DOLLAR DOMINANCE AND THE TRANSMISSION OF MONETARY POLICY*

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Has the dominance of the dollar in global trade rendered monetary policy ineffective? An emerging view contends that if a country invoices its exports in dollars, exchange rates cannot stabilize economic activity, as the classical expenditure-switching channel is muted. This view rests on the premise that export prices are sticky in dollars, breaking the link between export demand and depreciations. But this assumption is not borne out by the data: goods priced in dollars tend to have more flexible prices, along with higher elasticities of substitution. We propose a model with more realistic assumptions and show that even with dollar pricing, depreciating the currency by loosening monetary policy can still boost exports and activity materially. The limit to any expansion is not demand, but supply capacity. We also show that low exchange rate pass-through to dollar prices is not informative about price stickiness. The price response to exchange rates is small when demand elasticities are high, even with flexible prices: low pass-through is an equilibrium result, not evidence of a nominal friction. *JEL codes:* E31, E52, E58, F41, Q02, Q30.

I. Introduction

Can countercyclical monetary policy help stabilize the economy? The dominance of the dollar in international trade has led academics and policy makers to reevaluate their answers to this

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perennial question. An emerging academic and policy view contends that an exchange rate depreciation by a (non-U.S.) country invoicing in dollars does not materially boost its exports. In the economics jargon, the classical expenditure-switching toward that country's exports is curtailed. This weakens monetary policy transmission and undermines the Friedman (1953) and Mundell-Fleming (Fleming 1962; Mundell 1963) case for floating exchange rates: that they can function as efficient shock absorbers by rapidly adjusting external prices. Indeed, the International Monetary Fund (IMF) has suggested that weakened expenditure switching worsens the cost-benefit calculation for using flexible exchange rates to stabilize the economy (IMF 2019).[1]

This challenge to the Mundell-Fleming framework has come from a rapidly expanding collection of new positive evidence on the prevalence of vehicle currencies such as the dollar in international trade.[2] This evidence, it is argued, contradicts the standard Mundell-Fleming assumption that non-U.S. producers price exports in their own currency. This producer currency pricing (PCP) framework, formalized in an optimizing setting in the seminal work by Obstfeld and Rogoff (1995), had lent support to the classic Friedman (1953) arguments for floating exchange rates as automatic stabilizers. Recent work (Basu et al. 2020; Egorov and Mukhin 2023) has explored the normative implications of an alternative, dominant currency pricing (DCP) model, as formulated by Gopinath et al. (2020). These papers suggest that DCP limits the expenditure-switching benefits of exchange rates in external adjustment.

However, these challenges to the allocative role of exchange rates and monetary policy rest on two further assumptions. The first is that exporters invoicing in dollars have monopoly power and face limited international competition. The second and more crucial assumption is that these firms are subject to nominal rigidities, more specifically, that their prices are sticky in U.S. dollars. Given these two assumptions, exchange rate changes by

1. In particular, stabilization of trade volumes would require larger exchange rate movements, with negative balance sheet or inflationary consequences, requiring the use of other policy tools. See also IMF (2020), which suggests that when coupled with unhedged foreign exchange debt, dollar invoicing "may bolster the case" for using capital controls.

2. See Goldberg and Tille (2008), Gopinath (2015), Amiti, Itskhoki, and Konings (2022), and Corsetti, Crowley and Han (2022).

non-U.S. countries do not affect the dollar prices charged. With no change in prices, there is no change in quantity demanded and no effect on exports.

In this article, we argue that these joint assumptions of monopoly power and sticky dollar export prices are inconsistent with some key empirical facts on dollar pricing. In particular, invoicing in dollars is most prevalent for more homogeneous exports sold in highly competitive international markets, where exporting firms tend to have limited market power. Importantly, the U.S. dollar prices of these exports tend to be more flexible, since the costs of price stickiness are larger for goods with high demand elasticities. These relationships are strongest in emerging and developing economies, which is exactly where dollar invoicing is most prevalent. A major part of these economies' exports consist of commodities, which are a clear example of exports priced in dollars, but sold in globally competitive markets with flexible prices. A further large proportion of their exports are "commodity-like" homogeneous goods, and this is especially the case for those invoiced in dollars.

The crucial empirical observation that motivated these auxiliary assumptions was evidence of limited exchange rate pass-through into (dollar) export prices. Limited pass-through was interpreted as evidence of a friction: sticky dollar prices. We show how the same observation can arise instead as an equilibrium outcome when prices are flexible. In this setting, the dollar price response to exchange rates is small when demand elasticities are high, even though firms face no nominal rigidities. Exchange rate pass-through estimates are therefore not informative about the degree of nominal rigidities. This cautions against using these estimates to draw normative conclusions about the optimality of different exchange rate regimes and monetary policies.

We present a new open economy framework that enables more realistic microeconomic assumptions by allowing intra-sector international competition for tradable goods.[3] In our mixed currency pricing (MCP) framework, which nests both sticky-price DCP and PCP models as special cases, domestic exporters can face intense competition from international competitors producing highly substitutable varieties of the same good, even where substitution elasticities between different goods remain low. This

3. Variable cross-country competition for different products was set out by Armington (1969); our implementation follows Feenstra et al. (2018).

allows us to match the microeconomic evidence that demand elasticities are higher at a more disaggregated level (Broda and Weinstein 2006; Imbs and Mejean 2015); and that they are particularly high for the types of goods and countries that typically use dollar invoicing (Imbs and Mejean 2017).

Similarly, we incorporate heterogeneity in nominal rigidities across producers, allowing us to match the microeconomic evidence that prices are updated more frequently for goods commonly invoiced in dollars. Observations of low pass-through for these firms instead emerge endogenously in our framework. Our model includes sticky wages, representing sticky non-tradable input prices more broadly, which lead to monetary nonneutrality (as do sticky consumer prices in other, more monopolistic sectors). We use our MCP model to examine the effect of a loosening in domestic monetary policy that depreciates the currency in a small open economy, comparing to the benchmark sticky-price DCP and PCP cases.

Our key theoretical finding is that in our MCP framework, a monetary policy–induced depreciation can still significantly boost both exports and aggregate demand. The limit to this expansion is export supply capacity, rather than fixed demand under sticky dollar prices. The MCP model therefore restores the allocative properties of the exchange rate of the benchmark PCP framework of Obstfeld and Rogoff (1995).[4] It does this despite replicating the empirical finding of limited observed pass-through to dollar prices that motivated the sticky-dollar-price DCP assumptions.

Our result derives from using assumptions on elasticities and price flexibility in line with the microeconomic evidence. With sticky wages, the exchange rate depreciation lowers the domestic cost of production expressed in dollars. Absent any adjustment in price, this increases exporter profitability. Highly elastic demand means that passing through even a small part of this cost reduction can cause a substantial increase in export quantities. With flexible export prices, exporters do lower prices slightly, trading

4. This relates to the finding in Barro and Tenreyro (2006) that what matters is the wedge between marked-up prices and competitive prices, irrespective of where in the production chain the stickiness lies—whether in product prices, as in PCP, or in wages, as in our framework; in Barro and Tenreyro (2006)'s setting, intermediate inputs have sticky prices, whereas final products prices are flexible. Barro and Tenreyro (2006) also highlight that competitive products tend to have more flexible prices.

some of their profitability margin for a large increase in market share. The limit to the export expansion in our model is supply capacity, rather than demand. When the demand expansion runs into capacity constraints or increasing domestic marginal costs, this offsets the effect of the initial depreciation on dollar costs, leading to limited reduced-form dollar pass-through in equilibrium.

In the perfectly competitive limit, relevant for many emerging and developing economies and some advanced economies that are commodity exporters, there is no impact on the global price of the commodity after a depreciation. The adjustment comes entirely through an expansion of exports, until the increase in domestic marginal costs equals the size of the depreciation. This parallels the price behavior we would observe if prices were completely rigid in dollars, but the implications for export quantities are diametrically opposed.

Although price and quantity adjustment happens at the firm level (intensive margin) in the model, the setting can be expanded to capture entry by firms whose exports become profitable after the depreciation, thanks to the fall in dollar domestic costs. Bilbiie (2021) models a similar entry channel, and shows it replicates the features of price flexibility in a model with nominal rigidities.

In addition to matching the microeconomic evidence, our study also conducts a set of empirical tests using macroeconomic data. A key differentiator with sticky-price DCP models is that our MCP framework allows a material export response to exchange rate movements. Using a sample of emerging and developing countries (economies in which our microeconomic assumptions are most likely to hold), we find evidence in favor of our model. Monetary policy expansions leading to exchange rate depreciations cause significant increases in exports and aggregate activity. Focusing on two commodity exporters, Canada and Chile, we corroborate the aggregate results and find additional supporting evidence in the sectoral responses. Finally, we explore three case studies of large devaluations and find that they are followed by material increases in exports relative to trend.

I.A. Related Literature

Our findings relate to early debates in the new open economy macroeconomics literature launched by Obstfeld and Rogoff (1995). Their model, and subsequent work by Clarida, Galí, and

Gertler (2001), Corsetti and Pesenti (2001), Benigno and Benigno (2003), and Galí and Monacelli (2005), used the Mundell-Fleming assumption of PCP. Monetary policy–induced depreciations, combined with nominal stickiness in producer prices, therefore led to a fall in export prices (once converted into local currency), and expenditure switching toward the depreciated economy.

These findings were challenged by Betts and Devereux (2000) and Devereux and Engel (2003), who argued that local currency pricing (LCP)—pricing in the currency of the importer—better explained evidence of limited exchange rate pass-through. As with the assumption of sticky-price DCP, their assumed rigidity in local currency prices prevented expenditure switching after depreciations. With a limited allocative role for the exchange rate, LCP models were less favorable about the benefits of flexible exchange rates. Our model, by restoring the allocative role of the exchange rate in a model with dollar pricing, provides a setting in which the normative implications of dollar pricing can resemble PCP frameworks rather than LCP. Our arguments and our model could also apply equally to LCP settings, if firms invoicing in local currencies were exporting into competitive markets.

This article builds on the recent literature on DCP, surveyed by Gopinath and Itskhoki (2022), which argued that dollar pricing was likely to be a good first approximation for many countries (particularly emerging and developing economies). Our MCP framework studies monetary policy under dollar pricing, nesting sticky-price DCP models as a special case, but challenges their implications for exchange rate flexibility. Complementary challenges to some of the assumptions or implications of the DCP framework were made in Obstfeld (2020) and Gagnon and Sarsenbayev (2023).

Our model is also related to the Salter-Swan framework of policy analysis (Salter 1959; Swan 1963), elegantly microfounded for a two-good economy by Schmitt-Grohé and Uribe (2021). In our MCP model we embed a richer demand system, market structure, production networks and shock dynamics, with multiple goods (or sectors) and varieties within each sector, and a role for imported intermediate inputs. Our setup can also include different degrees of price flexibility across sectors, nesting both the flexible-price Salter-Swan and sticky-price DCP models. Moreover, our framework allows different elasticities of substitution between varieties across countries, relative to different types of goods within a country.[5] Different market structures lead to very different implications for the export channel of monetary transmission. We therefore formalize some of the intuition and arguments set out by Tenreyro (2019) and Frankel (2023). We also highlight the crucial role of supply constraints in determining the allocative properties of the exchange rate.

Our article makes three contributions relative to these literatures. First, it combines evidence and theory to challenge the DCP (and LCP) literature's inference that low exchange rate pass-through to dollar prices implies nominal rigidities (and monopoly power). Our MCP framework provides an alternative interpretation with different policy implications. Second, it formalizes these ideas by studying an open economy New Keynesian setting with a more flexible market structure. Intra-sector international competition allows us to use assumptions consistent with microeconomic evidence on elasticities and price rigidity. In contrast to existing sticky-price DCP models, our framework allows a material response of export volumes to exchange rate changes driven by monetary policy; the limit is set by supply capacity, not demand. Our third contribution is to test its predictions using three sets of empirical exercises and data sets. All exercises indicate that monetary policy–related depreciations can cause significant increases in exports, even when goods are priced in dollars.

The MCP framework fits with many stylized facts on pricing in international macroeconomics (or solves the associated "puzzles", set out by Obstfeld and Rogoff 2000). First, it presents an alternative explanation for the finding that the terms of trade are relatively stable after exchange rate movements (Gopinath et al. 2020). As under PCP, depreciations do increase competitiveness in the MCP setting; but as under DCP, this increase in competitiveness does not appear in the equilibrium terms of trade—in our case, owing to offsetting increases in marginal cost. Second, our model offers an explanation for the purchasing power parity (PPP) puzzle (Rogoff 1996) (the volatility and persis-

5. As in Feenstra et al. (2018), we follow a bottom-up approach to the elasticity of substitution. The setting reverses the usual CES nesting used in international finance and is in line with specifications used in trade models with macroeconomic applications, including Atkeson and Burstein (2008), Alessandria and Choi (2014), and Ghironi and Melitz (2005). See also the rich academic exchange on the size of the elasticities of substitution at the macroeconomic level in Backus, Kehoe, and Kydland (1994), Chari, Kehoe, and McGrattan (2002), Heathcote and Perri (2002), Corsetti, Dedola, and Leduc (2010), and Kohn, Leibovici, and Szkup (2020).

tence of the real exchange rate) and the associated Mussa puzzle (Mussa 1986) (the large increase in nominal and real exchange rate volatility following the post–Bretton Woods switch to floating exchange rates). Crucially, our explanation predicts limited movements in optimal reset prices after exchange rate changes, rather than assuming nominal rigidities, consistent with the evidence in Blanco and Cravino (2020) and Itskhoki and Mukhin (2025). Third, our model's mechanism via sticky wages is consistent with evidence that depreciations lead to slow adjustment of non-tradable prices (Burstein, Eichenbaum, and Rebelo 2005).

Our results have implications for the literature estimating exchange rate pass-through, as surveyed in Burstein and Gopinath (2014). Our framework highlights the possibility of a very different interpretation of many reduced-form pass-through regressions. Because these regressions typically omit or struggle to fully capture marginal costs, they risk misinterpreting offsetting movements in marginal costs as a lack of direct exchange rate pass-through. In our framework, competitive, flexible-price firms pass through changes in marginal cost fully and any apparent limited pass-through to export prices is an equilibrium result, rather than owing to an assumption of sticky prices. Our findings here resemble the argument in Head et al. (2012), who also model sticky prices as an equilibrium result.

