, & \text{under PCP,} \\ \bar{p}^*_{it}, & \text{under LCP,} \\ \bar{p}^{\ell}_{it} + e^{\ell *}_t, & \text{under currency } \ell, \end{cases}$$

where e_t and $e^{\ell *}_t$ are log bilateral exchange rates of the destination currency against producer currency and any currency ℓ respectively, with increases in e_t and $e^{\ell *}_t$ corresponding to a depreciation of the destination currency.

The optimal choice between producer currency and currency ℓ then compares expected profits, $\mathbb{E}\Pi(\bar{p}_{it};\Omega_t)$ versus $\mathbb{E}\Pi(\bar{p}^{\ell}_{it} + e^{\ell}_t;\Omega_t)$, where $e^{\ell}_t = e^{\ell *}_t - e_t$ is the bilateral exchange rate between currency ℓ and the producer currency with an increase in e^{ℓ}_t corresponding to a depreciation of the producer currency.[25] This is a choice between a sure price in producer currency and a price plus a random

[25]Since we did not force any structure on the profit function, it can be defined inclusive of the stochastic discount factor, and thus the comparison of expected profits is without loss of generality in a one-period model. More generally, as our currency choice analysis focuses on the second order approximation to the profit (value) function, the properties of the stochastic discount factor do not affect the optimal currency choice.

variable — the bilateral exchange rate. Therefore, the early currency choice literature attempted to address this problem by characterizing conditions under which a profit function is convex or concave in the exchange rate (see Giovannini, 1988; Friberg, 1998; Bacchetta and van Wincoop, 2005). Apart from being a difficult characterization problem, it turns out that conditions for the profit function to be globally convex or concave in the exchange rate are generally too strong.

A seminal insight in Engel (2006) was to link currency choice to optimal exchange rate pass-through. Intuitively, currency choice is an indexing decision to the exchange rate; thus, it attempts to approximate the desired response of prices, or the exchange rate pass-through. This analogy is exact if currency choice is allowed to be fractional in a basket of currencies, as in Corsetti and Pesenti (2005). More conventionally, currency choice is a discrete decision, which puts weights of 0 or 1 on any currency, thus resulting in either zero or complete pass-through in the very short run. Therefore, low desired exchange rate pass-through in a given currency favors the use of this currency for presetting prices.

Gopinath, Itskhoki, and Rigobon (2010) generalize this insight and show that currency choice is shaped by the properties of the desired price, which summarizes the relevant properties of the profit function from the point of view of currency choice. The desired price maximizes profits state-by-state:

$$\tilde{p}_{it} = \tilde{p}_i(\Omega_t) = \max_{p_{it}} \Pi_i(p_{it}|\Omega_t),$$

or, in other words, is the price that a firm would choose in a given state of the world if it could adjust prices flexibly. Mukhin (2021) further proves the following equivalence:

Proposition 1. *Up to the second order, the currency choice problem* $\arg\max_\ell \mathbb{E}\Pi_i(\bar{p}^\ell_{it} + e^\ell_t; \Omega_t)$ *is equivalent to* $\arg\min_\ell \operatorname{var}(\tilde{p}^\ell_{it})$*, that is determining the currency in which the desired price is least volatile.*

This result is intuitive upon reflection. When the desired price expressed in currency ℓ is volatile across states, currency ℓ is a poor choice for presetting prices, as it results in large gaps between $\bar{p}^\ell_{it}$ and $\tilde{p}^\ell_{it}$, and thus large losses in expected profits. In contrast, when the desired price is stable in currency ℓ, fixing the price in this currency results in little loss relative to having flexible prices $\tilde{p}^\ell_{it}$, as it can be accurately approximated by a constant $\bar{p}^{\ell}_{it}$.[26] In other words, hitting a moving target is easier when its movement is limited.

The currency choice in Proposition 1 can be tied to exchange rate pass-through. Note that we can expand $\mathrm{var}(\tilde{p}^{\ell}_{it}) = \mathrm{var}(\tilde{p}_{it}) + \mathrm{var}(e^{\ell}_{t}) - 2\mathrm{cov}(\tilde{p}_{it}, e^{\ell}_{t})$, since the desired price can be expressed in any currency as $\tilde{p}^{\ell}_{it} = \tilde{p}_{it} - e^{\ell}_{t}$. Currency ℓ is chosen over PCP if $\mathrm{var}(\tilde{p}^{\ell}_{it}) < \mathrm{var}(\tilde{p}_{it})$, or equivalently $\mathrm{var}(e^{\ell}_{t}) < 2\mathrm{cov}(\tilde{p}_{it}, e^{\ell}_{t})$, which can be rewritten as:

$$\frac{\mathrm{cov}(\tilde{p}_{it}, e^{\ell}_{t})}{\mathrm{var}(e^{\ell}_{t})} > \frac{1}{2}. \tag{11}$$

Note that the object on the left is an OLS projection coefficient of the desired price on the bilateral exchange rate with currency ℓ, or unconditional exchange rate pass-through into the desired price. If Eq. (11) is satisfied, the desired price in producer currency co-moves strongly with the currency ℓ exchange rate, making it relatively unstable in producer currency and relatively stable in currency ℓ. This favors currency ℓ for price setting. In contrast, if the inequality in Eq. (11) is reversed for every currency ℓ, then producer currency pricing is optimal.

