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Dominant Currency Paradigm*

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Abstract

We propose a 'dominant currency paradigm' with three key features: dominant currency pricing, pricing complementarities, and imported inputs in production. We test this paradigm using a new data set of bilateral price and volume indices for more than 2,500 country pairs that covers 91% of world trade, as well as detailed firm-product-country data for Colombian exports and imports. In strong support of the paradigm we find that: (1) Non-commodities terms of trade are uncorrelated with exchange rates. (2) The dollar exchange rate quantitatively dominates the bilateral exchange rate in price pass-through and trade elasticity regressions, and this effect is increasing in the share of imports invoiced in dollars. (3) U.S. import volumes are significantly less sensitive to bilateral exchange rates, compared to other countries' imports. (4) A 1% U.S. dollar appreciation against all other currencies predicts a 0.6% decline within a year in the volume of total trade between countries in the rest of the world, controlling for the global business cycle. We characterize the transmission of, and spillovers from, monetary policy shocks in this environment.

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1 Introduction

Nominal exchange rates have always been at the center of fierce economic and political debates on spillovers, currency wars, and competitiveness. It is easy to understand why: in the presence of price rigidities, nominal exchange rate fluctuations are associated with fluctuations in relative prices and therefore have consequences for real variables such as the trade balance, consumption, and output.

The relationship between nominal exchange rate fluctuations and other nominal and real variables depends critically on the currency in which prices are rigid. The first generation of New Keynesian (NK) models, the leading paradigm in international macroeconomics, assumes prices are sticky in the currency of the producing country. Under this 'producer currency pricing' paradigm (PCP), the law of one price holds and a nominal depreciation raises the price of imports relative to exports (the terms-of-trade) thus improving competitiveness. This paradigm was developed in the seminal contributions of Mundell (1963) and Fleming (1962), Svensson and van Wijnbergen (1989), and Obstfeld and Rogoff (1995).

There is, however, pervasive evidence that the law of one price fails to hold. Out of this observation grew a second pricing paradigm. In the original works of Betts and Devereux (2000) and Devereux and Engel (2003), prices are instead assumed to be sticky in the currency of the destination market. Under this 'local currency pricing' paradigm (LCP), a nominal depreciation lowers the price of imports relative to exports, a decline in the terms-of-trade, thus worsening competitiveness. Both paradigms have been extensively studied in the literature and are surveyed in Corsetti et al. (2010).

Recent empirical work on the currency of invoicing of international prices questions the validity of both approaches. Firstly, there is very little evidence that the best description of pricing in international markets follows either PCP or LCP. Instead, the vast majority of trade is invoiced in a small number of 'dominant currencies,' with the U.S. dollar playing an outsized role. This is documented in Goldberg and Tille (2008) and in Gopinath (2015). Secondly, exporters price in markets characterized by strategic complementarities in pricing that give rise to variations in desired mark-ups.[1] Thirdly,

[1] Burstein and Gopinath (2014) survey the evidence on variable mark-ups.

most exporting firms employ imported inputs in production, reducing the value added content of exports.[2] The workhorse NK models in the literature *à la* Galí and Monacelli (2005) instead assume constant demand elasticity and/or abstract from intermediate inputs.

Based on these observations, this paper proposes an alternative: the 'dominant currency paradigm' (DCP). Under DCP, firms set export prices in a dominant currency (most often the dollar) and change them infrequently. They face strategic complementarities in pricing, and there is roundabout production using domestic and foreign inputs. We then test this paradigm using a newly constructed data set of bilateral price and volume indices for more than 2,500 country pairs that covers 91% of world trade, and a firm level database of the universe of Colombian exports and imports.

According to DCP, the following should hold true: First, at both short and medium horizons the terms-of-trade should be insensitive to exchange rate fluctuations. Second, for non-U.S. countries exchange rate pass-through into import prices (in home currency) should be high and driven by the dollar exchange rate as opposed to the bilateral exchange rate. For the U.S., on the contrary, pass-through into import prices should be low. Third, for non-U.S. countries, import quantities should be driven by the dollar exchange rate as opposed to the bilateral exchange rate. In addition, U.S. import quantities should be less responsive to dollar exchange rate movements as compared to non-U.S. countries. Fourth, when the dollar appreciates uniformly against all other currencies, it should lead to a decline in trade between countries in the rest of the world (i.e. *excluding the U.S.*).