Our empirical findings, in particular, the expansionary effect of a depreciation caused by a monetary policy loosening, confirm the predictions of our model and speak directly to the theoretical ambiguity discussed by Auclert et al. (2021) (see also Díaz Alejandro 1963). They point out that under some calibrations of a heterogeneous-agent setting, depreciations may cause a contraction in activity. In our sample of developing and emerging economies, and in our analysis of Canada and Chile, we find that exchange rate depreciations stemming from monetary policy are expansionary, in part owing to an increase in export volumes.[6]

6. Our results here build on the findings of Champagne and Sekkel (2018) for Canada and echo those of De Gregorio et al. (2024) for Chile. See also Cesa-Bianchi, Thwaites, and Vicondoa (2020) for the United Kingdom, who find that, consistent with the MCP model, a tightening monetary policy shock causes an appreciation of sterling and a fall in exports and overall activity. While the U.K. economy is not a large exporter of commodities, it does export goods for which it has relatively limited market power in global markets (Broadbent 2017). These aggregate results are consistent with the United Kingdom using PCP for sectors with higher market power and sticky prices and flexible dollar pricing for more compet-

The article is organized as follows. Section II presents a simple graphical analysis to explain the role played by the assumptions of monopoly power and price stickiness in U.S. dollars. Section III discusses the three microeconomic empirical observations that motivate our assumptions (and their deviation from current DCP models). Section IV introduces the model and discusses its monetary policy implications via the exports channel. Section V compares our model's results to new macroeconomic empirical estimates on the impact of monetary policy: in a sample of developing and emerging economies and for two commodity exporters, Canada and Chile. This section also uses three case studies of large devaluations to document the behavior of exports following the exchange rate change. Section VI presents concluding remarks.

II. The Export Response to a Depreciation: Intuition

This section explains intuitively, with a simple graphical exposition, the critical role played by assumptions on price stickiness and monopoly power in determining the export response to a depreciation. It illustrates how varying those assumptions therefore alters the conclusions concerning the effect of monetary policy on activity via the expenditure-switching channel.

We present three cases, showing the joint determination of price and quantity for a representative export firm under different assumptions. The first represents the intuition underlying typical sticky-price DCP frameworks, and the second and third illustrate the alternative assumptions we allow for dollar-pricing firms in our MCP model. For simplicity of exposition, the figures are highly stylized, portraying linear demands and upward-sloping marginal cost curves. In the model presented later, we focus on the case of constant elasticity of substitution (CES)

itive sectors. Corsetti, Crowley and Han (2022) report that most U.K. exports to outside the European Union (excluding the United States) are in sterling, with a further significant proportion in a vehicle currency, and less than 10% in local currencies. Fukui, Nakamura, and Steinsson (2025) also find an expansionary effect from depreciations using a very different identification strategy; in their study, and in contrast with our focus here, the depreciation is not driven by monetary policy—depreciating countries' interest rates in their sample if anything increase relative to the control group in their study. This points to a different underlying shock and mechanism than the one we study theoretically and empirically in this article.

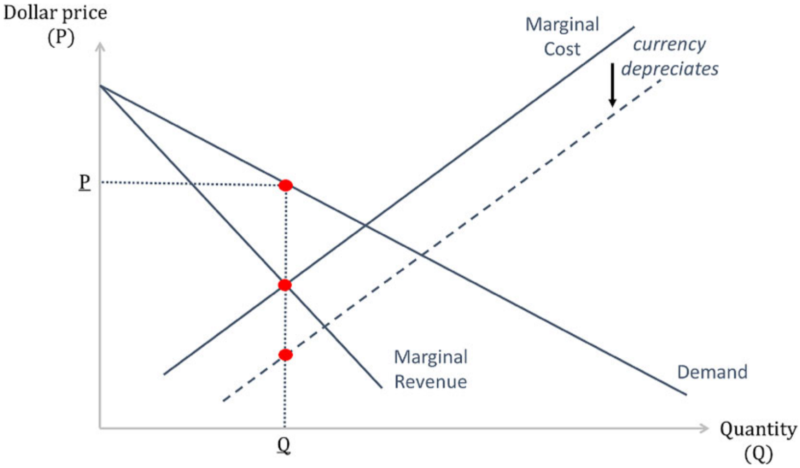

FIGURE I

A Sticky-Price Monopolist Exporter Facing a Depreciation

Costs (in dollars) fall, but price and quantity demanded are unchanged.

demand functions, where demand curves will be concave. The main conclusions are not affected by these simplifications.

II.A. The Monopolist Exporter Case

We examine the case of a monopolist producer who sets the (sticky) price in a dominant currency (the dollar), as in typical DCP frameworks. This is illustrated in Figure I.

The vertical axis shows the dollar price charged, which is initially optimally chosen at the point where downward-sloping marginal revenue meets upward-sloping marginal cost. A depreciation of the country's currency lowers domestic costs (expressed in dollars), as shown in the downward movement of the marginal cost curve.

The implicit assumption (at the macroeconomic level) is that some of the costs priced in domestic currency do not fully adjust in response to the depreciation, meaning their dollar value falls. These costs could be sticky domestic wages, or rents, for example. Because the good's price is assumed to be sticky in U.S. dollars, the quantity demanded does not adjust, despite the fall in dollar costs and increase in the profit margin. Exports do not change.

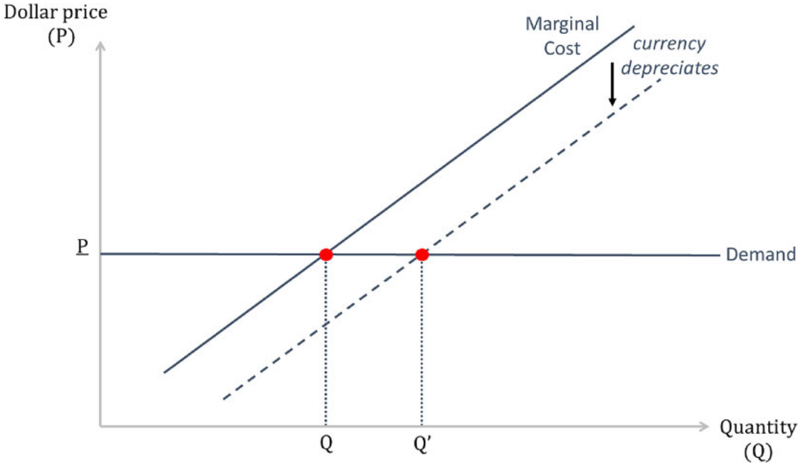

FIGURE II

Competitive Commodity Exporter Facing a Depreciation

Costs (in dollars) fall, price is unchanged and quantity supplied increases.

II.B. The Competitive Commodity Exporter Case

We consider the case of perfectly competitive exporter, selling a commodity whose price is determined in global markets. This is illustrated in Figure II.

The exporter faces a perfectly elastic demand curve and the price of the commodity is fully flexible. As in the previous case, a depreciation of the currency lowers domestic costs for the exporter. The price in dollars remains unchanged, but the depreciation leads to an expansion in quantities exported. There is zero reduced-form pass-through of the exchange rate depreciation into the dollar price of the exported commodity. This does not stem from nominal stickiness but from the infinitely high demand elasticity and an offsetting increase in marginal costs.

In this case, the size of the increase in exports will be limited entirely by supply capacity, rather than demand. This is captured for an individual firm by the slope of the marginal cost curve (and the macroeconomic response of sticky domestic costs such as wages). With a flat marginal cost curve, the exporter expands supply materially; with a steep curve, or capacity constraints leading to a vertical curve, the change in export quantity is limited.

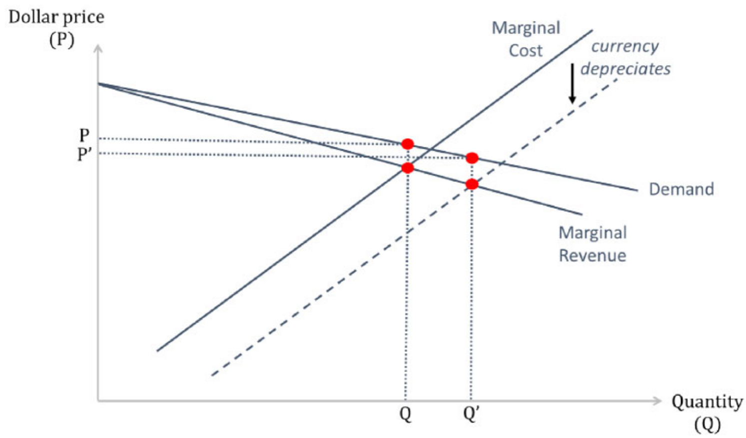

FIGURE III

Flexible-Price, High Demand Elasticity, Monopolistically Competitive Exporter Facing a Depreciation

Costs (in dollars) fall, price falls slightly, and quantity increases.

II.C. The Intermediate Case

We turn to an intermediate case in which the exporter faces an elastic demand but does have some monopoly power, illustrated in Figure III.

With elastic demand, the incentive to adjust prices in response to cost changes is much higher than for monopolists with more inelastic demand. This is because profits increase proportionally more when the exporter adjusts, given the greater sensitivity of demand. In other words, high demand elasticities naturally induce more price flexibility, so we assume that exporters are free to adjust their dollar prices. In equilibrium, despite price flexibility, optimal prices only move a small amount. Elastic demand leads to a shallow slope of the demand curve, so the overall dollar price adjustment is small. The optimal price moves from P to P', far smaller than the initial depreciation. Yet the quantity demanded adjusts by a large margin: from Q to Q'.

As in the case of the commodity exporter, the lack of price response is unrelated to nominal stickiness. Instead there is minimal reduced-form pass-through of the depreciation because the firm moves along the upward-sloping marginal cost curve. The equilibrium quantity adjustment will again depend crucially on export supply.

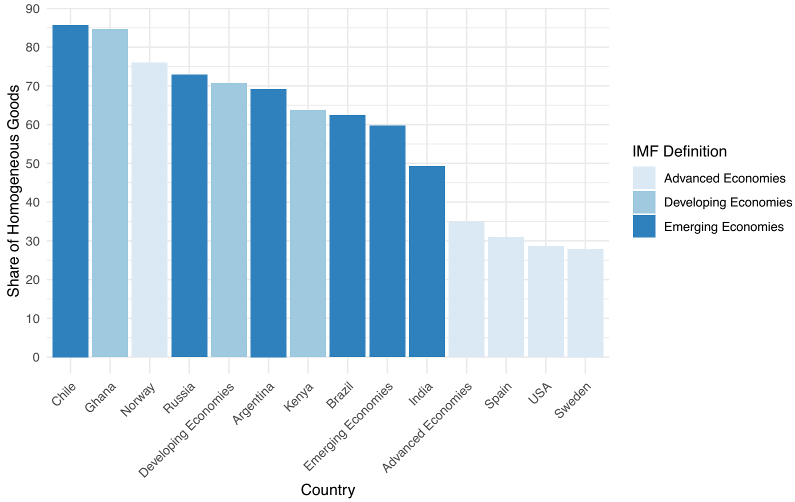

FIGURE IV

Homogeneous Share of Goods Exports, 1985–2023 Average

III. MOTIVATING EMPIRICAL OBSERVATIONS

This section discusses the three empirical observations that motivate our MCP assumptions and their deviation from the DCP premises of monopoly power and price stickiness.

FACT 1. Homogeneous products represent a large share of exports.

The share of commodities or commodity-like products sold in highly competitive export markets is large and varies across countries. This is illustrated in Figure IV, which shows the share of homogeneous products in total goods exports in selected countries at different levels of development. Following the classification proposed by Rauch (1999), homogeneous products are defined as those traded in organized exchanges or reference priced. Trade data correspond to the four-digit SITC level published in the United Nations Comtrade database. The bars correspond to country averages from 1985 to 2023. The figure also displays the averages by development groups. For developing economies, the share of homogeneous goods is on average above 70%; for emerging economies, the share is around 60%. For advanced economies, the share is also not negligible, averaging around 35%.

As Figure IV shows, low- and middle-income countries have average goods export shares of homogeneous products of around 50% or higher, while high-income countries are on average somewhat below 40%. Sub-Saharan Africa, Latin America and the Caribbean, and the Middle East and North Africa are all characterized by shares of homogeneous products that exceed 50% of their total goods exports.

FACT 2. Homogeneous products tend to have more flexible prices.

The strong empirical association between price flexibility and product homogeneity (or the degree of competition, which is closely associated with homogeneity) has been documented by multiple studies in different countries.[7] Bils and Klenow (2004), using data from the U.S. Bureau of Labor Statistics on consumer and goods expenditures, show that more homogeneous goods (such as fresh food and energy) display a much higher frequency of price adjustment than more differentiated goods and services. They also report that more competitive products display much more frequent price adjustments (with competition proxied by an inverse measure of sectoral concentration). This is corroborated by Nakamura and Steinsson (2008), who document that homogeneous goods have a higher price-change frequency. In particular, they find that the median monthly frequency of price change for finished-good producer prices is 10.8%, compared with 98.9% for crude materials. (Similar findings are documented in earlier work by Carlton 1986; Blinder et al. 1998).

Studies for euro area countries by Hernando and Alvarez (2004), Fabiani, Gattulli, and Sabbatini (2007), Álvarez et al. (2006), Cornille and Dossche (2006), and Vermeulen et al. (2012) find that a higher degree of competition (proxied by different variables across studies) results in more flexible price adjustment. In particular, prices of energy and food are changed at significantly higher frequency than nonenergy goods and services prices. Lach and Tsiddon (1992) and Konieczny and Skrzypacz (2005) find similar results for Israel and Poland, respectively. Gautier et al.

7. Product homogeneity is associated with the degree of competition as a lack of product differentiation can reduce market power. However, there are exceptions: some homogeneous markets (e.g., in the energy sector) might not be as competitive. The important point is that their prices are still flexible (e.g., energy prices tend to display high flexibility).

(2024) also find that euro area prices are more flexible for goods consisting of a higher share of energy and raw material inputs.

These differences in price flexibility across sectors are also evident in developing and emerging economies. Gouvea (2007) studies the microdata underlying Brazil's CPI basket and documents that more homogeneous products tend to display more frequent price adjustments. Overall, developing and emerging economies produce more homogeneous export goods, so price flexibility should be more prevalent in exports from these economies. Gouvea (2007) also finds a higher frequency of price adjustment in Brazil than in advanced economies. Alvarez et al. (2019) find similar results for Argentina, recording a higher frequency of price changes among homogeneous-good sectors and a higher frequency of adjustment overall. Nchake, Edwards, and Rankin (2015) document analogous patterns for Lesotho.

FACT 3. Invoicing in a vehicle currency is more prevalent in homogeneous, competitive-good sectors.

Seminal insights on vehicle currencies by McKinnon (1979), Carse and Wood (1979), and Magee and Rao (1980) emphasize that invoicing in a vehicle currency is more prevalent in homogeneous, competitive-good sectors, particularly primary commodity markets. This is tightly related, in turn, to the high degree of price flexibility in those markets. Magee and Rao (1980) highlight the economic value of continuous price monitoring in highly competitive sectors made possible by the use of a vehicle currency. The premise in their work is that dollar invoicing does not coincide with sticky prices; on the contrary, vehicle-currency invoicing is used to facilitate the continuous international comparability and price adjustments characteristic of competitive, homogeneous-product sectors.