Determinants of currency choice We next lay out a simple modeling framework, following Gopinath, Itskhoki, and Rigobon (2010) and Amiti, Itskhoki, and Konings (2020), in which the log desired price in the destination currency is expressed as the sum of the marginal cost and the desired markup, $\tilde{p}^{*}_{it} = \tilde{\mu}^{*}_{it} + (mc_{it} + e_t)$. Without loss of generality, the desired price in log deviations can be further expressed as a linear combination of the firm's marginal cost and its local competitors prices p^{*}_{-it}:

$$\tilde{p}^{*}_{it} = (1-\alpha_{it})(mc_{it} + e_t) + \alpha_{it} p^{*}_{-it}, \qquad \text{where} \tag{12}$$

$$mc_{it} = (1-\gamma_{it}) w_t + \gamma_{it}(v^{\ell}_{t} + e^{\ell}_{t}) - a_{it}.$$

[26]Formally, the profit loss can be approximated as $\Pi_i(\bar{p}^{\ell}_{it} + e^{\ell}_{t}) - \Pi_i(\tilde{p}_{it}) = \frac{\Pi''_i(\tilde{p}_{it})}{2}(\bar{p}^{\ell}_{it} + e^{\ell}_{t} - \tilde{p}_{it})^2$, as $\Pi'_i(\tilde{p}_{it}) = 0$ by the first order condition (FOC) and $\Pi''_i(\tilde{p}_{it}) < 0$ by the second order condition. The expected profit loss is thus second-order proportional to $\mathbb{E}\{\bar{p}^{\ell}_{it} - \tilde{p}^{\ell}_{it}\}^2 = \mathrm{var}(\tilde{p}^{\ell}_{it})$, where the last equality holds because the optimal preset price satisfies $\bar{p}^{\ell}_{it} = \mathbb{E}\tilde{p}^{\ell}_{it}$, as a linear approximation to FOC.

A firm i puts a weight of $(1-\alpha_{it})$ on its own marginal cost and a weight of α_{it} on its competitor prices due to variable markups and strategic complementarities in price setting. The firm's marginal cost mc_{it} in producer currency combines home input costs w_t and internationally sourced inputs in (a basket) currency ℓ at cost $v_t^\ell + e_t^\ell$ (when converted to producer currency) with an expenditure weight γ_{it}; the marginal cost also shifts with firm productivity shocks a_{it}.

Furthermore, in a broad class of monopolistic and oligopolistic competition models, the flexible weights α_{it} and γ_{it} can be related to structural parameters and measurable firm characteristics (see Amiti, Itskhoki, and Konings, 2014, 2019). In particular, larger firms tend to exhibit greater markup variability and stronger strategic complementarities (larger α_{it}) and thus lower cost pass-through $(1-\alpha_{it})$, and also tend to rely more on internationally sourced inputs (larger γ_{it}).[27] These two channels — via markups and marginal costs — constitute two sources of incomplete pass-through of the producer's exchange rate into the destination price, as well as make the export price sensitive to the dominant exchange rate. These forces are key in shaping both desired pass-through and optimal currency choice in the cross section of firms.

To the extent that a firm's competitors in the destination market price in local currency, a greater α_{it} makes the desired price more stable in the destination currency and hence favors local currency pricing (LCP). In contrast, firms with small α_{it} and γ_{it} have desired destination prices that comove closely with the marginal cost, which in turn is stable in producer currency (e.g., home wages), thus favoring producer currency pricing (PCP). This is typical of small constant-markup exporters. Finally, when γ_{it} is high, a firm's desired price tracks the cost of imported intermediate inputs, and if they are stable in dollars, the firm itself may favor dominant currency pricing (DCP). The more ubiquitous the use of the dollar among the firm's competitors, the more likely a positive α_{it} also favors DCP over LCP.

Dynamics These insights generalize to a dynamic environment with time-dependent price adjustment frictions (e.g., Calvo).[28] The variance term in Proposition 1 is replaced with a weighted average of

[27] Larger firms are more likely to pay fixed costs of access to foreign suppliers of intermediate inputs, making their production costs more import intensive, and are also more willing to reduce markups to maintain market shares in the destination market, favoring low pass-through into destination prices. These mechanisms have robust empirical support.

[28] See Gopinath and Itskhoki (2010) for the pass-through analysis under state-depending pricing.

conditional variances of $\tilde{p}^{\ell}_{t+h}$ at different horizons h. In the data, one needs to make inference from the observed prices — some of which are flexible while others are inflexible — about unobservable desired prices that determine currency choice. Gopinath, Itskhoki, and Rigobon (2010) show that a sufficient statistic for currency choice, *medium-run pass-through* (MRPT), can be measured directly in the data provided the instances of price adjustment are observed. In particular, MRPT is the cumulative ERPT elasticity conditional on the first instance of price adjustment, as it summarizes ERPT into desired prices during the period of price stickiness. The firm then adopts the currency in which MRPT is the lowest. MRPT differs markedly both from the short-run pass-through, which is mechanically driven by currency choice revealing limited information about desired pass-through, and the long-run pass-through, which can gradually accumulate over longer time intervals, far beyond typical sticky price durations.