The stability of the terms-of-trade under DCP follows from the pricing of imports and exports in a common currency and the low sensitivity of these prices to ER fluctuations. This contrasts with the predictions of the PCP and LCP paradigms. Under PCP (LCP) the terms-of-trade depreciates (appreciates) almost one-to-one with the exchange rate as the price of imports rise (is stable) alongside stable (rising) export prices, in home currency. It also differs from predictions of models with flexible

[2]The fact that most exporters are also importers is well documented. See Bernard et al. (2009), Kugler and Verhoogen (2009), Manova and Zhang (2009) among others. This is also reflected in the fact that value added exports are significantly lower than gross exports, particularly for manufacturing, as documented in Johnson (2014) and Johnson and Noguera (2012). Amiti et al. (2014) present empirical evidence of the influence of strategic complementarities in pricing and of imported inputs on pricing decisions of Belgian firms.

prices and strategic complementarities in pricing such as Atkeson and Burstein (2008) and Itskhoki and Mukhin (2017). Unlike these models, the terms-of-trade stability under DCP is associated with volatile movements of the relative price of imported to domestic goods for non-dominant (currency) countries. Furthermore, this volatility is driven by fluctuations in the value of the country's currency relative to the dominant currency, regardless of the country of origin of the imported goods. Consequently, demand for imports depends on the value of a country's currency relative to the dominant currency. When a country's currency depreciates relative to the dominant currency, all else equal, it reduces its demand for imports from *all* countries.

In the case of exports, in contrast to PCP, which associates exchange rate depreciations with increases in quantities exported (controlling for demand), DCP predicts a negligible impact on goods exported to the dominant-currency destination. For exporting firms whose dominant currency prices are unchanged there is no increase in exports. For those firms changing prices the rise in marginal cost following the rise in the price of imported inputs and the complementarities in pricing dampen their incentive to reduce prices, leaving exports mostly unchanged. The impact on exports to non-dominant currency destinations depends on the fluctuations of the exchange rate of the destination country currency with the dominant currency. If the exchange rate is stable then DCP predicts a weak impact on exports to non-dollar destinations. On the other hand, if the destination country currency weakens (strengthens) relative to the dominant currency it can lead to a decline (increase) in exports.

Fluctuations in the value of dominant currencies can also have implications for cyclical fluctuations in global trade (the sum of exports and imports). Under DCP, a strengthening of dominant currencies relative to non-dominant ones is associated with a decline in imports across the periphery without a significant increase in exports to dominant currency markets, thus negatively impacting global trade. In contrast, in the case of PCP, the rise in competitiveness for the periphery generates an increase in exports. Moreover, the increase in exports dampens the decline in imports as production relies on imported intermediate inputs. In the case of LCP, both the import and export response is muted so the impact on global trade is weak.

We further demonstrate numerically that the different paradigms lead to contrasting implications for the transmission of monetary policy shocks within and across countries. With a Taylor rule, the inflation-output trade-off in response to a monetary policy (MP) shock for a non-dominant currency worsens under DCP relative to PCP. That is, a monetary policy rate cut raises inflation by much more than it increases output, as compared to PCP. Further, under DCP, contractionary MP shocks in the dominant country have strong spillovers to MP in the rest-of-the world and reduce rest-of-world and global trade, while MP shocks in non-dominant currency countries generate only weak spillovers and have little impact on world trade.

Our empirical findings strongly support the predictions of DCP. Using the global database of bilateral trade price and volume indices we show the following. First, a regression of the bilateral non-commodities terms of trade on changes in the bilateral exchange rate yields a contemporaneous coefficient on the exchange rate of 0.037, with a 95% confidence interval $[0.02, 0.05]$, consistent with DCP. For comparison, the coefficient should be close to 1 under PCP and to -1 under LCP.

For our second finding, we estimate exchange rate pass-through and trade elasticity regressions at the country-pair level. We first follow standard practice and estimate the pass-through of *bilateral* exchange rates into import prices and volumes.[3] We document that when country j's currency depreciates relative to country i by 10%, import prices in country j for goods imported from country i rise by 8%, suggestive of close to complete pass-through at the one year horizon. However, adding the *U.S. dollar* exchange rate as an additional explanatory variable and controlling for the global business cycle with time fixed-effects knocks the coefficient on the bilateral exchange rate from 0.76 down to 0.16. The coefficient on the dollar exchange rate of 0.78 largely dominates that of the bilateral exchange rate. Moreover, the magnitude of the dollar pass-through is systematically related to the dollar invoicing shares of countries. Specifically, increasing the dollar invoicing share by 10