We corroborate the relation between dollar invoicing and the prevalence of homogeneous goods in exports using evidence from a large (unbalanced) panel of countries. Table I shows regressions of the share of exports invoiced in dollars on the share of homogeneous products in total goods exports. As before, we use four-digit-level data from UN Comtrade and follow the classification by Rauch (1999) in which homogeneous products are defined as those traded in organized exchanges or reference priced. Data on the share of exports invoiced in dollars from 1990 to 2019 are obtained from Boz et al. (2022); accordingly, the regressions cover

TABLE I
EXPORT SHARE INVOICED IN DOLLARS AND EXPORT SHARE OF HOMOGENEOUS GOODS

	Share of exports invoiced in dollars			
	(1)	(2)	(3)	Averages
Export share of homogeneous goods	0.712***	0.759***	0.799***	0.835***
	(0.0325)	(0.0337)	(0.0481)	(0.228)
Constant	0.169***	0.148***	0.223***	0.167
	(0.0165)	(0.0169)	(0.0223)	(0.125)
Year fixed effects	No	Yes	Yes	n/a
Weighted by GDP	No	No	Yes	Yes
Observations	1,173	1,173	1,173	101
R-squared	0.290	0.330	0.365	0.375

Notes. The table shows the estimated coefficients from a regression of the share of exports invoiced in dollars on the export shares of homogeneous goods in total goods exports. The final column shows the same regressions for the average of each variable over the sample. Robust standard errors are in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$.

1990–2019. The table indicates that on average a 10 percentage point increase in the export share of homogeneous goods is associated with an increase in the share of exports invoiced in dollars of 7 to 8 percentage points. (A regression of average values over the period leads to the higher estimate.)

Using more disaggregated data on Canadian imports, Goldberg and Tille (2008) show that vehicle-currency invoicing is more prevalent in homogeneous good sectors. Moreover, the prevalence of the dollar in trade flows that do not involve the United States reflects trade in homogeneous products where firms need to keep their price in line with their competitors. In particular, they show that the likelihood of vehicle-currency pricing is higher for exporters selling homogeneous goods (vis-à-vis sellers of differentiated products) and decreases with the market share of the exporting country. The use of a vehicle currency, combined with flexibility in price adjustment, allows sellers to reduce price differences with their competitors. By contrast, producers of more differentiated products have more pricing power and care less about price movements relative to their competitors.

In related work, Gopinath, Itskhoki, and Rigobon (2010) use import price data for the United States to show that dollar pricing is more prevalent in homogeneous good sectors such as "Animal or Vegetable Fats and Oils," "Wood and articles of Wood," and

"Mineral Products." In contrast, differentiated goods are more commonly priced in the exporters' own currencies.

A corollary of Facts 1 and 3 is the well-known observation that vehicle-currency invoicing is much more prevalent in developing and emerging countries. Importantly, from Facts 2 and 3, and as emphasized in Magee and Rao (1980), vehicle-currency invoicing should be associated with higher price flexibility.

These three facts challenge the key assumptions underpinning sticky-price DCP models, particularly for developing and emerging countries—namely, monopoly power in export markets and sticky dollar prices. First, developing and emerging countries tend to export homogeneous products, which are associated with high demand elasticities and high competition, rather than monopoly power. Second, the high elasticities in turn are associated with price flexibility, not price stickiness, as the profit incentive to adjust prices is stronger under more elastic demands. (Note that even in homogeneous-good sectors with monopoly power, such as energy markets, prices tend to be flexible.) Finally, these flexibly priced homogeneous goods are the ones more likely to be priced in vehicle currencies such as the dollar, rather than sticky-price vehicle-currency invoicing.

IV. An Open Economy Model of Monetary Policy Transmission

This section presents a new open economy macroeconomic model that we use to study the export channel of monetary policy transmission. It sets out an MCP model that features dominant, dollar currency pricing, and production using imported intermediate inputs, in line with the key features of the recent New Keynesian DCP literature. But it also includes a flexible market structure that allows intra-sector international competition, heterogeneity in the degree of price stickiness, and PCP firms that opt to price using domestic currency.

We first calibrate the model to represent a typical emerging or developing small open economy, particularly if a commodity exporter. Simulating the model economy's response to a monetary policy shock leads to a strong response of exports to a monetary policy–induced depreciation, matching the allocative properties of standard PCP frameworks, rather than sticky-price DCP models. We also discuss the appropriate calibration for an advanced economy, highlighting that similar intuition may still follow through in many cases. Finally, we explore the mechanism, highlighting the crucial roles of supply constraints and price flexibility.

Our model economy consists of households who consume domestically produced and imported goods, and provide labor to firms while saving in domestic and international asset markets. Firms produce goods for domestic consumption and exports. We close the model with a monetary authority who sets domestic interest rates, subject to a Taylor rule.

IV.A. Households

The economy is populated by a unit mass of households indexed by h in the home country, j. Each household has lifetime expected utility given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{j,t}^{1-\sigma_c}}{1-\sigma_c} - \frac{N_{j,t}(h)^{1+\varphi}}{1+\varphi} \right), \tag{1}$$

where $C_{j,t}$ is total consumption, $N_{j,t}(h)$ is labor supply, σ_c is the coefficient of relative risk aversion and the reciprocal of the intertemporal elasticity of substitution, and φ is the reciprocal of the labor supply elasticity.[8]

Total consumption has a nested CES structure, which allows for a distinction between the elasticity of substitution between different goods or industries and the elasticity of substitution between different varieties of the same good produced at home or abroad.[9] This reverses the nested CES structure often used in the open-economy macroeconomic literature (e.g., Galí and Monacelli 2005), which allows substitution between baskets of goods produced in different countries but does not feature competition at a lower level of aggregation. A household in country j consumes a bundle of goods given by

$$C_{j,t} \equiv \left(\int_0^1 C_{j,t}(g)^{\frac{\sigma-1}{\sigma}} dg \right)^{\frac{\sigma}{\sigma-1}}, \tag{2}$$

where σ is the elasticity of substitution across different goods or industries. In each category g, consumption consists of different

8. We assume domestic risk sharing for consumption, allowing us to drop the index h, as it implies that $C_{j,t}(h) = C_{j,t}$ for all $h \in (0, 1)$.

9. The idea of variable cross-country competition for different products was set out by Armington (1969); similar demand setups are used in Eaton and Kortum (2002) and Feenstra et al. (2018).

varieties produced either at home (country j) or abroad (in all countries $i \neq j$). Each country produces a set of varieties of each good of measure $\left|\Omega_i^g\right|$, all of which may be sold domestically, but potentially also as exports in each other country.

Consumption of good g in the home country j is given by

$$(3) \qquad C_{j,t}(g) \equiv \left(\sum_i \left(\frac{\gamma_{ij}^g}{\left|\Omega_i^g\right|} \right)^{\frac{1}{\eta^g}} \int_{\omega \in \Omega_i^g} C_{ij,t}^g(\omega)^{\frac{\eta^g - 1}{\eta^g}} d\omega \right)^{\frac{\eta^g}{\eta^g - 1}},$$

where $C_{ij,t}^g(\omega)$ denotes consumption by home (j) households of variety ω, of good g, produced (and exported) by country i. For $i = j$, this consists of domestically produced varieties. The elasticity of substitution between domestic and foreign varieties, as well as between different varieties in a country, is given by η^g, which may vary for different types of goods. The parameter γ_{ij}^g captures a preference for varieties of the good produced in country i, with $\sum_i \gamma_{ij}^g = 1$ and γ_{jj}^g representing home bias, arising directly from consumer preferences or proxying for trade and distribution costs associated with exporting. A value of $\gamma_{jj}^g = 1$ therefore implies that good g is not importable for country j, while $\gamma_{ij}^g = 0$ implies it is not exported from country i to country j. Non-tradable goods are those for which both $\gamma_{jj}^g = 1$ and $\gamma_{ji}^g = 0$ hold, for all i.

These indices imply consumption demand for good g in country j of

$$(4) \qquad C_{j,t}(g) = \left(\frac{P_{j,t}(g)}{P_{j,t}} \right)^{-\sigma} C_{j,t},$$

and demand for variety ω of good g, produced in country i of

$$(5) \qquad C_{ij,t}^g(\omega) = \frac{\gamma_{ij}^g}{\left|\Omega_i^g\right|} \left(\frac{P_{ij,t}^g(\omega)}{P_{j,t}(g)} \right)^{-\eta^g} C_{j,t}(g),$$

where $P_{ij,t}^g(\omega)$ is the price of the good (in j currency). $P_{j,t}(g)$ is a (j currency) price index for varieties of good g, defined as

$$(6) \qquad P_{j,t}(g) \equiv \left(\sum_i \frac{\gamma_{ij}^g}{\left|\Omega_i^g\right|} \int_{\omega \in \Omega_i^g} P_{ij,t}^g(\omega)^{1-\eta^g} d\omega \right)^{\frac{1}{1-\eta^g}}.$$

The country j consumer price index is given by

$$(7) \qquad P_{j,t} \equiv \left(\int_0^1 P_{j,t}(g)^{1-\sigma} dg \right)^{\frac{1}{1-\sigma}}.$$

Imposing $\eta^g = \sigma$ would imply a market structure similar to standard DCP models such as Gopinath et al. (2020) or Egorov and Mukhin (2023). In those models, there is no distinction between different varieties of the same good, on the one hand, and different goods or industries, on the other. In our more general setup, the degree of international competition influences the scope for substitution between different varieties.

In our model, the influence of different relative prices, and so of exchange rates, will vary across different goods. At one extreme, consumer goods with a high degree of brand loyalty (e.g., some types of car), or highly specialized intermediate inputs (e.g., some types of computer software), are likely to have low values of η^g. For these goods, the price relative to other goods in the CPI $(\frac{P_{j,t}(g)}{P_{j,t}})$ will be the main determinant of demand. At the other extreme, for highly homogeneous goods such as commodities, $\eta^g >> \sigma$ is likely.

The key relevant price will be the price relative to other varieties $(\frac{P^g_{ij,t}(\omega)}{P_{j,t}(g)})$, including those produced abroad. At the limit $\eta^g \to \infty$, goods are perfectly competitive, and any fluctuations in exchange rates in a single producing country are likely to be met by an offsetting adjustment in the domestic currency price.

1. *Exchange Rates.* We use $\mathcal{E}_{ij}$ to denote the price of currency i in currency j, such that an increase in $\mathcal{E}_{ij}$ implies a depreciation of currency j against i. A key exchange rate in the model is the bilateral exchange rate against the dominant, vehicle currency, which we assume is the dollar. The price of dollars in currency j is given by $\mathcal{E}_{\$j}$.

2. *Asset Markets.* Domestically, consumers have access to a full set of state-contingent securities (in zero net supply), with $B_{j,t}$ denoting domestic debt repaid by consumers in country j at the beginning of period t. $B_{j,t+1}(s)$ denotes newly issued one-period domestic debt, to be repaid in period $t+1$ in state $s \in S$, where S is the set of all possible states. Internationally, there is no risk sharing across countries, with consumers having access only to risk-free securities in U.S. dollars, with dollar debt given by $B^{\$}_{j,t}$.

3. *Wage Setting.* As in Erceg, Henderson and Levin (2000), each household is a monopoly supplier of differentiated labor, denoted $N_{j,t}(h)$, at wage rate $W_{j,t}(h)$. Labor is bundled together for

use in production using an index:

$$L_{j,t} = \left(\int_0^1 N_{j,t}(h)^{\frac{\vartheta-1}{\vartheta}} dh \right)^{\frac{\vartheta}{\vartheta-1}}. \tag{8}$$

Cost minimization by firms or a labor aggregator, taking the wage rate as given, gives differentiated labor demand of:

$$N_{j,t}(h) = \left(\frac{W_{j,t}(h)}{W_{j,t}} \right)^{-\vartheta} L_{j,t}, \tag{9}$$

where $W_{j,t} \equiv (\int_0^1 W_{j,t}(h)^{1-\vartheta} dh)^{\frac{1}{1-\vartheta}}$ is the aggregate wage index. Households are subject to a Calvo (1983)–type friction in wage setting in domestic currency and may only change their wage each period with probability $1 - \delta_w$.

Households in country j maximize equation (1) by choosing a sequence of consumption, wage, and debt positions $\{C_{j,t}, W_{j,t}(h), \{B_{j,t+1}(s)\}_{s \in S}, B^{\$}_{j,t+1}\}_{t=0}^{\infty}$, subject to labor demand (9) and the sequence of budget constraints:

$$\begin{aligned} P_{j,t}C_{j,t} + \mathcal{E}_{\$j,t}\left(1 + i^{\$}_{j,t}\right)B^{\$}_{j,t} + B_{j,t} = W_{j,t}(h)N_{j,t}(h) + \Pi_{j,t} + \mathcal{E}_{\$j,t}B^{\$}_{j,t+1} \\ + \sum_{s \in S} Q_{j,t+1}(s)B_{j,t+1}(s), \end{aligned} \tag{10}$$

where $\Pi_{j,t}$ are lump-sum profits redistributed from domestic firms, $Q_{j,t+1}(s)$ is the period t price of debt $(B_{j,t+1}(s))$ that pays one unit of currency in state s in period $t+1$, and $i^{\$}_{j,t}$ is the dollar interest rate paid on internationally traded debt $(B^{\$}_{j,t+1})$ in country j. Following Schmitt-Grohé and Uribe (2003), we allow for a country-specific risk premium on the bond to ensure stationarity of the linearized model:

$$i^{\$}_{j,t} = \bar{i}^{\$}_j + \psi \left(e^{\frac{B^{\$}_{j,t}}{P^{\$}_{\$,t}} - \overline{B}^{\$}_j} - 1 \right), \tag{11}$$

where $\bar{i}^{\$}_j$ and $\overline{B}^{\$}_j$ are the steady-state dollar interest rate and debt position, $P^{\$}_{\$,t}$ is the U.S. CPI in dollars and ψ calibrates the sensitivity of the risk premium.

Defining the risk-free domestic interest rate $(1 + i_{j,t+1} \equiv \frac{1}{\sum_{s \in S} Q_{j,t+1}(s)})$ as the inverse of the price of one-period debt that pays one unit of domestic currency in any state of the world, then the maximization implies a standard intertemporal Euler equation:

$$C_{j,t}^{-\sigma_c} = \beta(1 + i_{j,t+1})\mathbb{E}_t\left(C_{j,t+1}^{-\sigma_c}\frac{P_{j,t}}{P_{j,t+1}}\right). \tag{12}$$

A similar condition for the internationally traded bond implies an uncovered interest parity (UIP) condition:

$$(1 + i_{j,t+1})\mathbb{E}_t\left(\frac{C_{j,t+1}^{-\sigma_c}}{P_{j,t+1}}\right) = \left(1 + i_{j,t+1}^{\$}\right)\mathbb{E}_t\left(\frac{C_{j,t+1}^{-\sigma_c}}{P_{j,t+1}}\frac{\mathcal{E}_{\$j,t+1}}{\mathcal{E}_{\$j,t}}\right). \tag{13}$$

The optimality condition for wage setting in period t is given by

$$\mathbb{E}_t\sum_{s=0}^{\infty}(\beta\delta_w)^s N_{j,t+s}(h)C_{j,t+s}^{-\sigma_c}\left[\frac{\overline{W}_{j,t}(h)}{P_{j,t+s}} - \frac{\vartheta}{\vartheta-1}N_{j,t+s}(h)^{\varphi}C_{j,t+s}^{\sigma_c}\right] = 0, \tag{14}$$

where $\overline{W}_{j,t}(h)$ is the optimal reset wage in period t.