Financial hedging and natural hedging Financial hedging of currency positions is often informally viewed as a substitute for currency choice in the goods market. For example, if the dollar revenues of the exporter are hedged (swapped) in the financial market, dollar pricing is viewed as possibly inconsequential. This is not correct, because price fluctuations in the goods market result in import and export quantity movements, independently of whether export revenues are hedged in the financial market. In other words, to the extent that the financial hedge is a side bet in the financial market and does not affect the marginal cost of the firm, the currency of price stickiness in the product market is consequential for allocations.[29]

In contrast, real (or natural) hedging occurs when the marginal cost is exposed to foreign inputs with prices that co-move with the exchange rate, so that the firm can keep its foreign-currency export prices stable, and in particular not have to increase prices with an exchange rate appreciation as the firm sources production inputs in foreign currency as well. Financial hedging by means of forward exchange rate contracts is not a substitute for real hedging, although it can be used to relax financial

[29] Another way to see this is to recall that the desired price equals the desired markup over the marginal cost, where the markup generally reflects the curvature of residual demand and the cost reflects the properties of the production technology and input prices. Financial hedging under conventional circumstances affects neither curvature of product demand, nor properties of technology or market prices of inputs, and thus does not alter the optimal price setting and currency choice decisions.

constraints in certain states of the world (see Froot, Scharfstein, and Stein, 1993).[30] In turn, financial frictions do not change the theory of currency choice in the goods market, but may alter the desired price of the firm which is still flexible, but now reflects financing frictions (see Bahaj and Reis, 2020).

5.2 Empirical evidence on currency choice

The theory of currency choice laid out above has a number of testable implications that have been implemented in the data. We now discuss two sets of testable ideas:

1. Currency choice depends on desired pass-through, and in particular on MRPT conditional on price adjustment. If MRPT can be measured then it is a sufficient statistic for currency choice.

   (a) In contrast, the theory can be falsified by showing that MRPT is not a determinant of currency choice. In particular, if currency choice is exogenous, then conditional on price adjustment the behavior of prices should not depend on the currency of pricing.[31]

   (b) In general, there is a two-way feedback between currency choice and ERPT. While currency choice affects short-run ERPT mechanically the reverse effect is only present when currency choice is endogenous. Furthermore, controlling for selection in currency choice, the residual differences in ERPT across firms with differential currency invoicing must be transitory, vanishing after the first price adjustment. In contrast, if endogenous selection cannot be controlled for, there is likely a permanent difference in ERPT behavior across firms with different currency choice even after multiple rounds of price adjustment. This both offers a testable implication and constitutes a challenge in interpreting empirical results.

2. Desired pass-through is an endogenous firm-level outcome, which can be traced to measurable firm characteristics such as import intensity and markup variability. Therefore, the theory can be tested by relating currency choice outcomes to firm characteristics (exogenous or endogenous)

[30] See Fauceglia, Shingal, and Wermelinger (2014), Lyonnet, Martin, and Mejean (2021) and Alfaro, Calani, and Varela (2021) on the mechanisms of real and financial hedging of the exchange rate risk.

[31] To be precise, the exact argument relies on the random walk property of the nominal exchange rate, in which case the reset price should not depend on the currency of pricing (see Gopinath, Itskhoki, and Rigobon, 2010).

that do not affect currency choice directly but instead shape desired ERPT. Controlling for firm characteristics that determine the selection into invoicing currency makes it possible to evaluate the causal effect of currency choice on the dynamics of prices and quantities.

ERPT and currency choice We first review the evidence on the relationship between ERPT at different horizons and currency choice. Gopinath, Itskhoki, and Rigobon (2010) use the BLS transaction-level data on US import and export prices (IPI and EPI datasets) and document this relationship for dollar and non-dollar pricing firms. First, they show that in the short run pass-through is indeed mechanically related to currency choice due to price stickiness. Over the first few months after an exchange rate shock ERPT in dollar import prices is close to 0 for prices quoted in dollars and close to 1 for prices quoted in other currencies, confirming implications of sticky price dynamics, as we discussed in Section 2. We reproduce these results in Appendix Figure A1.

What is perhaps more surprising, shown in Appendix Figure A1, is the very slow build up in pass-through over time, and the limited convergence in ERPT between dollar and non-dollar priced goods even two years out, considerably beyond standard durations of price stickiness. This evidence is consistent with the endogeneity of currency choice, as conditional on price adjustment the currency of price stickiness should *not* have an effect, as long as exchange rates follow a random walk. It is however difficult to verify this conclusively because aggregate ERPT mixes together prices that have already adjusted with prices that have yet to adjust and this can introduce a mechanical gap between dollar and non-dollar price index dynamics.