[3]This follows naturally from the classic Mundell-Fleming paradigm, according to which the price an importing country faces (when expressed in the importing country's currency) fluctuates closely with the bilateral exchange rate. Accordingly, studies of exchange rate pass-through focus on trade-weighted or bilateral exchange rate changes (Goldberg and Knetter, 1997; Burstein and Gopinath, 2014).

percentage points causes the contemporaneous dollar pass-through to increase by 3.5 percentage points. Similar to the price regressions, adding the U.S. dollar exchange rate to a bilateral volume forecasting regression knocks down the coefficient on the bilateral exchange rate by a substantial amount. The contemporaneous volume elasticity for the dollar exchange rate is -0.19, while the elasticity for the bilateral exchange rate is an order of magnitude smaller at -0.03.

These pass-through estimates point to a potential misspecification in the standard pass-through regressions that ignore the role of the dollar. We also show that the dollar's role as an invoicing currency is indeed special, as it handily beats the explanatory power of the euro in price and volume regressions. The data is also consistent with an additional key prediction of the dominant currency paradigm: U.S. import prices and volumes are significantly less sensitive to the exchange rate, as compared to other countries' imports.

Third, we demonstrate empirically that the strength of the U.S. dollar is a key predictor of rest-of-world (i.e. excluding the U.S.) trade volume and inflation, again controlling for measures of the global business cycle. We find that a 1% appreciation of the U.S. dollar relative to all other currencies is associated with a 0.6% contraction in rest-of-world aggregate import volume within the year. Furthermore, countries with larger dollar import invoicing shares experience higher pass-through of the dollar exchange rate into consumer and producer price inflation.

The global database has the advantage of covering almost all of world trade, but it is not at the firm level and is only available at an annual frequency. We demonstrate that all our aggregate findings hold also when we use firm-level data from Colombia, a small open economy that is representative of emerging markets in its heavy reliance on dollar invoicing with 98% of exports invoiced in dollars. Using prices and quantities defined at the firm-10-digit product-country (origin or destination)-quarter (or year) level for manufactured goods (excluding petrochemical and basic metal industries), we confirm that the U.S. dollar exchange rate knocks down the bilateral exchange rate for price pass through and trade elasticity of exports and imports to/from non-dollarized economies. Further, we demonstrate that DCP is able to match the dynamics of price pass-through.

To further contrast the different pricing paradigms, we simulate a model economy that is subject to commodity price shocks, productivity shocks, and third country exchange rate shocks, all calibrated to Colombia, and test its ability to match the data. Using a combination of calibration and estimation, we document that the data strongly rejects PCP and LCP in favor of DCP. We demonstrate that all features of DCP matter for quantitatively matching the facts, including strategic complementarities in pricing and imported input use. Under our benchmark DCP specification we find, in line with the data, the export pass-through at four quarters to both dollar and non-dollar destinations to be 65%. Instead, when we shut down strategic complementarities and imported input use, the predicted pass-through declines by half to 30%.

Related literature. Our paper is related to a relatively small literature that models dollar pricing. These include Corsetti and Pesenti (2005), Goldberg and Tille (2008), Goldberg and Tille (2009), Devereux et al. (2007), Cook and Devereux (2006) and Canzoneri et al. (2013). All of these models, with the exception of Canzoneri et al. (2013), are effectively static with one-period-ahead price stickiness. Unlike Canzoneri et al. (2013), we explore a three region world, which is crucial to analyze differences between dominant and non-dominant currencies. Goldberg and Tille (2009) explore three regions but in a static environment. In addition, the dollar pricing literature assumes constant desired mark-ups and production functions that use only labor.

Our contribution to this literature is two-fold. Firstly, we develop a new Keynesian open economy model that combines dynamic dominant currency pricing, variable mark-ups and imported input use in production. We develop testable implications and demonstrate the differential transmission of monetary policy shocks across countries. Secondly, we empirically evaluate the dominant currency paradigm using two novel databases described previously.

Our empirical evidence on the terms of trade is related to Obstfeld and Rogoff (2000), who conduct one of the earliest tests of the Mundell-Fleming paradigm against the Betts-Devereux-Engel paradigm. Obstfeld and Rogoff (2000) examine the correlation between *country*-level terms of trade and the trade-weighted exchange rate for 21 countries, using quarterly data for 1982-1998. They report an average correlation of 0.26, which they interpret as a rejection of local currency pricing. Even though the correlation is well less than 1, which would lend weak support for producer currency pricing, they conjecture that the low correlation could be because of the construction of the trade-weighted exchange rates and/or because their terms of trade measures include commodity prices. With the help of our globally representative data set, we improve upon Obstfeld and Rogoff (2000) in several dimensions. Specifically, we examine the *bilateral* terms of trade, excluding commodity prices and we estimate pass-through coefficients as opposed to correlations. Moreover, we test additional predictions of the different pricing paradigms.