IV.B. Firms

Firms produce using labor and intermediate inputs, taking wages, input prices, and their industry's total factor inputs as given. We include imported intermediate inputs partly for added realism, to help us better match macroeconomic data. They also dampen the export response to exchange rate movements in existing DCP models, so including them in our MCP model avoids biasing our results toward our main finding. Firms are monopolistically competitive and prices are staggered, for sticky-price sectors, following Calvo (1983). The production function of a firm in country j producing variety ω of good g is given by:

$$Y_{j,t}^{g}(\omega) = A_{j,t}^{g}\left(L_{j,t}^{g}(\omega)\right)^{1-\alpha}\left(X_{j,t}^{g}(\omega)\right)^{\alpha}\left[\left(L_{j,t}^{g}\right)^{1-\alpha}\left(X_{j,t}^{g}\right)^{\alpha}\right]^{\nu_g-1}. \tag{15}$$

$A_{j,t}^{g}$ is a productivity parameter for good g; $X_{j,t}^{g}(\omega)$ the use of intermediate inputs by the firm producing variety ω, and $L_{j,t}^{g}(\omega)$ its labor input, with α and $1-\alpha$ their respective shares in the production process. $X_{j,t}^{g} \equiv \int_{\omega\in\Omega_j^g}X_{j,t}^{g}(\omega)d\omega$ and $L_{j,t}^{g} \equiv \int_{\omega\in\Omega_j^g}L_{j,t}^{g}(\omega)d\omega$ are the total use of each input by the industry producing good g. $\nu_g \leqslant 1$ determines returns to scale for that sector, with decreasing returns for $\nu_g < 1$ and constant returns for $\nu_g = 1$. Decreasing returns at the industry level are a simple way of capturing the features that are likely to lead to an upward-sloping marginal cost curve. We interpret these as arising due to fixed good-specific factors of production, such as structures.[10] But they could be interpreted more broadly as a range of different supply-side constraints on expanding production.

Firms use domestic and imported varieties of consumption goods as intermediate inputs, with $X_{j,t}$ taking an identical form to the consumption aggregator:

$$X_{j,t} \equiv \left(\int_0^1 X_{j,t}(g)^{\frac{\sigma-1}{\sigma}} dg \right)^{\frac{\sigma}{\sigma-1}}, \tag{16}$$

where the index (g) refers to the consumption good used, and we omit the indices for the good and variety being produced.

Combining the resulting intermediate input demands with consumption demand given by equations (4) and (5) leads to overall export demand of variety ω produced in country j and exported to country i of:

$$Y^g_{ji,t}(\omega) = \frac{\gamma^g_{ji}}{\left|\Omega^g_j\right|} \left(\frac{P^g_{ji,t}(\omega)}{P_{i,t}(g)} \right)^{-\eta^g} \left(\frac{P_{i,t}(g)}{P_{i,t}} \right)^{-\sigma} \left(C_{i,t} + X_{i,t} \right), \tag{17}$$

where $P^g_{ji,t}(\omega)$ is the price in i currency. For country j, $Y^g_{jj,t}(\omega)$ is domestic demand for the variety.

1. *Pricing.* Each firm sets prices in each market separately, potentially subject to a Calvo friction. For each good, firms in each country set prices either in dollars, given by $P^{g,\$}_{ji,t}(\omega)$ or in their own currency (producer currency pricing, PCP), given by $P^{g,j}_{ji,t}(\omega)$. In a given period, each firm is able to optimally reset prices with a good-specific probability $1 - \delta^g_p$. The good-specific probability allows for heterogeneity in the degree of nominal rigidities across different types of goods, in line with the microeconomic evidence.

Per period profits for producer-pricing varieties in country j are given by

$$\Pi_{j,t}(\omega) = \sum_i \left(P^{g,j}_{ji,t}(\omega) Y^g_{ji,t}(\omega) - MC_{j,t}(\omega) Y^g_{ji,t}(\omega) \right), \tag{18}$$

10. We assume decreasing returns at the industry level rather than the firm level for analytical convenience in cases where firms also have sticky prices, although these features could arise with competitive rental markets for these good-specific factors.

where $MC_{j,t}$ are marginal costs. For dollar pricing varieties, it is convenient to express per period dollar profits as

$$\Pi^{\$}_{j,t}(\omega) = \sum_i \left(P^{g,\$}_{ji,t}(\omega) Y^g_{ji,t}(\omega) - \frac{MC_{j,t}(\omega) Y^g_{ji,t}(\omega)}{\mathcal{E}_{\$j,t}} \right), \tag{19}$$

where for each export location, the first term is total dollar revenues, and the second term is total dollar costs.

Firms maximize expected discounted profits in any currency by posting a separate price in each export destination i, subject to demand (equation (17)) and the identity $P^g_{ji,t}(\omega) = \mathcal{E}_{ki,t} P^{g,k}_{ji,t}(\omega)$, which converts the local currency i price to the invoicing currency price for each pricing currency $k = j, \$$. For PCP firms, profit maximization in period t gives the optimal reset price satisfying

$$\mathbb{E}_t \left[\sum_{s=0}^{\infty} \left(\beta \delta^g_p\right)^s \frac{C^{\sigma_c}_{j,t} P_{j,t}}{C^{\sigma_c}_{j,t+s} P_{j,t+s}} Y^g_{ji,t+s}(\omega) \left(\overline{P}^{g,j}_{ji,t}(\omega) - \frac{\eta^g}{\eta^g - 1} MC_{j,t+s}(\omega) \right) \right] = 0, \tag{20}$$

with the producer-currency price set equal to a markup $\frac{\eta^g}{\eta^g-1}$ over a weighted average of future marginal costs. A similar condition holds for dollar-pricing firms:

$$\mathbb{E}_t \left[\sum_{s=0}^{\infty} \left(\beta \delta^g_p\right)^s \frac{C^{\sigma_c}_{j,t} P_{j,t}}{C^{\sigma_c}_{j,t+s} P_{j,t+s}} Y^g_{ji,t+s}(\omega) \left(\overline{P}^{g,\$}_{ji,t}(\omega) - \frac{\eta^g}{\eta^g - 1} \frac{MC_{j,t+s}(\omega)}{\mathcal{E}_{\$j,t+s}} \right) \right] = 0, \tag{21}$$

with dollar prices set as a markup over the weighted average of future dollar marginal costs.

Since the period t optimal dollar reset price can also be expressed as $\overline{P}^{g,\$}_{ji,t}(\omega) = \frac{\overline{P}^{g,j}_{ji,t}(\omega)}{\mathcal{E}_{\$j,t}}$, then equation (21) implies that the dollar reset price will only differ from the optimal producer-currency reset price when the dollar exchange rate ($\mathcal{E}_{\$j,t}$) is expected to appreciate or depreciate in periods $s > t$. Under flexible prices ($\delta^g_p \to 0$), the invoicing currency becomes irrelevant, since current-period dollar prices depend only on current-period dollar marginal costs.

2. *Costs.* Cost minimization each period, subject to equation (15), gives the marginal cost of producing good g, variety ω: in

terms of labor input,

$$MC^{g}_{j,t}(\omega) = \frac{W_{j,t}L_{j,t}(\omega)}{(1-\alpha)Y^{g}_{j,t}(\omega)}; \tag{22}$$

and intermediates,

$$MC^{g}_{j,t}(\omega) = \frac{P_{j,t}X_{j,t}(\omega)}{\alpha Y^{g}_{j,t}(\omega)}. \tag{23}$$

Combining the two conditions gives

$$MC^{g}_{j,t}(\omega) = MC^{g}_{j,t} = \frac{1}{(1-\alpha)^{1-\alpha}\alpha^{\alpha}} \frac{W^{1-\alpha}_{j,t} P^{\alpha}_{j,t} \left[L^{1-\alpha}_{j,t} X^{\alpha}_{j,t}\right]^{1-\nu^{g}}}{A^{g}_{j,t}}, \tag{24}$$

with marginal costs, and the optimal input shares, therefore the same across different varieties of the same good produced in the same country. These marginal costs are increasing in industry output of the good if $\nu^{g} < 1$.[11]

IV.C. Monetary Policy and Market Clearing

We close the model using a simple inflation-targeting Taylor rule specification for monetary policy in each country, given by:

$$\frac{1+i_{j,t}}{1+\bar{i}_{j}} = \left(\frac{1+i_{j,t-1}}{1+\bar{i}_{j}}\right)^{\rho} (1+\pi_{j,t})^{(1-\rho)\phi_{\pi}} \zeta^{M}_{j,t}, \tag{25}$$

where ρ is a parameter determining policy smoothing, $\phi_{\pi} > 1$ is the response to deviations of inflation from target, $\bar{i}_{j}$ is the steady-state equilibrium nominal interest rate in country j, and $\zeta^{M}_{j,t}$ is an AR(1) monetary policy shock in j.

Market clearing for each variety produced in country j gives

$$Y^{g}_{j,t}(\omega) = \sum_{i} Y^{g}_{ji,t}(\omega). \tag{26}$$

While in factor markets:

$$L_{j,t} = \int_{0}^{1} L^{g}_{j,t}\, dg, \tag{27}$$

11. Strictly, our upward-sloping marginal cost curves shown in the stylized charts in Section II therefore arise in the model at the domestic industry level, rather than at the individual firm or variety level. Under fully flexible prices, however, our specification is equivalent, to a log-linear approximation, to assuming decreasing returns and upward-sloping marginal costs at the individual firm level.

and

$$X_{j,t} = \int_0^1 X_{j,t}^g dg, \tag{28}$$

where g refers to the good being produced.

Finally, for reporting some of our results, we define auxiliary variables to measure aggregate metrics. Nominal net exports from country j to country i are given by:

$$NTB_{ji,t} \equiv \int_0^1 \left(\int_{\omega \in \Omega_j^g} P_{ji,t}^g(\omega) Y_{ji,t}^g(\omega) d\omega - \int_{\omega \in \Omega_i^g} P_{ij,t}^g(\omega) Y_{ij,t}^g(\omega) d\omega \right) dg, \tag{29}$$

with nominal aggregate net exports/trade balance for country j equal to

$$NTB_{j,t} \equiv \sum_{i \neq j} NTB_{ji,t}. \tag{30}$$

Using this, we then define aggregate (net) output as the sum of nominal consumption and nominal net exports, deflated by the CPI:

$$Y_{j,t} \equiv \frac{P_{j,t}C_{j,t} + NTB_{j,t}}{P_{j,t}}. \tag{31}$$

For simplicity, we define export and import price indices (for country j, for each trading partner i, all in j currency), based on the steady-state export and import shares, as:

$$P_{ji,t} \equiv \int_0^1 \left(\frac{\gamma_{ji}^g}{\left|\Omega_j^g\right| \int_0^1 \gamma_{ji}^g dg} \int_{\omega \in \Omega_j^g} P_{ji,t}^g(\omega) d\omega \right) dg \tag{32}$$

for exports, and

$$P_{ij,t} \equiv \int_0^1 \left(\frac{\gamma_{ij}^g}{\left|\Omega_i^g\right| \int_0^1 \gamma_{ij}^g dg} \int_{\omega \in \Omega_i^g} P_{ij,t}^g(\omega) d\omega \right) dg \tag{33}$$

for imports. We define real export and import quantities by deflating nominal exports and imports by these indices: $Y_{ji,t} \equiv \left[\int_0^1 \left(\int_{\omega \in \Omega_j^g} P_{ji,t}^g(\omega) Y_{ji,t}^g(\omega) d\omega \right) dg \right] P_{ji,t}^{-1}$ and $Y_{ij,t} \equiv \left[\int_0^1 \left(\int_{\omega \in \Omega_i^g} P_{ij,t}^g(\omega) Y_{ij,t}^g(\omega) d\omega \right) dg \right] P_{ij,t}^{-1}$.

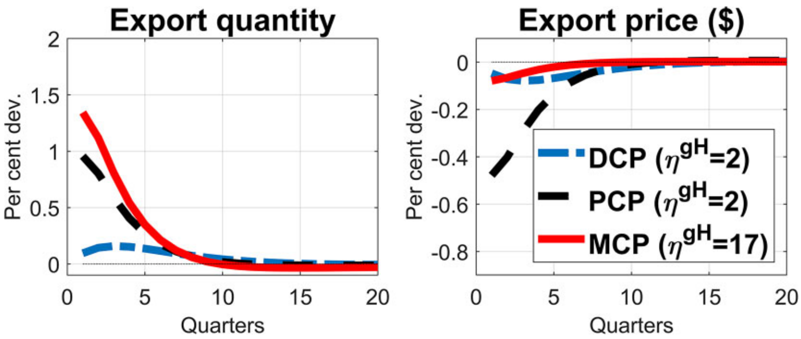

FIGURE V

Export Responses to a Home Monetary Policy Shock Under Different Models

Impulse responses to a 100 basis point negative monetary policy shock that reduces the policy rate by 25 basis points. The results are generated under the calibration shown in Table II.

IV.D. The Export Channel of Monetary Policy Transmission

This section simulates the model under different assumptions for pricing and demand. We compare outcomes in response to a monetary policy loosening. The results illustrate how the MCP model restores the strong export response to exchange rate depreciations of the classic PCP model. But it does so while also matching the empirical findings of limited exchange-rate pass through and terms-of-trade fluctuations.

Our headline result is shown in Figure V. We simulate three models in response to a monetary policy loosening that generates an exchange rate depreciation. Our MCP model is shown in solid red lines. For comparison, we show a standard PCP model along the lines of Obstfeld and Rogoff (1995) in black dashed lines; and a benchmark sticky-price DCP model along the lines of Gopinath et al. (2020) in dash-dotted blue lines.

The MCP model replicates the allocative properties of the Obstfeld and Rogoff (1995) PCP framework: export volumes increase strongly in response to a depreciation. But we get this despite a limited price response, similar to the sticky-price DCP framework. Together, our results suggest that one should be cautious in drawing conclusions about the response of export volumes to exchange rates from the price response.

The rest of this section delves into this result in more detail. We begin by discussing the calibration of the model simulations, including our assumptions on trading patterns for different types of goods. We then show the full set of simulated responses following a monetary policy shock in the different models. We explain in detail the mechanisms underlying these different results.

1. *Calibration.* To illustrate our results and mechanisms, we first calibrate the model to represent a small, open emerging or developing economy. We use a simplified market structure, similar to that used in Egorov and Mukhin (2023). We think of this as particularly relevant to economies that export commodities or relatively homogeneous products. We allow for three types of goods. More homogeneous goods are denoted by g_H, where we allow prices to be flexible, but with international competition leading to a high demand elasticity. The other two types of goods are differentiated, with exporters possessing monopoly power and facing sticky-price frictions. These goods are denoted by g_M or g_N; we explain the differences between the two types next.

We use some stylized assumptions on trade patterns: our small open economy has two representative trading partners: the United States and the rest of the world. Home represents our developing or emerging economy. It produces its homogeneous goods g_H only for export to the global market. In contrast, its differentiated goods g_N are non-tradable, and consumed entirely at home. It also imports differentiated monopolistic goods g_M from the United States and the rest of the world.