To further test the theory of currency choice Gopinath, Itskhoki, and Rigobon (2010) estimate MRPT by running the following micro-level ERPT regression for imports into the United States:

$$\Delta\bar{p}_{it} = \left[\beta_D \cdot \iota_i^D + \beta_{ND} \cdot (1 - \iota_i^D)\right]\Delta_c e_{it} + \text{controls} + \varepsilon_{it}, \tag{13}$$

where $\bar{p}_{it}$ is the reset price for imported product i adjusted at t, so that $\Delta\bar{p}_{it} = \Delta_c p_{it}$ is the change in the observed value of the sticky price from one instance of price setting to the next, and $\Delta_c e_{it}$ is the cumulative change in the respective bilateral exchange rate with the dollar over the period of price

Table 7: ERPT conditional on price adjustment: dollar vs non-dollar pricing

	Share	MRPT		LRPT	
	Non-Dollar	Dollar	Non-Dollar	Dollar	Non-Dollar
All countries	0.19	0.24 (0.03)	0.92 (0.04)	0.49 (0.06)	0.98 (0.06)
Euro Zone	0.25	0.23 (0.03)	0.92 (0.08)	0.42 (0.09)	0.95 (0.08)
Non-Euro Zone	0.15	0.23 (0.05)	0.85 (0.11)	0.56 (0.09)	0.96 (0.12)

Note: From Gopinath, Itskhoki, and Rigobon (2010). MRPT corresponds to ERPT conditional on the first price adjustment and LRPT to ERPT over the life of the product (see illustration in Appendix Figure A4). The sample includes imports to the United States from 12 countries with a non-trivial share of non-dollar-priced exports to the United States. Euro countries: Germany (40% non-dollar), Italy (22%), Belgium (17%), France (13%), Spain (11%), Austria (10%), Netherlands (10%). Non-euro: Switzerland (38%), Japan (21%), UK (19%), Sweden (12%), Canada (4%).

inadjustment of product i (see Appendix Figure A4 for illustration). Indicator $\iota_i^D = 1$ if product i is priced in dollars and $\iota_i^D = 0$ otherwise (when it is priced in the producer currency). Thus, β_D captures average MRPT of dollar pricers and β_{ND} average MRPT of non-dollar pricers, and according to theory we expect $\beta_D < 0.5 < \beta_{ND}$. Table 7 reports MRPT estimates by currency for US imports overall and for a subset of exporting countries from the Euro Zone and outside the Euro Zone.[32]

Around twelve countries have a non-trivial share of non-dollar exports to the United States, most notably Germany and Italy inside the Euro Zone and Switzerland, Japan and the UK outside the Euro Zone. For these countries, non-dollar exports account for 19% of overall exports on average, with Germany at the high end with 40% of its exports to the United States priced in euros. Gopinath, Itskhoki, and Rigobon (2010) find MRPT to be low for dollar-priced goods, just below 25%, while it is very high, around 95% for non-dollar priced imports. This gap partially closes after multiple rounds of adjustment: LRPT (life-long pass-through) is around 50% for dollar-priced goods and 95% for non-dollar priced goods. This gap, which lasts beyond 1 or even 2 years is reflective of the endogenous selection into currency of pricing. To summarize, consistent with the theory laid out above which emphasizes MRPT as a sufficient statistic, the data features $\beta_D < 0.5 < \beta_{ND}$ for MRPT, while in the long-run the pass-through of dollar priced goods increases partially towards that of non-dollar priced goods.

[32]Similar results hold for a subsample of differentiated goods and for estimates within narrow categories of goods, and for US exports.

Firm characteristics MRPT can be traced to more primitive firm characteristics. One such characteristic is firm size, which in theories of firm heterogeneity as well as in the data correlates robustly with other firm characteristics and outcomes, namely productivity, skill and capital intensity, export and import intensity. Because firm size is determined independently of and before any specific exchange rate changes are realized it is a useful firm characteristic, even if not fully exogenous, for determining currency choice and ERPT.

Berman, Martin, and Mayer (2012) document the gap in ERPT between small and large French exporters. Amiti, Itskhoki, and Konings (2020) show that firm size is directly linked with the currency use of Belgian firms in exports, as we reproduce in Appendix Figure A3.[33] Small firms almost entirely use PCP (euro export pricing) to all destinations, with a steep decline in the use of the euro for large and very large firms. Large firms increasingly rely on the US dollar in pricing their exports to all destinations, while very large firms also use destination currencies other than the US dollar in pricing their exports. Thus, the literature concludes that firm size correlates strongly with currency choice across firms, suggesting that currency choice is indeed an active endogenous decision at the firm level.

Firm size is a useful proxy for the strength of strategic complementarities in price setting and for a firm's reliance on foreign imported inputs or foreign-currency borrowing. Amiti, Itskhoki, and Konings (2014) show that large exporting firms rely more heavily on foreign-sourced inputs. Larger firms are also characterized by greater markup variability and lower pass-through of cost shocks, as shown both theoretically and empirically in Amiti, Itskhoki, and Konings (2019). Table 8 summarizes the empirical patterns of currency choice observed in the Belgian export data, for both the choice to export in any foreign currency (non-euros, $\iota_{ikt} = 1$) and in dollars specifically ($\iota^D_{ikt} = 1$).