Our exchange rate pass-through analysis is among the first to exploit a globally representative data set on bilateral trade volumes and values. To our knowledge, the only other work that utilizes a similarly rich data set is Bussière et al. (2016), who analyze trade prices and quantities at the product level.[4]

The remaining literature on exchange rate pass-through falls into two main camps. First, many papers use unilateral (i.e., country-level) time series, which limits the ability to analyze cross-sectional heterogeneity and necessitates the use of trade-weighted rather than truly bilateral exchange rates (e.g., Leigh et al., 2015). Second, a recent literature estimates pass-through of bilateral exchange rates into product-level prices, as opposed to unit values, but these micro data sets are available for only a few countries (see the review by Burstein and Gopinath, 2014).

The evidence on asymmetric responses of the volume of exports and imports is consistent with that documented by Alessandria et al. (2013) for exports and Gopinath and Neiman (2014) for imports.[5]

[4]The goal of that paper is to quantify the elasticity of prices and quantities to the bilateral exchange rate and check if Marshall-Lerner conditions hold. In contrast, our goal is to empirically evaluate the predictions of the various pricing paradigms and in the process highlight the dollar's central role in global trade.

[5]The typical explanations for the sluggish export response relies on quantity frictions arising from sunk or search costs under PCP. DCP, consistent with the data, predicts that such relative prices are stable and therefore, does not require quantity frictions in the short-term to generate slow adjustments in exports.

Outline. Section 2 presents the DCP model, proposes testable implications, and contrasts the transmission of monetary policy shocks across pricing paradigms. Section 3 empirically tests the implications derived in Section 2 using the global database. Section 4 tests and estimates the model using the Colombian micro data. Section 5 concludes.

2 Model

Consider an economy j that trades goods and assets with the rest of the world. The nominal bilateral exchange rate between country j and another country i is denoted $\mathcal{E}_{ij}$, expressed as the price of currency i in terms of currency j. We assume that the U.S. dollar is the dominant currency and let $\mathcal{E}_{\$j}$ denote the price of a U.S. dollar in currency j. An increase in $\mathcal{E}_{ij}$ (resp. $\mathcal{E}_{\$j}$) represents a depreciation of country j's currency against that of country i (resp. the dollar).

As in the canonical open economy framework of Galí (2008), firms adjust prices infrequently *à la* Calvo. However, we depart from Galí (2008) along four dimensions. First, we nest three different pricing paradigms: producer currency pricing, local currency pricing as well as dominant currency pricing. Second, the production function uses not just labor but also intermediate inputs produced domestically and abroad. Third, we allow for strategic complementarity in pricing that gives rise to variable, as opposed to constant, mark-ups. Last, international asset markets are incomplete with only risk-less bonds being traded, while Galí (2008) assumes complete markets. We describe the details below.

2.1 Households

Country j is populated with a continuum of symmetric households of measure one. In each period household h consumes a bundle of traded goods $C_{j,t}(h)$. Each household also sets a wage rate $W_{j,t}(h)$ and supplies an individual variety of labor $N_{j,t}(h)$ in order to satisfy demand at this wage rate. Households own all domestic firms. To simplify exposition we omit the indexation of households when possible. The per-period utility function is separable in consumption and labor and given by,

$$U(C_{j,t}, N_{j,t}) = \frac{1}{1-\sigma_c} C_{j,t}^{1-\sigma_c} - \frac{\kappa}{1+\varphi} N_{j,t}^{1+\varphi} \tag{1}$$

where $\sigma_c > 0$ is the household's coefficient of relative risk aversion, $\varphi > 0$ is the inverse of the Frisch elasticity of labor supply and κ scales the disutility of labor.