The consumption basket of home therefore simplifies to

$$C_{H,t} = \left(\kappa_M C_{H,t}(g_M)^{\frac{\sigma-1}{\sigma}} + (1-\kappa_M) C_{N,t}(g_N)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, \tag{34}$$

where κ_M is the share of home consumption consisting of the differentiated imported good, with the rest of consumption consisting of non-tradables. The intermediate-input basket uses the same proportions of goods.

Our calibration sets $\eta_{g_H} >> \eta_{g_M} = \eta_{g_N} = \sigma$, which means that demand for each variety of non-tradables reduces to:

$$Y_{H,t}(\omega)^{g_N} = Y_{HH,t}^{g_N}(\omega) = \frac{1}{\left|\Omega_H^{g_N}\right|}\left(\frac{P_{HH,t}^{g_N}(\omega)}{P_{H,t}}\right)^{-\sigma}(C_{H,t} + X_{H,t}). \tag{35}$$

Absent large fluctuations in the global price of the homogeneous export good, demand from the United States for each variety is approximately

$$Y^{g_H}_{HU,t}(\omega) \approx \frac{1}{\left|\Omega^{g_H}_{H}\right|}\left(\frac{P^{\$,g_H}_{HU,t}(\omega)}{P^{\$}_{U,t}(g_H)}\right)^{-\eta_{g_H}} \gamma^{g_H}_{HU}\left(C_{U,t}+X_{U,t}\right), \quad (36)$$

with an analogous demand from the rest of the world.

Table II gives the full calibration of the model. To focus on the differences in our framework, we either use standard parameters or follow the benchmark DCP model of Gopinath et al. (2020), for parameters related to households, monetary policy, and demand and supply of non-tradable and imported goods. We set the cross-product or sector elasticity, σ, equal to two. We also set the cross-variety elasticity of these goods equal to two, implying the same limited degree of competition across varieties of these goods as between different goods. As in Gopinath et al. (2020), we set the price-rigidity parameters equal to 0.75, implying a price duration of four quarters.

Our model's key departures from the benchmark DCP framework relate to our export goods. In line with the type of goods (commodities, or commodity-like goods) exported in many emerging and developing economies, our model assumes that exports are priced flexibly ($\delta^{g_H}_p = 0$) and that they are homogeneous, with $\eta^{g_H} = 17$. This is the elasticity found by Broda and Weinstein (2006) for the crude oil sector for 1972–1988, so it captures well the market structure for a highly competitive commodity. Coincidentally, it is also the mean elasticity over different products found by the same authors over the same period, when classified at the most disaggregated level, which is the measure most relevant for capturing our channel of international competition. So, in line with the results in Imbs and Mejean (2015), higher elasticities can also be interpreted more broadly as applicable to a wide range of disaggregated export goods, particularly the homogeneous goods exported by many emerging and developing economies.[12]

We compare our MCP framework to standard sticky-price (DCP and PCP) models that otherwise have the same calibration.

12. Online Appendix Figure A.1 shows that the model responses are almost identical using the lower mean elasticity of 13 that Broda and Weinstein (2006) report for 1990–2001, and that the export quantity response is only somewhat dampened (and price response only somewhat stronger) using the value of 4 used in Kohn, Leibovici, and Szkup (2020), the lowest mean elasticity that Broda and Weinstein (2006) report, when averaging at the highest level of aggregation.

TABLE II
MCP Export Model Calibration

Parameter	Description	Value	Notes
Household preferences			
β	Discount factor	0.99	SS interest rate of 4%
σ_c	Risk aversion	2	Gopinath et al. (2020)
φ	Frisch elasticity	2	Gopinath et al. (2020)
ϑ	Labor demand elasticity	4	Gopinath et al. (2020)
ψ	Risk premium sensitivity	$10^{(-6)}$	Small
$\overline{B}_j^{\$}$	Steady-state foreign debt	0	
Demand			
σ	Cross-product elasticity	2	Gopinath et al. (2020)
κ_M	Import/tradable share in home consumption	0.5	Commodity-exporting SOE
η^{g_N}	Non-tradable cross-variety elasticity	2	Gopinath et al. (2020)
η^{g_H}	Home export cross-variety elasticity	17	Broda and Weinstein (2006)
η^{g_M}	Imported good cross-variety elasticity	2	Gopinath et al. (2020)
$\gamma_{HH}^{g_N}$	Home consumption of non-tradables	1	NT assumption
$\gamma_{HH}^{g_H}$	Home consumption of home exports	0	Commodity-exporting SOE
$\gamma_{UH}^{g_M}$	Share of United States in home imports	0.5	Illustrative
$\gamma_{RH}^{g_M}$	Share of ROW in home imports	0.5	Illustrative
$\frac{\gamma_{HR}^{g_H} Y_R}{\gamma_{HU}^{g_H} Y_U}$	Share of ROW in home exports	0.5	Illustrative

TABLE II
CONTINUED

Parameter	Description	Value	Notes
Supply			
α	Intermediate share	2/3	Gopinath et al. (2020)
ν^{g_N}	Non-tradable returns to scale	1	Standard
ν^{g_H}	Home export returns to scale	0.85	From mining structures/Canadian VA
A^{g_N}	Non-tradable TFP	1	Normalization
$\frac{Y^{g_H}/L^{g_H}}{Y^{g_N}/L^{g_N}}$	SS relative export TFP	1	Target with world demand
δ_w	Wage rigidity	0.75	four-quarter duration
$\delta_p^{g_N}$	Non-tradable good price rigidity	0.75	four-quarter duration
$\delta_p^{g_H}$	Home export price rigidity	0	Flexible
$\delta_p^{g_M}$	Imported good price rigidity	0.75	four-quarter duration
Monetary policy			
ρ	Taylor rule smoothing	0.5	Gopinath et al. (2020)
ρ_M	Monetary shock persistence	0.3	
ϕ_π	Taylor rule inflation weight	1.5	Standard

Notes. TFP denotes total factor productivity; SS denotes steady-state; SOE denotes small open economy; VA denotes value-added; NT denotes non-tradable.

For these models we set $\delta_p^{g_H} = 0.75$, consistent with a mean price duration of one year. Without intra-sector competition, these models are also equivalent to assuming that $\eta^{g_H} = \sigma = 2$. With price stickiness, the currency choice matters, so we compare to two cases: the DCP assumption of exports priced in dollars and the Mundell-Fleming PCP assumption of exports priced in the home currency.

The other crucial parameter in our framework is returns to scale in the export sector. We interpret this as arising from a fixed factor of production and calibrate (in all three models) based on the share of capital structures in value added. (This is a production factor that would be difficult to vary over business cycle frequencies). Specifically, we use data for the mining sector in Canada, a key commodity-exporting sector in a small open economy.[13] We describe in Section V how for non-commodity sectors, less reliant on fixed-forms capital in production, a lower value of ν^g would be appropriate. But different reasons for upward-sloping supply curves could also justify alternative values. Given the importance of this parameter and its uncertainty, we discuss the sensitivity of our results to supply constraints in the next subsection. Wage stickiness is another determinant of the marginal cost response in our model: we set the wage-rigidity parameter equal to that for differentiated good prices, also implying a mean duration of one year.

Finally, we calibrate the size of each sector to illustrative values for a small, commodity-exporting emerging or developing economy. We set the import share in the home consumption basket equal to 50%, reflecting production oriented toward commodities and commodity-like goods and more differentiated goods coming via imports. For simplicity, we assume that world demand for the export good and world supply of the import good are both split equally between the United States and the rest of the world. Finally, we exogenously choose steady-state U.S. demand to hit a (relative) steady-state total factor productivity target for the ex-

13. We assume that $1 - \nu$ represents the share of structures in gross output, and map from value-added to our model's gross output measure using our calibrated intermediates share of $\alpha = \frac{2}{3}$. We therefore multiply the average structures share in value added (between 1961 and 2021) of 0.44 by $(1 - \alpha)$ to give $1 - \nu = 0.15$ (rounded to two decimal places). We measure the structures share as the value of structures as a proportion of the gross capital stock, multiplied by the capital compensation share in value added.

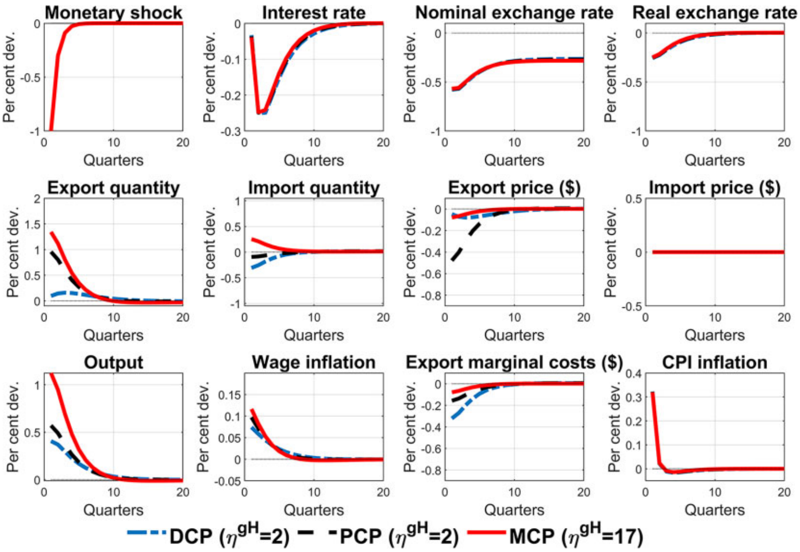

FIGURE VI

Quarterly Impulse Responses to a Home Monetary Policy Shock Under Different Models

Impulse responses to a 100 basis point negative monetary policy shock that reduces the policy rate by 25 basis points. The results are generated under the calibration shown in Table II. Inflation and wage inflation are shown in quarterly percent; the monetary shock and interest rate are shown as annualized percentage point changes. The nominal and real exchange rates are shown as $\mathcal{E}_{\$H,t}^{-1}$ and $P_{H,t}^{-1}\mathcal{E}_{\$H,t}^{-1}P_{U,t}$ such that a decrease in the plotted exchange rate corresponds to a depreciation of the home currency. Output is a net output (or real income) measure, as defined in equation (31).

port sector of one (implying the same steady-state productivity as the non-tradable sector).[14]

2. *Full Simulation Results.* Figure VI shows the full set of impulse responses from these three different models to a 100 basis point monetary policy shock. Owing to the endogenous response of policy, this reduces the policy rate by around 25 basis points in all cases, leading to a nominal depreciation of around 0.5%, part of which unwinds gradually. The exchange rate depreciation leads to a jump in import prices, since these are not

14. For sectors with decreasing returns to scale, steady-state TFP depends on the value of ν^g as well as A^g.

sticky in local currency. This feeds through into an increase in CPI inflation and means that the real exchange rate depreciation is smaller, given the 50% share of non-tradables in the price basket.

As shown, the responses of export quantities and export prices differ across models. Under producer currency pricing (black dashed lines), the dollar export price falls nearly in line with the nominal depreciation, as exporters are unable to reprice to reflect the weaker exchange rate. This leads to a large expenditure-switching effect driven by the U.S. and the rest of the world's consumers, so the quantity of exports goes up by 0.96% on impact. The extra expansion in output drives up marginal costs, partly owing to higher wages and partly to decreasing returns to scale. As a result, dollar marginal costs fall less than the depreciation, and exporters' markups are squeezed more than they would optimally choose, absent sticky prices.

Under sticky dollar pricing for exports (dash-dotted blue lines), dollar marginal costs fall from the depreciation. But the dollar price is unable to move for most firms, so it changes little, meaning markups rise by more than firms would optimally choose. With little price change, exports increase only marginally—the expenditure-switching channel is switched off. Aggregate output still expands, but this is mainly from a rise in non-tradable output in response to lower real interest rates.

The red solid lines show that the MCP model replicates the price response of the DCP model but restores the expenditure-switching quantity response of PCP. Export prices fall only a small amount, but this is because there is only a small fall in the optimal reset price, rather than owing to price rigidities. This is consistent with the decomposition of Blanco and Cravino (2020), which shows that the co-movement between nominal and real exchange rates relates to (small) movements in reset prices, rather than sticky prices.

With a high elasticity of substitution across varieties in different countries, even a small price change induces a large expenditure-switching effect, and exports increase by 1.34%, even larger than in the PCP case. As with PCP, the extra export output drives up dollar marginal costs, offsetting the downward pressure from the depreciation. Equilibrium is restored when marginal cost equates with marginal revenue, which, given the elastic demand curve, is only slightly lower than the original price.

TABLE III
YEAR 1 AVERAGE RESPONSES TO 100 BASIS POINT NEGATIVE MONETARY POLICY SHOCK

	PCP model $\delta_p^{gH} = 0.75$, $\eta^{gH} = 2$	DCP model $\delta_p^{gH} = 0.75$, $\eta^{gH} = 2$	MCP model $\delta_p^{gH} = 0$, $\eta^{gH} = 17$
Dollar exchange rate (% depreciation)	0.52	0.52	0.52
Annual CPI inflation (end year 1, %)	0.32	0.32	0.32
Output (%)	0.42	0.32	0.81
Dollar export price (%)	−0.34	−0.07	−0.06
Export quantity (%)	0.69	0.14	0.95

These results turn on their head two of the key mechanisms in the sticky-price DCP framework. First, despite full pass-through to export prices, the net change in export prices is much smaller than the initial depreciation. Reduced-form regressions that do not fully account for all changes in marginal cost are therefore likely to overestimate the role for price stickiness. Second, the key constraint on export output is supply, rather than demand. The expenditure-switching demand channel is as strong as under PCP, and output will increase to satisfy demand until it runs into a capacity constraint, for example, in the form of higher input costs or fixed factors of production.

Table III summarizes the responses of some of the key variables in the different models to compare to the empirical results in the next section.

3. *Varying the Share of Homogeneous DCP Exporters.* Our model assumption that all exporting firms sell more homogeneous, flexibly priced goods is a good approximation for many emerging and developing economies, as discussed in Fact 1. But evidence from advanced economies and some emerging economies is consistent with a mix of homogeneous and more differentiated exports, as shown in Figure IV. Similarly, different firms in advanced economies typically follow different pricing strategies, with different degrees of price flexibility and more than one different currency used (Amiti, Itskhoki, and Konings 2022; Corsetti, Crowley and Han 2022). Corsetti, Crowley and Han (2022) further show multiple currencies used by the same firm, even for the same product and export destination.

A corollary of the results, however, is that the implications of our model follow through as long as Facts 2 and 3 hold at the sector, firm, or even product level. That is, as long as products sold using dollars or other vehicle currencies are more homogeneous, flexibly priced goods, then the model permits a potent export channel of monetary policy operating via the exchange rate.

Importantly, the export expansion can also happen in advanced economies where there are larger shares of differentiated goods, producers have more market power, and there are greater nominal rigidities. This point is illustrated in Figure VII, which introduces a second export good into our model. We assume this is differentiated, with prices sticky in the exporting producer's currency, and with the same decreasing returns to scale parameter.[15] The figure shows impulse responses to a monetary policy shock when the steady-state share of differentiated producer currency pricing firms is 20% (red solid lines), and when it is 80% (black dashed lines).