Conditional on other determinants, large firms are less likely to use the euro and more likely to use foreign currencies. Among the very large firms, we observe a greater incidence of choosing the destination currency (LCP) over dollar invoicing. International input sourcing in foreign currencies is another major determinant of foreign-currency use in exports, and in particular sourcing inputs in dollars is the major determinant of dollar use in exports (see also Chung, 2016). Similarly, being a

[33] No similar relationship is present for imports; that is, it appears that currency choice is the decision made by exporters and taken as given, together with prices, by importers who in turn choose quantities.

Table 8: Currency choice in exports

	Foreign currency, ι_{ikt}		Dollar, ι^D_{ikt}	
	(1)	(2)	(3)	(4)
Import intensity	0.286^{***} (0.105)	0.308^{***} (0.112)	0.503^{***} (0.158)	0.632^{***} (0.193)
Firm size	0.088^{***} (0.015)	0.089^{***} (0.015)	-0.081^{***} (0.010)	-0.095^{***} (0.022)
Firm's foreign FDI		0.093^{***} (0.035)		0.094^{**} (0.040)
Competitor currency choice		0.536^{***} (0.150)		0.582^{**} (0.280)
# obs.	$734,012$	$656,389$	$202,412$	$154,152$
R^2_{adj}	0.577	–	0.879	–
Fixed Effects:				
destination&industry (HS4)		✓		✓
industry×destination	✓		✓	
month×year	✓	✓	✓	✓

Notes: From Amiti, Itskhoki, and Konings (2020). The observations are for Belgian exports to all extra-EU destinations, at the firm-product-destination level. The dependent variables are dummies $\iota_{ikt} = 0$ if the export transaction is invoiced in euros and 1 otherwise; $\iota^D_{ikt} = 1$ if the export transaction is invoiced in dollars for the subsample of non-euro exports to destinations with a floating exchange rate vis-à-vis the dollar. Import intensity is the share of foreign-currency imported inputs in total variable costs. Firm size is log firm employment. Firm's foreign FDI is a dummy equal to 1 if the firm has/receives FDI in/from the destination country. Competitor currency choice is the average ι_{jkt} (or ι^D_{jkt}, respectively) for Belgian competitors of the firm selling to the same destination in the same HS-4 indsutry.

part of an international company (in terms of ownership) increases the likelihood of dollar pricing. Lastly, there are strong strategic complementarities in currency choice across firms, both for the use of any foreign currency and the dollar in particular. The correlates of currency choice also predict ERPT, offering an additional empirical check on the theory.

Currency choice and outcomes Lastly, we return to the feedback from currency choice into economic outcomes, namely the dynamics of trade prices and quantities. This question was explored in Section 2, but now we explicitly control for endogenous selection into currency choice. The goal is to compare otherwise similar firms making different currency decisions, and compare the export price and quantity dynamics for such firms.

Towards this end, Amiti, Itskhoki, and Konings (2020) use the firm-level desired ERPT determinants as well as the realized currency choice to predict the differential dynamic response of the firm's export prices and quantities to movements in exchange rates. Standard sticky-price theory predicts an estimating equation for product-level export prices p^*_{ikt} expressed in the destination currency:

$$\Delta_h p^*_{ikt} = \big[\alpha_h - \beta_h x_i - \delta_h \iota_{ik}\big]\Delta_h e_{kt} + \big[\beta^D_h x_i + \delta^D_h \iota^D_{ik}\big]\Delta_h e^D_{kt} + \text{fixed effects} + \epsilon^h_{ikt}, \tag{14}$$

where the two exchange rates e_{kt} and e^D_{kt} are respectively the producer-destination and the dollar-destination bilateral exchange rates, Δ_h is the time difference over h-months, the indicators ι_{ik} and ι^D_{ik} equal one if firm i exports to destination k in any foreign currency and in dollars specifically, and x_i are firm characteristics which determine desired ERPT (e.g., firm size and import intensity). Specification in Eq. (14) controls for country-industry-time fixed effects, thus absorbing macroeconomic variation and using for identification the differential response of product-level prices to the same exchange rate movements across exporters within given industry-destinations.

According to theory, coefficients β_h and β^D_h should be zero in the short run, when prices are entirely sticky, and then increase with horizon h, as prices gradually adjust. In contrast, δ_h and δ^D_h should be large and positive in the short run, reflecting the mechanical effects of price stickiness on prices, and then gradually decay towards zero as prices adjust. Furthermore, δ_h and δ^D_h have a structural interpretation and, for example in a Calvo model, decline hyperbolically with h, driven by the fraction of firms that have adjusted their prices at least once. Amiti, Itskhoki, and Konings (2020) find a confirmation of these predicted patterns in the data, and in particular that the differential pass-through across invoicing currencies between otherwise similar firms is large in the short run and then decays towards zero in the long run. Furthermore, they identify a strong effect of currency of pricing, conditional on the other firm characteristics, on the dynamics of export quantities (see Figure 3 above).[34] These dynamics confirm that foreign-currency price stickiness has allocative effects on trade quantities, which is the foundational assumption for the positive and normative equilibrium analysis described in Sections 3–4.

[34]Figure 3 plots the dynamics of quantity elasticity σ_h from the IV regression of changes in export quantities $\Delta_h y^*_{ikt}$ on changes in export prices $\Delta_h p^*_{ikt}$, using Eq. (14) as the first stage.