The consumption aggregator $C_{j,t}$ is implicitly defined by a Kimball (1995) homothetic demand aggregator:

$$\sum_i \frac{1}{|\Omega_i|} \int_{\omega \in \Omega_i} \gamma_{ij} \Upsilon \left(\frac{|\Omega_i| C_{ij,t}(\omega)}{\gamma_{ij} C_{j,t}} \right) d\omega = 1. \tag{2}$$

In Eq. (2), $C_{ij,t}(\omega)$ represents the consumption by households in country j of variety ω produced by country i at time t. γ_{ij} is a set of preference weights that captures home consumption bias in country j, with $\sum_i \gamma_{ij} = 1$, while $|\Omega_i|$ is the measure of varieties produced in country i. The function $\Upsilon(.)$ satisfies the constraints $\Upsilon(1) = 1$, $\Upsilon'(.) > 0$ and $\Upsilon''(.) < 0$. As is well-known, this demand structure gives rise to strategic complementarities in pricing and variable mark-ups. It captures the classic Dornbusch (1987) and Krugman (1987) channel of variable mark-ups and pricing-to-market as described below.

Households in country j solve the following dynamic optimization problem,

$$\max_{C_{j,t}, W_{j,t}, B_{\$j,t+1}, B_{j,t+1}(s')} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_{j,t}, N_{j,t}), \tag{3}$$

where $\mathbb{E}_t$ denotes expectations conditional on information available at time t, subject to the per-period budget constraint expressed in home currency,

$$\begin{aligned} P_{j,t}C_{j,t} + \mathcal{E}_{\$j,t}(1+i^{\$}_{j,t-1})B^{\$}_{j,t} + B_{j,t} &= W_{j,t}(h)N_{j,t}(h) + \Pi_{j,t} \\ &\quad + \mathcal{E}_{\$j,t}B^{\$}_{j,t+1} + \sum_{s' \in \mathcal{S}} Q_{j,t}(s')B_{j,t+1}(s'). \end{aligned} \tag{4}$$

In this expression, $P_{j,t}$ is the price index for the domestic consumption aggregator $C_{j,t}$. $\Pi_{j,t}$ represents domestic profits transferred to domestic households, owners of domestic firms. On the financial side, households trade a risk-free international bond denominated in dollars that pays a nominal interest rate $i^{\$}_{j,t}$.[6] $B^{\$}_{j,t+1}$ denotes the dollar debt holdings of this bond at time t. They also have access to a full set of domestic state contingent securities (in j currency) that are traded domestically and in zero net supply. Denoting $\mathcal{S}$ the set of possible states of the world, $Q_{j,t}(s)$ is the period-t price of the security that pays one unit of home currency in period $t+1$ and state $s \in \mathcal{S}$, and $B_{j,t+1}(s)$ are the corresponding holdings.

The optimality conditions of the household's problem yield the following demand system:

$$C_{ij,t}(\omega) = \gamma_{ij}\psi\left(D_{j,t}\frac{P_{ij,t}(\omega)}{P_{j,t}}\right)C_{j,t}, \tag{5}$$

where $\psi(.) := \Upsilon'^{-1}(.) > 0$ so that $\psi'(.) < 0$, $D_{j,t} := \sum_i \int_{\Omega_i} \Upsilon'\left(\frac{|\Omega_i| C_{ij,t}(\omega)}{\gamma_{ij}C_{j,t}}\right)\frac{C_{ij,t}(\omega)}{C_{j,t}}d\omega$ is a demand index and $P_{ij,t}(\omega)$ denotes the price of variety ω produced in country i and sold in country j, *in currency* j. Define the elasticity of demand $\sigma_{ij,t}(\omega) := -\frac{\partial \log C_{ij,t}(\omega)}{\partial \log Z_{ij,t}(\omega)}$, where $Z_{ij,t}(\omega) := D_{j,t}\frac{P_{ij,t}(\omega)}{P_{j,t}}$. The log of the optimal flexible price mark-up is $\mu_{ij,t}(\omega) := \log\left(\frac{\sigma_{ij,t}}{\sigma_{ij,t}-1}\right)$. It is time-varying and we let $\Gamma_{ij,t}(\omega) := \frac{\partial \mu_{ij,t}}{\partial \log Z_{ij,t}(\omega)}$ denote the elasticity of that markup. By definition, the price index $P_{j,t}$ satisfies $P_{j,t}C_{j,t} = \sum_i \int_{\Omega_i} P_{ij,t}(\omega)C_{ij,t}(\omega)d\omega$.