Our calibration implies that flexible-price homogeneous good firms pricing in dollars and differentiated good PCP firms both expand exports by relatively similar amounts. Consequently, a monetary policy shock that depreciates the currency leads to a significant expansion of exports, irrespective of the share of each type of good/firm, shown in the top left panel. For flexible price goods, the intuition is as before: with highly elastic demand, the expansion occurs with only a small decrease in dollar prices (top right panel). For differentiated goods, sticky home currency prices mean most of the depreciation passes through into lower dollar prices, so despite a low elasticity, the large price reduction stimulates an export expansion.

These results may be an upper bound on the advanced economy impact, however, since they assume that all differentiated good firms price in producer currency. In practice the impact of monetary policy–induced exchange rate movements on exports will depend on the share of differentiated producers that price in either a local or dominant currency. These shares, and therefore the appropriate calibration of our model, will vary across countries and potentially over time. In Belgium, for example, Amiti,

15. We calibrate the steady-state relative size of each export sector directly and continue to assume that demand is evenly split between the United States and the rest of the world. We then set exogenous U.S. demand to achieve a target for total productivity in each sector (relative to the non-tradable sector) of two.

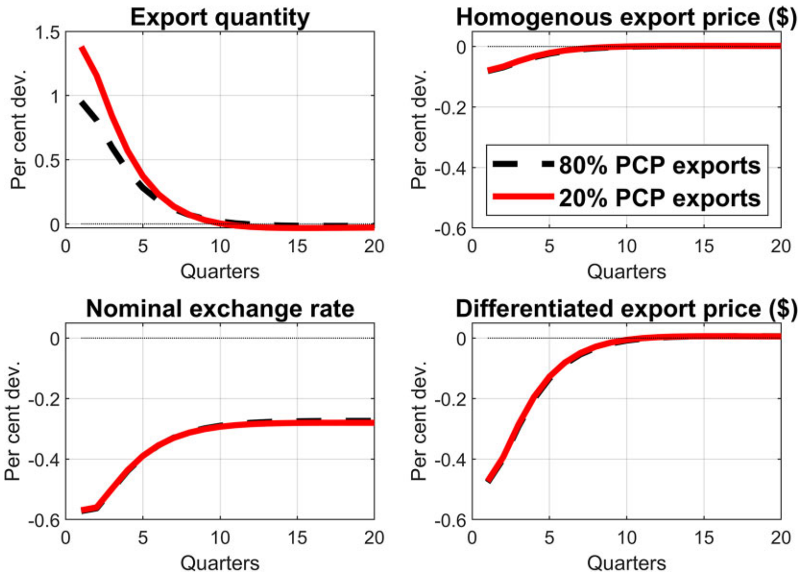

FIGURE VII

Quarterly Impulse Responses to a Home Monetary Policy Shock with Different Shares of Producer Currency and Dollar Pricing Firms

Impulse responses to a 100 basis point negative monetary policy shock. The results are generated under the calibration shown in Table II, with the addition of a second export good sector that produces a differentiated good, g_{H2}, with sticky home-currency prices, calibrated as $\delta_p^{g_{H2}} = 0.75$ and $\eta^{g_{H2}} = 2$. We label the homogeneous good as g_{H1} and set the steady-state relative size of the second export sector as either $\frac{\gamma_{HU}^{g_{H2}}}{\gamma_{HU}^{g_{H1}}} = \frac{\gamma_{HR}^{g_{H2}}}{\gamma_{HR}^{g_{H1}}} = 0.8$, or 0.2. Steady-state world demand is set exogenously to target TFP in both sectors (relative to the non-tradable sector) of two: the value is chosen to minimize the sum of the squared distance to the two productivity targets. The nominal exchange rate is shown as $\mathcal{E}_{\$H,t}^{-1}$ such that a decrease in the plotted exchange rate corresponds to a depreciation of the home currency. Aggregate export quantities are aggregate nominal exports deflated by the export price defined in equation (32).

Itskhoki, and Konings (2022) find that 37% of differentiated good exports are priced in euros, compared with 42% in dollars, and the remaining 21% in a third currency, usually a local currency.

4. *Price Flexibility.* Our model's calibration of price flexibility is also likely to be a good approximation for many developing and emerging economies, particularly those exporting commodities. For advanced economies, the evidence underlying Fact 2 sug-

gests that although more homogeneous goods and services overall have more flexible prices than differentiated goods, median price durations vary across different subcategories. For non-commodity homogeneous goods in advanced economies, price durations of up to two quarters are common.

Assuming slightly longer price durations consistent with some advanced economy observations has relatively little qualitative impact on our main results, however. Even away from the perfectly flexible limit, high elasticity and somewhat flexible prices still generate a significant export quantity response. Only once price stickiness is increased such that price durations are three quarters or longer is the export response significantly curtailed.[16]

Moreover, product-wide price flexibility can arise even when individual prices are sticky, as long as there is entry of new exporters. This will be likely as potential entrants' products will become more competitive after a depreciation. Firms opting to enter (or reenter) the market for a particular good can do so at the optimal price, free of any nominal rigidities affecting their competitors. For this reason, estimates of price flexibility using microdata are likely to represent a lower bound for the product-wide flexibility. Our model parameter represents the sum of the intensive and extensive margins of price adjustment. Bilbiie (2021) presents a model in which complete price flexibility arises from this extensive margin when there is free entry.

To summarize, we have shown how our model can be used to analyze the richer distribution of demand conditions and pricing strategies for advanced-economy exporters. Crucially, even if there are a greater number of monopolistic or sticky-price firms exporting, as long as dollar-pricing firms tend to have higher demand elasticity and more flexible prices, then dollar pricing is unlikely to have large allocative implications, relative to the PCP benchmark. (Though dollar pricing, as included in our MCP model, can help rationalize empirical findings of low pass-through to prices, in line with the empirical literature.)

IV.E. The Role of Supply Constraints

Given flexible prices, the key constraint for exporters in our model is supply. For an individual exporter, as illustrated in Section II, these constraints can be characterized by the slope of

16. See Online Appendix Figure A.2, which compares results when dollar export prices are fully flexible, to when they are fixed for two or three quarters.

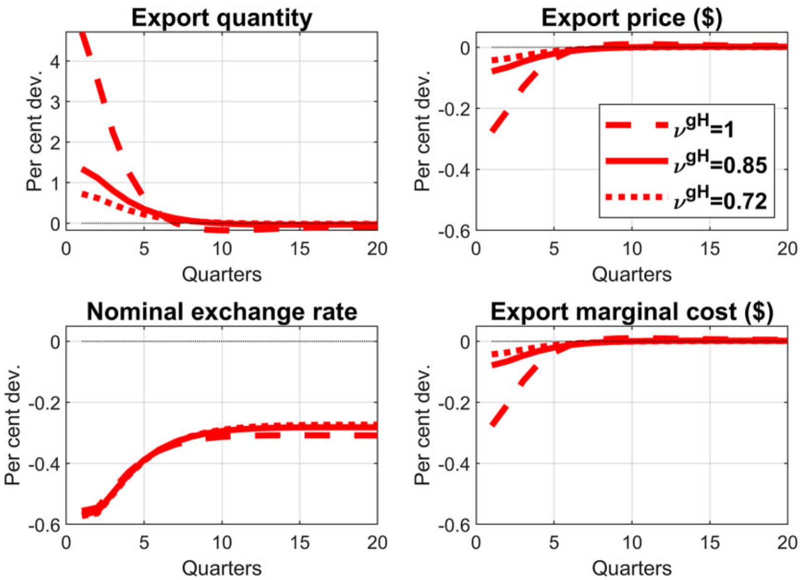

FIGURE VIII

Quarterly Impulse Responses to a Home Monetary Policy Shock Under Different Assumptions on Returns to Scale

Impulse responses to a 100 basis point negative monetary policy shock. The results are generated under the calibration shown in Table II, other than ν^{g_H}, which is varied as described. The nominal exchange rate is shown as $\mathcal{E}^{-1}_{\$H,t}$, such that a decrease in the plotted exchange rate corresponds to a depreciation of the home currency.

their marginal cost curve. Steeply upward-sloping marginal cost limits the response of exports to the exchange rate or other price movements. Here we illustrate the sensitivity of the export quantity response to the tightness of this constraint, or the effective slope of the marginal cost curve.

This is illustrated in Figure VIII, which returns to an assumption of a single export good, with fully flexible prices and elastic demand. The calibration varies the returns to scale parameter, ν^{g_H} in the exporter production function, holding all other parameters fixed. The solid line shows moderately decreasing returns to scale, in line with the calibration used in Figure VI. The dashed line instead shows constant returns to scale in production. The dotted line shows the response with sharply decreasing returns to scale, implying a steeply increasing marginal cost.

The simulations highlight the importance of this parameter in determining both the export quantity and potentially the export price response. Under constant returns to scale, a very large increase in exports occurs, since this feeds back relatively little into marginal costs. Dollar marginal costs fall owing to the depreciation, though this fall is partly offset by higher imported intermediate costs.[17] Under either decreasing returns to scale calibration, there is a further offset of the marginal cost fall from the increase in export quantities, which ultimately limits the size of the price reduction and makes for a smaller rise in exports.

Our specification and calibration for decreasing returns to scale interprets the curvature in the supply curve as coming from a fixed factor of production. But it could also come from different alternative sources of supply constraints, such as capital with adjustment costs, or the frictions associated with reallocating resources across sectors. It is also plausible that these constraints are larger in the short run and fade over time.

An additional effect present in our model is the impact of higher wages. Even with constant returns to scale for each firm or sector, as aggregate exports and output increase, this leads to higher wage inflation, driving up domestic marginal costs and offsetting part of the depreciation. With sticky wages, this is small, but as wages become more flexible, the supply constraint arising via this general equilibrium channel increases. At the limit, with fully flexible wages (and prices), dollar marginal costs do not move and the depreciation has no impact. Our simulations use a standard calibration that wages are sticky for four quarters, which implies that this effect is quantitatively small.

Our results also have implications for the literature estimating exchange rate pass-through, surveyed in Burstein and Gopinath (2014). Good measures of marginal cost are difficult to come by, so the literature typically needs to rely on proxies, if used at all. Our framework implies that doing so risks omitting an important variable that should be correlated with the exchange rate. At a minimum, researchers should be aware that reduced-form regressions seeking to calculate exchange rate "pass-through" will often combine the direct pass-through of the exchange rate movement with any indirect effect on marginal costs from an increase or decrease in export quantities.

17. Online Appendix Figure A.3 shows that our assumption of a high share of imported intermediates serves to dampen the export response to a depreciation.

V. The Empirical Effect of Exchange Rate Changes

We now conduct macroeconomic empirical tests of the model's predictions. The previous sections have shown why estimates of exchange rate pass-through into export prices cannot differentiate between sticky-price DCP models and our MCP framework. We therefore focus on the response of export quantities and activity, where DCP models predict a limited response but our MCP model allows a larger impact, determined by the response of export supply, rather than demand.

To motivate our empirical strategy, we use our model to illustrate some of the challenges in identifying the export response. These challenges are relevant for our own strategy and for many of the approaches followed in the literature to date. The first difficulty is establishing causality: the exchange rate is an endogenous variable, and its movements tend to be correlated with other determinants of exports. Because fully exogenous movements in the exchange rate are hard to find, we turn to exchange rate movements driven by identified monetary policy shocks. In doing so, we directly test our model predictions on the effect on exports of exchange rate movements caused by exogenous monetary policy innovations.

The second challenge is that these shocks may not be the source of sufficient variation in the data. We illustrate that this empirical approach relies on monetary shocks being large enough relative to other model shocks (particularly commodity prices) to successfully recover the true export response. This presents a challenge, as true monetary shocks have become smaller and less persistent in recent decades (Ramey 2016), and policy shocks may not be a major source of exchange rate variation (Itskhoki and Mukhin 2021). (Exchange rate variation might be more influenced by the systematic or endogenous part of monetary policy, rather than its shocks.) We supplement this macroeconomic test with an alternative by providing case study illustrations of large devaluations. Here, we are trading off exogeneity (the devaluations are endogenous) for shocks with larger variance.

We proceed with our empirical results in three steps, following these alternative approaches. We first use a novel panel data set for developing and emerging economies and find that identified monetary policy shocks lead to a significant response of exports, similar in size to our model results. Then we zoom in on one advanced and one emerging economy—Canada and

Chile—that export commodities and invoice prices largely in dollars. We show that our model, calibrated to match the main features of these economies, can broadly replicate the response of different types of exports (and other macroeconomic variables) to monetary policy shocks. Finally, we show that in case studies of large devaluations in three Latin American countries, exports increase markedly relative to trend. Although each approach has drawbacks individually, combined they suggest a range of macroeconomic evidence in support of our model.

V.A. Identification Challenges and Empirical Approach

To illustrate the challenges of identifying the effect of the exchange rate on exports, we simulate the MCP model in response to a set of shocks, studying whether our empirical approach can recover the true model responses.

We simulate the model with two export goods, as in Figure VII. We generate results under the calibration shown in Table II, with the addition of a second export good sector that produces a differentiated good, with sticky producer currency prices.[18] We simulate the model in response to a set of four shocks. These are (i) a home monetary policy shock, ζ_H^M; (ii) a shock to the UIP condition (13); (iii) a shock to the dollar price of the homogeneous or "commodity-like" good, $P_U^{\$}(g_{H1})$; and (iv) a shock to world demand, modeled as a simultaneous demand shock in equation (36) for the United States and the equivalent equation for the rest of the world.

We set the shock variances to broadly match equivalent statistics in the Canadian data set we use in the empirical estimates, described below. Specifically, we match the global commodity price variance to that of a Canadian commodity price index (in dollars) at a quarterly frequency. We set world demand to match the variance of linearly detrended log U.S. industrial production. We set the variance of monetary shocks equal to that of the Canadian monetary shock series of Champagne and Sekkel (2018). We calibrate the UIP shock such that the model variance of the policy rate roughly matches that of the Canadian Bank Rate in the

18. We set the steady-state share of differentiated exports in total exports to 50%, and set TFP and returns to scale to be equal to that in the homogeneous export sector (labeled g_{H1}). We set price stickiness and cross-variety elasticity for the differentiated good sector, g_{H2}, to $\delta_p^{g_{H2}} = 0.75$ and $\eta^{g_{H2}} = 2$, respectively.

data.[19] We assume that the shocks are uncorrelated and set the shock persistence to 0.9 for the two global shocks, reflecting that commodity price movements are highly persistent in the data. We set the monetary policy and UIP shock persistence to 0.3.

1. *Endogeneity of the Exchange Rate.* The simulation illustrates some of the empirical challenges in recovering the underlying export response to exchange rate changes. The high variance of commodity prices in the data leads to a positive unconditional correlation between exchange rate appreciations and exports. Increases in commodity prices (or differentiated export demand), and the associated monetary response, lead to exchange rate appreciations while simultaneously increasing export quantities.[20] This correlation blurs the underlying negative export response in the data.