Switching While there is considerable variation in currency choice in the cross-section of firms, there are few switches in currency choice over time, with currency invoicing being a very persistent firm-level decision. Nonetheless, Gopinath, Itskhoki, and Rigobon (2010) identify about 125 switchers from dollars to non-dollars, or vice versa. These firms exhibit differential ERPT behavior before the switch, as well as further change their MRPT after switching the currency of invoicing. Since ERPT conditional on adjustment is not mechanically linked to currency invoicing, this suggests that shifts in firm-level fundamentals affect currency choice over time (see also Corsetti, Crowley, and Han, 2020). There remains an open question of whether shifts in currency of pricing take place on the intensive (existing firm-products) or the extensive margin (new firm-products) in response to aggregate shifts such as changing patterns of monetary anchoring by major trade partners.

5.3 General Equilibrium and Counterfactuals

Strategic complementarities in pricing and imported intermediate inputs, in addition to sticky prices in invoicing currency, are essential for the existence of a DCP equilibrium. These ingredients, emphasized early on in the currency choice literature (see Engel, 2006; Gopinath, Itskhoki, and Rigobon, 2010), are becoming increasingly more common in workhorse international macro models (see Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller, 2020).

Mukhin (2021) quantitatively demonstrates that under realistic parameter values requiring a moderate degree of strategic complementarity and a high level of openness in import sourcing and exports (see Figure 6), DCP emerges as the equilibrium in a general-equilibrium multi-country environment. Strong strategic complementarities, on the other hand, shift the equilibrium from DCP to LCP, while very low openness replaces DCP with PCP.[35] The region of the DCP equilibrium is reinforced by: (a) greater price stickiness (which increases the overlap of equilibria resulting in greater multiplicity), (b) stability of the dominant currency relative to the alternatives, and (c) relative size of the dominant country, in particular in international trade. Because of reinforcing factors, DCP equilibrium can exist even when

[35] Earlier literature (e.g. Devereux, Engel, and Storgaard, 2004; Bhattarai, 2009) focused on emergence of LCP vs PCP equilibria, typically studying a world of two large symmetric countries.

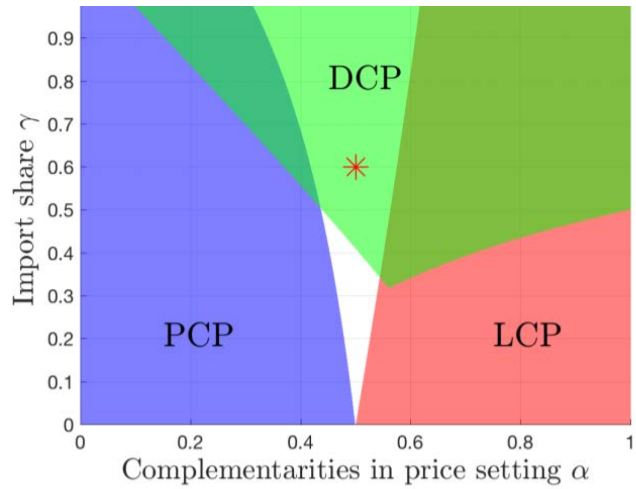

Figure 6: Existence of DCP equilibrium

Note: From Mukhin (2021). The figure plots the overlapping regions of PCP, LCP and DCP equilibria in a calibrated general equilibrium model of currency choice; the white region corresponds to a mixed equilibrium, where DCP coexists with PCP and/or LCP adopted in some trade flows. Parameters α and γ are defined in Eq. (12).

the dominant country is of the same (infinitesimal) size as other economies and the dominant currency has the same volatility as other currencies.[36]

The volatility of the dominant currency is, of course, endogenous — both to the monetary policy of the dominant country, but also to the monetary and exchange rate policies of other countries, some of which may choose to peg to the dollar, thus making it less volatile and reinforcing the DCP equilibrium. Mukhin (2021) shows that DCP equilibrium still exists robustly when this endogeneity is taken into account, including under optimal exchange rate policy.

Complementarities between dominant currency pricing at the firm level and dollar anchoring at the monetary policy level further reinforce DCP equilibrium, but also result in multiplicity. In certain parts of the parameter space, a monetary authority may have the ability and also the incentive to displace the DCP equilibrium by abandoning the partial peg and increasing the volatility of trade-weighted dollar exchange rate. The formation of currency unions can give rise to a regional currency that can crowd out the use of the global dominant currency in regional trade as has been the case for the euro.

[36]For earlier literature on multiplicity and persistence of currency equilibria, see Krugman (1980) and Rey (2001); for macroeconomic determinants of the role of a currency, see Campa and Goldberg (2005) and Goldberg and Tille (2008).

6 Conclusions and Directions for Future Research

Over a decade of research on the dominant currency paradigm has established robust theoretical implications for international macroeconomics and provided substantial supporting empirical evidence. However, further research is needed on several fronts, including to causally estimate the impact of the dominant currency on global trade, to empirically estimate the impact of financial variables on the currency of choice, and to examine the interactions between the currency's role in goods markets and in financial markets.

Further research on endogenous currency choice in general equilibrium could explore which forces help preserve existing dominant currency equilibria and what it will take for new currency equilibria to emerge, particularly taking into account the complementarities between a currency's role in invoicing and as a store of value. The role of monetary and exchange rate policies in reinforcing dominant currency equilibria could also benefit from further exploration.

Ilzetzki, Reinhart, and Rogoff (2019) estimate that the number of countries that are currently anchored to the dollar in the form of strict pegs or managed floats are as high as during the Bretton Woods period. While such anchoring could follow from the widespread use of the dollar in trade and finance, the anchoring in turn reinforces the widespread adoption of the dollar. The ascent of China over the last 30 years along with its policy to maintain the yuan in a narrow band with respect to the dollar has likely reinforced the DCP equilibrium.

Further research is also needed on digital currencies, including crypto-currencies, private stable coins and central bank digital currencies. The rapid growth in these markets are likely to have significant implications for international macroeconomics.

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A Appendix: Additional Figures

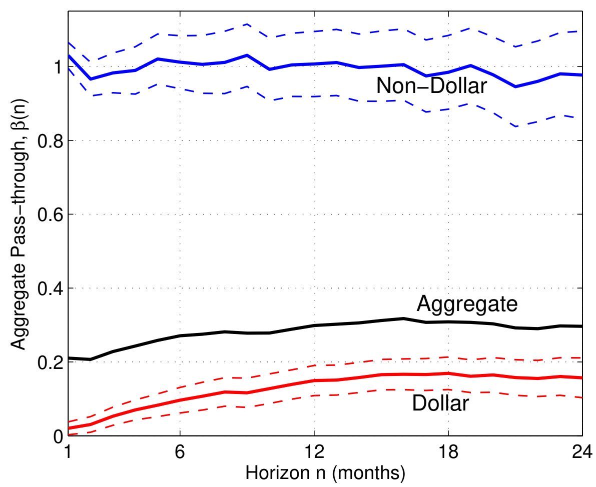
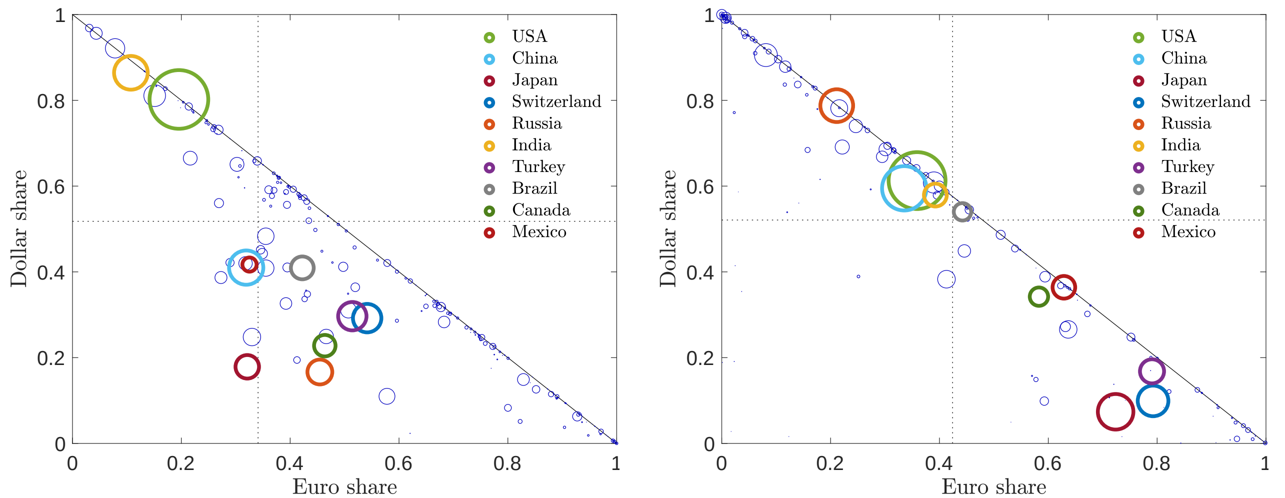