2. *Identified Monetary Policy Shocks.* To side-step the endogeneity challenge, our first approach is to examine the export response to exchange rate changes caused by monetary policy shocks. To illustrate the approach, we estimate a small hybrid VAR on the same model-simulated data. The VAR is given by:

$$\mathbf{X_t} = \mathbf{c} + \mathbf{B}\mathbf{X_{t-1}} + \epsilon_{\mathbf{t}}, \tag{37}$$

with one lag, where c is a vector of constants, and the vector of observables $\mathbf{X_t} \equiv [\zeta_t^M \; \mathcal{E}_{\$H,t} \; Y_t^{g_{H2}} \; Y_t^{g_{H1}} \; Y_t]^\top$ represents, respectively, the monetary policy shock, the dollar exchange rate, differentiated exports (g_{H2}), homogeneous exports (g_{H1}), and output. To capture the challenges faced using limited samples of data, our econometrician is constrained to use a small set of variables and lags. We assume that they do possess a perfectly identified series of monetary shocks and treat the simulated model shock process, ζ_t^M, as that series. We order it first in a recursively identified VAR to recover the effects of the policy shock. The impulse responses are shown in Figure IX. The VAR point estimates are able to recover accurately the negative contemporaneous responses of both

19. The quarterly standard deviation of commodity prices in our sample is 36.4%, U.S. industrial production is 7.4%, monetary shocks an annualized 0.5 percentage points, and Bank Rate 4.3 percentage points.

20. See Online Appendix Figure A.5 for the impulse response to a commodity price shock.

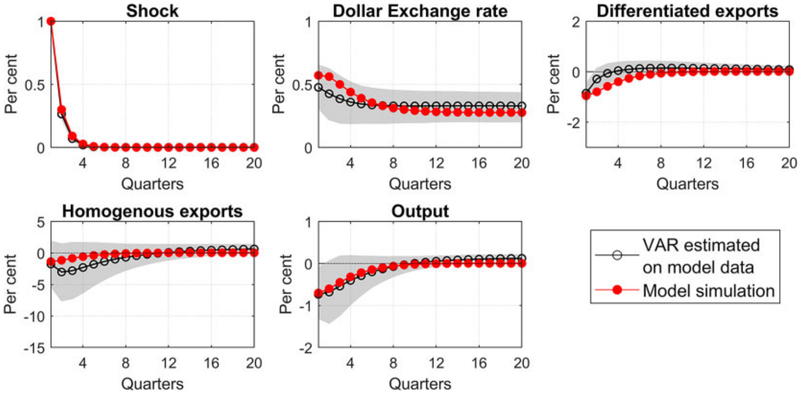

FIGURE IX

Hybrid VAR Estimated on Model Simulated Data: Impulse Responses to a Monetary Shock

Impulse responses to a 100 basis point contractionary monetary policy shock (in black with circles), estimated on model-simulated data. The shaded areas show 68% confidence intervals. The estimated VAR is described in equation (37), with one lag, with the vector of model observable variables described in the text and the monetary shock series ordered first. The model was simulated for 1,000 periods under the calibration shown in Table II, in response to the set of shocks described in the text. The true model impulse responses to a monetary shock are shown in red with filled circles. The nominal exchange rate is plotted so that an increase corresponds to an appreciation of the home currency.

types of exports to an exchange rate appreciation. They also recover the negative effect on output.

The results also illustrate the difficulties faced by this approach when there is insufficient variation in the monetary policy shock series. Compared with the responses on impact, the estimation is less successful in recovering the dynamic effects of the true model. The point estimates are also not estimated with great precision—for homogeneous good exports, zero is within the 68% confidence bands. This may be a particular issue in more recent samples, as argued by Ramey (2016). Online Appendix Figure A.6 repeats the exercise with the standard deviation of monetary policy shocks set to the (lower) value in the most recent 15 years of the series (2000 Q4 to 2015 Q3), and Online Appendix Figure A.7 does so with the standard deviation set to the (higher) value in the earliest 15 years (1974 Q2 to 1989 Q1). With a low variance of monetary shocks, our VAR estimates become highly imprecise and exhibit greater bias.

These difficulties arise despite our assumption that we could perfectly identify the monetary policy shock process. In practice, this presents an additional challenge. In our empirical tests, we use off-the-shelf shock series from the literature. But for emerging and developing economies in particular, these tend to be less readily available (e.g., there is less likely to be intraday financial market data used to construct high-frequency monetary surprise series). This motivates one of our approaches: our choice to pool across countries and estimate the response of exports to monetary policy shocks in a panel of emerging and developing economies. As an alternative approach, we examine case study illustrations of large devaluations in emerging economies in Latin America. Although these depreciations are clearly endogenous, their causes are likely to weigh independently on exports, and so are likely to bias the results away from finding a positive export response.

3. *Gravity Equations.* An alternative test of quantity responses, sometimes used in the literature, is estimated gravity-type equations. The strategy consists of regressing bilateral trade flows between two countries on (i) their bilateral exchange and (ii) the dollar exchange rate. There are issues with this strategy given the endogeneity of the exchange rates. As highlighted by Tenreyro (2007) and Gopinath et al. (2020), this makes any causal interpretation of the various exchange rate coefficients impossible.

A different complication concerns misspecification of the gravity equation. As implied by Anderson and van Wincoop (2003)'s seminal contribution, it is not possible to separately identify from bilateral gravity equations between two countries (other than the United States) the effect of one of the country's exchange rate vis-à-vis the dollar (or the currency of another third country not included in the pair). This is because the dollar exchange rate (or any third currency) will pick up a host of other omitted time and country-specific factors that are relevant determinants of bilateral trade flows. These omitted factors are the reason gravity equations typically control for country-time fixed effects. This approach is unavailable for dominant currencies, as the dollar exchange rate would be fully absorbed by these effects. Given these difficulties, we turn to our suggested approaches above—using identified monetary shocks and case studies of large depreciations.

V.B. Empirical Results

We start with approaches using identified monetary policy shocks. We study the macroeconomic effect of monetary policy shocks, focusing on exports, in a panel of developing and emerging economies. We then zoom in on two economies that are particularly useful tests of our model: Canada and Chile. Finally, we follow a complementary approach by examining case studies of large depreciations in three Latin American economies.

1. *The Effect of Exchange Rate Movements in Emerging and Developing Economies.* We use a novel panel database of 37 emerging and developing economies constructed by Brandao-Marques et al. (2021).[21] We follow the methodology in Brandao-Marques et al. (2021), which builds on Jordà (2005)'s local projection model, to study how exports and activity are affected by exogenous changes in monetary policy via the exchange rate. Specifically, monetary policy shocks are identified by purging the impact of past macroeconomic conditions, along with forecasts of future inflation and activity, on interest rate changes.[22] Monetary policy shocks are obtained as residuals $\hat{\epsilon}_{i,t}$ from an estimated interest rate rule of the form:

$$\Delta i_{i,t} = \alpha + \phi_{\pi^f} E_t \pi^f_{i,t+12} + \phi_{y^f} E_t \Delta y^f_{i,t+12} + \sum_{j=1}^{2} \phi_\pi \pi_{i,t-j}$$

$$+ \sum_{j=1}^{2} \phi_y \Delta y_{i,t-j} + \sum_{j=1}^{2} \phi_e \Delta NEER_{i,t-j} + \sum_{j=1}^{2} \phi_i i_{i,t-j} + \epsilon_{i,t}, \tag{38}$$

where α is a constant and $\pi_{i,t}$, $\Delta y_{i,t}$ and $\Delta i_{i,t}$ are, respectively, inflation, output growth, and the change in interest rate. $E_t \pi^f_{i,t+12}$ and $E_t \Delta y^f_{i,t+12}$ are the 12-month-ahead forecasts for inflation and

21. The original data set contains 38 countries with data on exports and interest rates, listed in Online Appendix Table A.1. We exclude Argentina, which is an outlier in terms of inflation rates, though we note that its exclusion does not alter the main results, as illustrated in Online Appendix Figure A.8, which shows the estimated impulse responses with Argentina in the sample.

22. The underlying assumption is that contemporaneous macroeconomic data are not available to the policy maker at the time of the policy decision; they are reported with a lag; however 12-month-ahead forecasts of future inflation and activity are available and influence policy rates.

GDP growth at time t and $\Delta NEER_{i,t}$ is the nominal effective exchange rate change.

These monetary policy shocks are by construction uncorrelated with past inflation and activity and with current forecasts of future realizations of these variables; they represent an exogenous driver of exchange rate changes. The question we are interested in assessing is whether a change in monetary policy with its associated exchange rate movement leads to a response of exports and, more generally, of activity, against the null hypothesis of no change.

To carry out this assessment, we estimate the effects of a one standard deviation monetary policy shock on a given macroeconomic variable ($z_{i,t+h}$) at each time horizon (h) using Jordà (2005)'s local projection method with country-fixed effects (μ_i^h). The estimated equation is given by:

$$z_{i,t+h} = \mu_i^h + \sum_{j=0}^{2} \gamma_j^h \hat{\epsilon}_{i,t-j} + \delta_0^h \Delta NEER_{i,t} \times \hat{\epsilon}_{i,t}$$

$$+ \sum_{j=0}^{2} \beta_j^h \times controls_{i,t-j} + \omega_{i,t}^h, \tag{39}$$

where $\omega_{i,t}^h$ captures the estimation residuals.[23] Following this estimation, we report the response functions of the key macroeconomic aggregates resulting from a contractionary standardized change in the policy impulse, $\gamma_0^h + sd(NEER) \times \delta_0^h$.

The impulse responses to these shocks, normalized so that interest rates increase by 1 percentage point on impact, are displayed in Figure X. The bottom left panel shows a sustained appreciation of the exchange rate ranging from 0.3% to 0.6% over the period. This is similar in size to the MCP model results summarized in Table III. The response of dollar exports, plotted in the top middle panel, shows a contraction that peaks (in absolute value) at just over 1.5% 11 months after the policy shock. Over the first year the average fall is 0.99%, similar to our MCP model simulation results for export quantities reported in Table III.

It is clear that the data look closer to either the MCP simulation or to PCP, where exports respond strongly to the policy-induced appreciation, in contrast to the sticky-price DCP predic-

23. Note that $\Delta NEER_{i,t}$ enters only as an interaction term with the monetary policy shock $\hat{\epsilon}_{i,t}$ and does not enter independently in the $z_{i,t+h}$ equation.

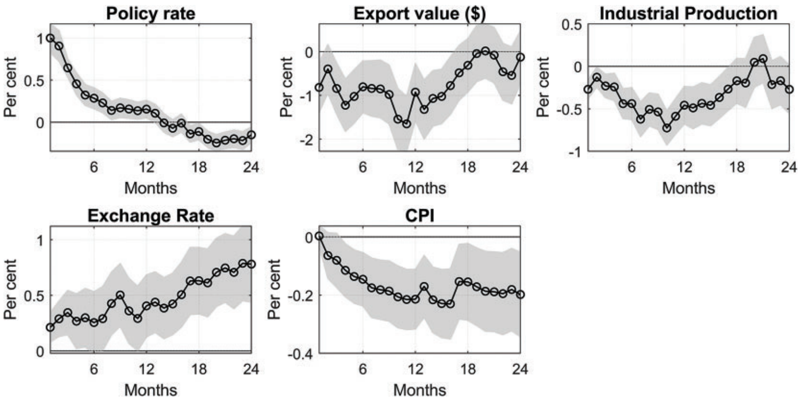

FIGURE X

Effect of a Monetary Tightening Shock on Exchange Rate, Exports, CPI, and Industrial Production in Emerging and Developing Countries

Local projections to a 1 standard deviation monetary policy tightening that appreciates the exchange rate by 1 standard deviation. Results have then been normalized so that the policy rate increases by 1 percentage point on impact. The shaded areas show 68% confidence intervals. Increase in the exchange-rate variable indicates an appreciation.

tion of almost no change in exports. Although these results are consistent with our model, they come from a range of different countries, with different export production and pricing characteristics.

2. *The Effect of Exchange Rate Movements on Commodity Exporters: Canada and Chile.* We focus on two economies where we can directly test some of our model's properties. Canada and Chile are both small open economies that are significant commodity exporters, with petroleum and related products accounting for a large share of Canadian exports, and copper playing a similar role for Chile. In each economy, both commodity and non-commodity export goods are priced largely in dollars.[24]

Chile is a typical example of an emerging market for which our model's main microeconomic assumptions are likely to hold. Even its non-copper manufacturing exports consist of commodity-like, homogeneous goods, such as processed food. Canada, by

24. In the data set used in Table I, the average share of dollar denominated exports is 70% for Canada and 94% for Chile.

contrast, is an outlier relative to the evidence presented in Table I. Given its proximity to and trading relationships with the United States, the majority of its exports have been to the United States. In aggregate, dollar pricing is therefore more prevalent, even for differentiated products, than is the case for the average economy in the world.[25] As a result, Canada is a unique example of an economy with a large subset of dollar exports that are more differentiated.

We estimate impulse responses to monetary shocks in each economy, using externally identified policy-shock series. We compare these responses to our model-simulated responses, with the model calibrated to match key aspects of the Canadian and Chilean economies. In particular we assume that there are three production goods in each economy: a non-tradable good (g_N), which we think of as services and is consumed at home along with imported goods, and two export-only goods, both priced in dollars. One good is a commodity (g_{H1}), and one is more differentiated (g_{H2}), representing non-commodity good exports (e.g., manufacturing).

The full set of parameters that we calibrate differently for each economy is shown in Table IV. We match the import share in home consumption to estimates of the share of imports in CPI or consumption in each economy.[26] We set the share of the commodity export in total exports to the share of primary products in total goods exports. Both values are higher in Chile than in Canada. As before, we set the cross-variety elasticity of commodities to 17. For the other export-good elasticity, we set this to around eight for Chile, matching mean microeconomic (five-digit SITC level) estimates for food between 1990 and 2001 in Broda and Weinstein (2006), and to five for Canada, representing chemicals exports, calibrated using the same data set.[27] For the returns to scale parameter, where our calibration is most uncertain, we use the same value in both economies. We maintain our previous calibration for the commodity sector, based on the structures share in

25. For non-U.S. imports to Canada, Goldberg and Tille (2008) find that differentiated products are less likely to be priced in vehicle currencies. We conjecture that this is also likely to be the case for non-U.S. exports from Canada.

26. From Savoie-Chabot and Khan (2015) for Canada and Naudon and Vial (2016) for Chile.

27. We focus on chemicals because this is the only differentiated good category for which Canada was a net exporter over our sample.