Figure A1: Aggregate ERPT dynamics by currency

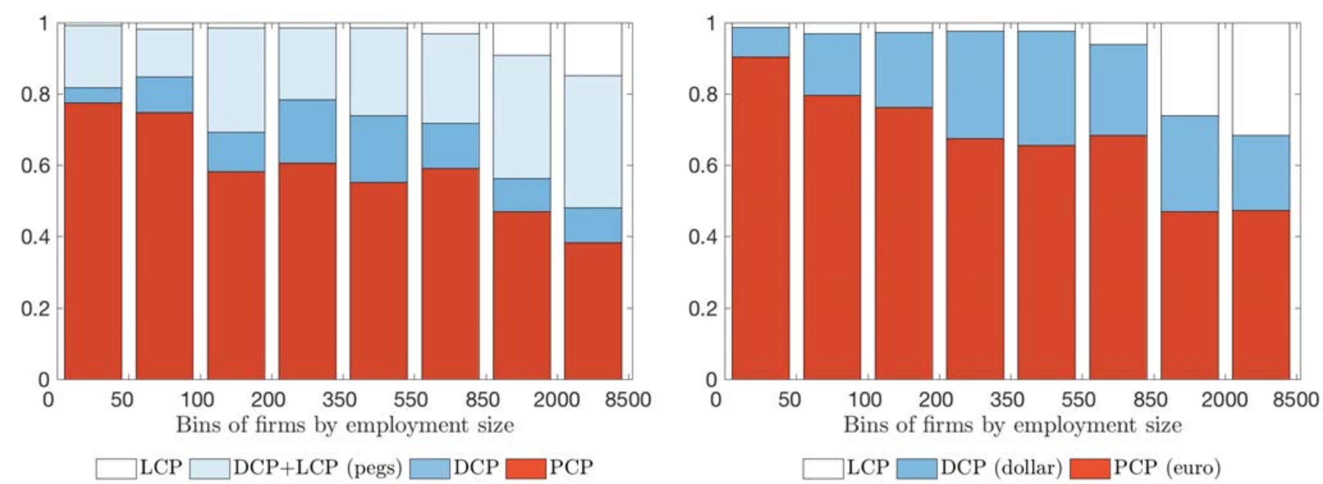
Note: From Gopinath, Itskhoki, and Rigobon (2010). Aggregate ERPT by currency of pricing is estimated with the following distributed-lag regression: $\Delta p_{kt}^J = \alpha_k^J + \sum_{j=0}^n \beta_j^J \Delta e_{k,t-j} + \sum_{j=0}^n \gamma_j^J \pi_{t-j} + \sum_{j=0}^3 \delta_j^J y_{t-j} + \varepsilon_{kt}$, where p_{kt}^J is the average import price index from country k for product imported in dollars and non-dollars, $J \in \{D, ND\}$, and e_{kt} is the corresponding bilateral exchange rate (with the US dollar being simultaneously the importer's currency, LCP and DCP are indistinguishable, yet both differ from PCP). The data is monthly, and this regression is estimated at various monthly horizons, $n \in \{1, .., 24\}$, from one to 24 months. $\beta^J(n) \equiv \sum_{j=0}^n \beta_j^J$ is the cumulative impulse response of import prices to the exchange rate for $J \in \{D, ND\}$, capturing cumulative ERPT at various horizons. The results show a distinct difference between dollar and non-dollar ERPT at all horizons. This feature is present equally in all countries, and the bulk of variation in import ERPT from each destination is accounted for by the share of non-dollar trade flows. The absence of convergence in ERPT across currency bins even 24 months out suggests strong selection on ERPT into different currency of pricing.



(a) Exports outside EU (b) Imports from outside EU

Figure A2: Dominant currency use in Belgian bilateral trade

Note: From Amiti, Itskhoki, and Konings (2020). The figures plot shares of dollar and euro invoicing by country, for Belgian exports (left) and imports (right) outside the EU; circles represent the relative size of individual trade partners. The distance to the diagonal corresponds to the share of third currencies (other than the dollar and the euro, typically the currency of the trade partner). The legends identify the top-10 Belgian trade partners outside the EU in terms of total trade. The dotted lines identify the average euro and dollar shares in the overall Belgian exports and imports outside the EU.



(a) All destinations (ex-eurozone) (b) Excluding US and dollar pegs

Figure A3: Firm size and currency choice in exports

Note: From Amiti, Itskhoki, and Konings (2020). Export currency invoicing shares by employment size bins of firms: the red bars correspond to euros (PCP), the dark blue bars to dollars (DCP), the white bars to destination currency (LCP); the left panel additionally uses the light-blue bars for the DCP+LCP category which corresponds to the US dollar use in exports to the US and dollar-pegged destinations.

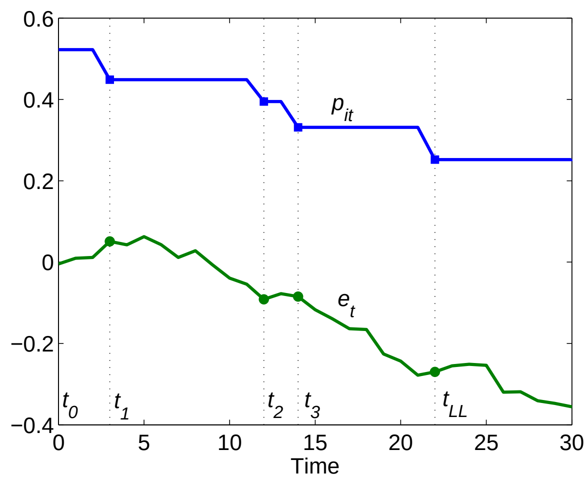


Figure A4: MRPT and LRPT illustration

Note: From Gopinath and Itskhoki (2011). MRPT specification in Eq. (13) regresses $\Delta\bar{p}_{it} = \Delta_c p_{it} = p_{i,t_j} - p_{i,t_{j-1}}$ on $\Delta_c e_{it} = e_{t_j} - e_{t_{j-1}}$ for $j \in \{1, 2, .., LL\}$, where e_t is the respective bilateral exchange rate with the dollar. LRPT coefficients in Table 7 correspond to the regression of $p_{i,t_{LL}} - p_{i,t_0}$ on $e_{t_{LL}} - e_{t_0}$, that is ERPT over the life of the product in the sample (from the first price to the last new price).