TABLE IV
CANADA AND CHILE MODEL CALIBRATIONS

Parameter	Description	Canada	Chile	Notes
Demand				
κ_M	Import/tradable share in consumption	0.25	0.4	Matches import share
η^{g_1}	Commodity cross-variety elasticity	17	17	Petroleum (Canada); copper (Chile)
η^{g_2}	Other export cross-variety elasticity	4.94	8.04	Chemicals (Canada); food (Chile)
$\frac{\gamma_{HU}^{gH1}}{\gamma_{HU}^{gH1}+\gamma_{HU}^{gH2}}$	Share of commodity in total exports	0.38	0.62	Primary exports/goods exports
Supply				
ν^{gN}	Commodity returns to scale	0.853	0.853	From mining structures/Canadian VA
ν^{gH2}	Other export returns to scale	0.935	0.935	From chemicals structures/Canadian VA
$\frac{Y^{gH1}/L^{gH1}}{Y^{gN}/L^{gN}}$	SS relative TFP, commodity	2.49	4.87	Target of 5
$\frac{Y^{gH2}/L^{gH2}}{Y^{gN}/L^{gN}}$	SS relative TFP, other exports	2.91	2.47	Target of 2
δ_p^{gH1}	Commodity price rigidity	0	0	Flexible prices
δ_p^{gH2}	Other export price rigidity	0.5	0.5	Two quarter price duration
Monetary policy				
ρ_M	Monetary policy shock persistence	0.6	0.1	Chosen to mimic ER dynamics

Notes. SS denotes steady-state; TFP denotes total factor productivity; VA denotes value-added; ER denotes exchange rate.

value-added for the Canadian mining sector. For the other export sector, we set this parameter to 0.935, based on the equivalent for the Canadian chemicals (and plastics) manufacturing sector. We assume commodity prices are fully flexible, that the non-tradable price rigidity parameter is 0.75, and that the other export good rigidity parameter is at an intermediate value of 0.5, consistent with the intermediate cross-variety elasticities for these goods.

We compare the model simulations with the estimated responses to identified monetary policy shocks for each economy. For Canada, we use the shock series of Champagne and Sekkel (2018), which uses a narrative identification strategy: supplementing estimated interest rate rule equations with real-time central bank forecasts for 1974–2015. For Chile, there is no comparable long time series of shocks readily available, so we use the estimated Chile shocks from Brandao-Marques et al. (2021) for 2003–2017.

For each economy, we estimate the VAR:

$$\mathbf{X_t} = \mathbf{c} + \delta t + \mathbf{B(L)X_{t-1}} + \mathbf{C(L)W_{t-1}} + \boldsymbol{\epsilon}_\mathbf{t}, \tag{40}$$

where $B(L)$ and $C(L)$ are lag polynomials, c is a constant vector, δ is the coefficient on a time trend, and $\mathbf{X_t}$ is the vector of observables. For Canada only, $\mathbf{W_t}$ is the U.S. dollar price of Canadian commodities, which we assume is exogenous, in line with the small open economy literature. We identify the effect of monetary policy shocks by ordering our shock series first in a recursive VAR. We use slightly different sets of observables for each economy, motivated largely by data availability. We also follow Champagne and Sekkel (2018) for Canada by using their cumulated shock series in place of Bank Rate in the VAR, whereas for Chile we use the raw shocks, with the policy rate as an additional observable.[28]

The estimated impulse responses to monetary shocks are compared with our model-simulated results in Figure XI (for Canada) and Figure XII (for Chile). The figures show the responses of those variables with close model analogues, and the model responses are scaled to match the average estimated ex-

28. Online Appendix Figures A.10–A.17 vary the assumptions on sample period, lag length, variables included, and shock ordering for Canada; Online Appendix Figures A.19–A.25 vary the assumptions on lag length, variables included, and shock ordering for Chile. (The small sample for our Chile shock series precludes examining subsamples).

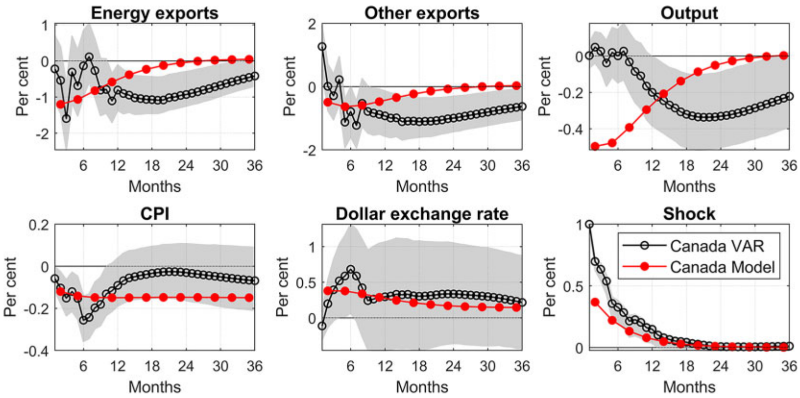

FIGURE XI

Model Simulation Results Compared with Canada Hybrid VAR Estimates

Impulse responses to a contractionary monetary policy shock (in black open circles), estimated on monthly Canadian data from January 1981 to October 2015. The estimated VAR is described in equation (40), with six lags. The shaded areas show 68% confidence intervals. It contains the endogenous variables (ordered first to last): cumulative monetary shock series, Canada-U.S. exchange rate (plotted so that an increase is an appreciation of the Canadian dollar) rate, CPI, GDP, chemicals exports, energy exports, and (not shown) machinery exports and chemicals, energy, and machinery imports. It also contains six lags of a U.S. dollar commodity index as exogenous variables. The red lines with solid circle markers show model impulse responses to a contractionary monetary policy shock in the MCP model with two export goods, both priced in dollars, calibrated according to values for Canada in Table IV (or Table II for all other parameters).

change rate responses over the first six months.[29] We also reduce the persistence of the Chilean monetary shock to better match this exchange rate response.

For both economies, our baseline empirical results show economically and statistically significant declines of CPI, output, and exports in response to a monetary policy tightening that induces an exchange rate appreciation. Moreover, the MCP model is able to broadly replicate these responses, as well as the differential scale and timing of different export types.

For Canada, shown in Figure XI, a 1 percentage point monetary tightening leads to an appreciation against the U.S. dollar of around 0.5%, and a CPI and GDP fall. Energy exports fall by a peak of just over 1.5% occurring after three months, with chem-

29. Online Appendix Figure A.9 shows the full set of responses for Canada; Online Appendix Figure A.18 shows all responses for Chile.

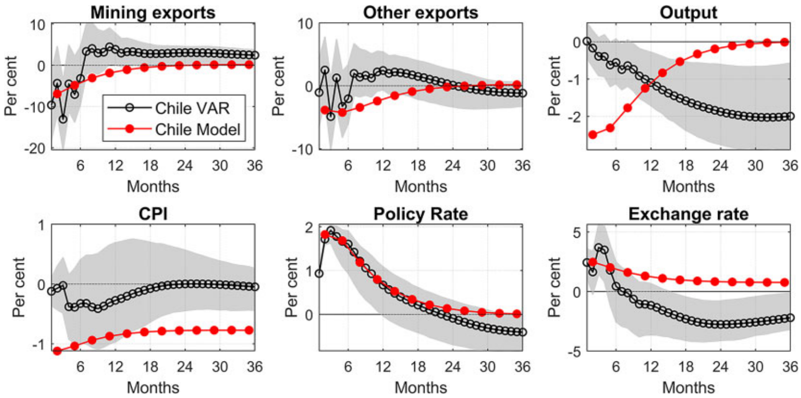

FIGURE XII

Model Simulation Results Compared with Chile Hybrid VAR Estimates

Impulse responses to a contractionary monetary policy shock (in black open circles), estimated on monthly Chilean data from April 2003 to July 2017. The estimated VAR is described in equation (40), with four lags. The shaded areas show 68% confidence intervals. It contains the endogenous variables (ordered first to last): monetary shock series (not shown); multilateral exchange rate (plotted so that an increase is an appreciation of the Chilean peso), policy rate, CPI, non-mining IMACEC (output), mining IMACEC (not shown), manufacturing (other) exports and mining exports. The red lines with solid circle markers show model impulse responses to a contractionary monetary policy shock in the MCP model with two export goods, both priced in dollars, calibrated according to values for Chile in Table IV (or Table II for all other parameters).

icals exports declining by a peak of over 1% after seven months. Our model can replicate the scale of these falls, with a larger decline for energy exports, given a higher demand elasticity calibration. By incorporating our evidence that higher elasticities are associated with greater price flexibility, the model can also replicate the faster effect on energy exports, although the simulated responses unwind more quickly for both goods. The model also matches the size of the effects on CPI and output. The speed of the output response in the model is faster than the data suggest, reflecting that we have not incorporated some of the features common in larger-scale dynamic stochastic general equilibrium models that lead to slower output dynamics.

The differences between the responses of energy exports and chemical exports are consistent with some of the key implications of the MCP model. First, unless subject to steep supply curves, more flexibly priced, homogeneous-good exports should respond strongly to exchange rate movements, even if priced in dollars.

Second, even more differentiated goods may still show economically significant responses, either because they are priced in producer currency, or, as in our model simulation here, because they still exhibit moderate amounts of price flexibility and elasticity.[30]

For Chile, shown in Figure XII, a 1 percentage point monetary policy shock leads to a further endogenous interest rate increase to a total of around 2 percentage points and a larger but less persistent appreciation, peaking at nearly 4%. CPI falls, though not significantly, and non-mining activity falls gradually. Mining exports fall sharply on impact, by around 10%, while manufacturing exports, though volatile, also fall during the first six months (by an average of 1.25%). Again, our model is able to broadly match the relative effects, with a higher elasticity and greater price flexibility in the mining sector implying a larger fall in exports, despite the steeper supply curve implied by the returns to scale parameterization. The model somewhat overstates the CPI and manufacturing export falls, which could reflect the relatively simple production structure in the model, or biases in the estimated responses.

These simulations show that the MCP model, calibrated to match two different small open economies, can replicate the empirical responses to monetary policy shocks seen in the data. The empirical results are also consistent with the key feature of the MCP model, that exports (particularly of more homogeneous goods) can respond materially to exchange rate movements.

While encouraging for the MCP model, our empirical results are still subject to many of the challenges set out already. They rely on the identification of the monetary shock series used in each case, and the magnitudes and significance of the responses are sensitive to the precise specifications. One particular issue is that the exchange rate responses to the monetary shocks tend not to be both large and persistent, consistent with these shocks not being the major driver of exchange rate movements. Although this is not a challenge to our main findings, it does present a challenge to using monetary policy shocks to explore the response

30. For some other differentiated exports, we do not always find significant falls in response to tightening monetary policy shocks. In particular, for auto exports, there is actually a significant increase in response to an appreciation (see Online Appendix Figure A.14). The lack of a negative response could be because these goods better match the sticky-price DCP model, or could be owing to steeper supply curves. But neither feature would explain a significant positive response.

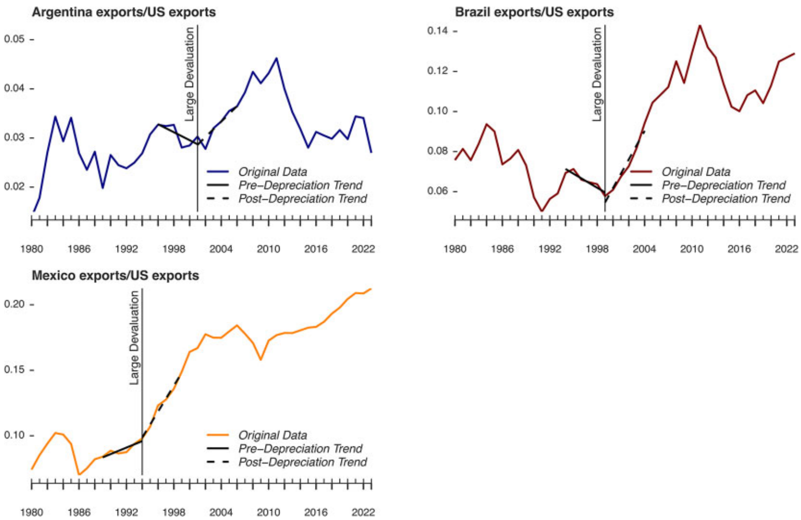

FIGURE XIII

Exports Before and After Large Devaluations: Argentina, Brazil, and Mexico

Data are annual and devaluations are dated as 1994 for Mexico, 1999 for Brazil, and 2001 for Argentina. To control for global trends in exports, total exports by each of the three countries are expressed relative to U.S. total exports. Trend lines correspond to the five years before and after the devaluation start dates in each country.

of exports to exchange rates. This motivates our final macroeconomic test, examining large devaluations.

3. *Large Devaluations and Exports.* Figure XIII displays the behavior of annual exports before and after three large devaluation episodes: Argentina in December 2001, Brazil in December 1999, and Mexico in November 1994. In Argentina, the depreciation, measured as the cumulative exchange rate increase (local currency per dollar) six months after the beginning of the devaluation (December 2001) reached 130%; in Brazil, the corresponding cumulative exchange rate increase reached 40%; and in Mexico, it reached 50%. The vertical lines in the plots show the dates of the depreciation. To control for global trends in trade flows, exports (in dollars) in each country are normalized by total exports (also in dollars) by the United States. (Normalizing by global exports yields a similar picture.)

The plots show a visible change in export trends, with (normalized) exports growing rapidly after the sharp devaluations, having previously been falling or growing slowly. Given that exchange rate devaluations typically take place in downturns, when exports tend to be weak, arguably a positive response of exports (relative to trend) provides a lower bound for the export impact of devaluations.

Combined with our empirical results from identified monetary policy shocks, we take these findings as robust evidence that exports can respond strongly to exchange rate movements, even when dollar pricing is prevalent. Connecting this finding with one of the key motivating observations of the DCP framework—the lack of measured pass-through of exchange rate changes—helps us choose our MCP model ahead of PCP and DCP. Crucially, in our model, as in PCP, there can exist an important role for exports in the monetary transmission mechanism.

We have presented different tests exploiting exogenous policy shocks and large endogenous devaluations to distinguish between our MCP model and the sticky-price DCP framework. Although each test has drawbacks, we think that combined, they present robust evidence in favor of our framework. We suggest that they are better suited to comparing models than alternatives proposed in the literature.

VI. Concluding Remarks

Recent policy and academic work has highlighted the importance of dollar pricing in international trade, particularly in emerging and developing economies. But policy conclusions from existing DCP models also rely on two further premises: monopoly power and sticky dollar prices in export markets. These assumptions seem at odds with the experience of firms that choose to price in dollars, many of whom export commodities, or “commodity-like” homogeneous goods, whose prices tend to be flexible.

We present a more general MCP framework, which allows greater global competition and price flexibility for some goods, while retaining the assumptions of monopoly power and nominal rigidities for others. Our model can therefore capture the salient features of dollar pricing, including the microeconomic evidence on price flexibility and demand elasticities, as well as the use of imported intermediates. The analysis calibrates the model to be consistent with the evidence from many emerging and developing economies that are flexible price takers in export markets, with sticky-price monopolistic competition for imports and nontradables.

The results highlight that these assumptions lead to limited observed exchange rate pass-through—as in the data—even though export prices are flexible. Importantly, export quantities can still react strongly to exchange rate movements in our setting, restoring the policy implications of classic PCP models. Identifying the effect of exchange rate movements on exports therefore provides an additional macroeconomic test of the framework, differentiating it from sticky-price DCP models.

We carry out a range of empirical tests using different data sets and methods. We find evidence consistent with our model and with significant responses of exports to exchange rate movements. Overall, our results suggest that monetary policy and the exchange rate can continue to be effective stabilization tools, even in a world of dollar dominance. The policy implications of dollar pricing may need to be reassessed.

Supplementary Material

An Online Appendix for this article can be found at *The Quarterly Journal of Economics* online.

Data Availability

The data underlying this article are available in the Harvard Dataverse, https://doi.org/10.7910/DVN/SASVME (McLeay and Tenreyro 2025).

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