Inter-temporal optimality conditions for international and domestic bonds are given by the usual Euler equations:

$$C_{j,t}^{-\sigma_c} = \beta(1+i^{\$}_{j,t})\mathbb{E}_t\left[C_{j,t+1}^{-\sigma_c}\frac{P_{j,t}}{P_{j,t+1}}\frac{\mathcal{E}_{\$j,t+1}}{\mathcal{E}_{\$j,t}}\right] \tag{6}$$

$$C_{j,t}^{-\sigma_c} = \beta(1+i_{j,t})\mathbb{E}_t\left[C_{j,t+1}^{-\sigma_c}\frac{P_{j,t}}{P_{j,t+1}}\right] \tag{7}$$

where $(1+i_{j,t}) = \left(\sum_{s'\in\mathcal{S}} Q_{j,t}(s')\right)^{-1}$ is the inverse of the price of a nominally risk-free j-currency bond at time t that delivers one unit of j currency in every state of the world in period $t+1$.

Households are subject to a Calvo friction when setting wages in j-currency: in any given period, they may adjust their wage with probability $1-\delta_w$, and maintain the previous-period nominal wage otherwise. As we will see, they face a downward sloping demand for the specific variety of labor they supply given by $N_{j,t}(h) = \left(\frac{W_{j,t}(h)}{W_{j,t}}\right)^{-\vartheta} N_{j,t}$, where $\vartheta > 1$ is the elasticity of labor demand and

[6] This dollar interest rate can be country specific, hence the dependency on j to reflect country risk premia, financial frictions or to ensure stationarity of the linearized model.

$W_{j,t}$ is the aggregate nominal wage in country j, defined below. The standard optimality condition for wage setting is given by:

$$\mathbb{E}_t \sum_{s=t}^{\infty} \delta_w^{s-t} \Theta_{j,t,s} N_{j,s} W_{j,s}^{\vartheta(1+\varphi)} \left[\frac{\vartheta}{\vartheta - 1} \kappa P_{j,s} C_{j,s}^{\sigma} N_{j,s}^{\varphi} - \frac{\bar{W}_{j,t}(h)^{1+\vartheta\varphi}}{W_{j,s}^{\vartheta\varphi}} \right] = 0, \tag{8}$$

where $\Theta_{j,t,s} := \beta^{s-t} \frac{C_{j,s}^{-\sigma_c}}{C_{j,t}^{-\sigma_c}} \frac{P_{j,t}}{P_{j,s}}$ is the stochastic discount factor between periods t and $s \geq t$ used to discount profits and $\bar{W}_{j,t}(h)$ is the optimal nominal reset wage in period t and country j. This implies that $\bar{W}_{j,t}(h)$ is preset as a constant mark-up over the expected weighted-average of future marginal rates of substitution between labor and consumption and aggregate wage rates, during the duration of the wage. Sticky wages are useful to match the empirical fact that wage-based real exchange rates move closely with the nominal exchange rates.

2.2 Producers

Each producer in j manufactures a unique variety ω, which is sold both domestically and internationally. The output of the firm is used both for final consumption and as an intermediate input for production. The production function uses a combination of labor $L_{j,t}$ and intermediate inputs $X_{j,t}$, with a Cobb Douglas production function:

$$Y_{j,t} = e^{a_{j,t}} L_{j,t}^{1-\alpha} X_{j,t}^{\alpha} \tag{9}$$

where α is the share of intermediates in production and $a_{j,t}$ is an aggregate productivity shock. The intermediate input aggregator $X_{j,t}$ takes the same form as the consumption aggregator in Eq. (2):

$$\sum_i \frac{1}{|\Omega_i|} \int_{\omega \in \Omega_i} \gamma_{ij} \Upsilon \left(\frac{|\Omega_i| X_{ij,t}(\omega)}{\gamma_{ij} X_{j,t}} \right) d\omega = 1, \tag{10}$$

where $X_{ij,t}(\omega)$ represents the demand by firms in country j for variety ω produced in country i as intermediate input. The labor input $L_{j,t}$ is a constant elasticity aggregator of the individual varieties $L_{j,t}(h)$ supplied by each household, $L_{j,t} = \left[\int_0^1 L_{j,t}(h)^{(\vartheta-1)/\vartheta} \mathrm{d}h \right]^{\vartheta/(\vartheta-1)}$, with $\vartheta > 1$.

By symmetry, a good produced in j can be used for consumption or as an intermediate input in each country i and the demand for domestic individual varieties (both for consumption and as intermediate input) takes a form similar to that in Eq. (5).

Markets are assumed to be segmented so firms can set different prices by destination market and invoicing currency. Denote $P^k_{ji,t}(\omega)$ the price of a variety ω originating in j, sold in country i and invoiced in currency k. The per-period nominal profits of the domestic firm producing variety ω are then given by:

$$\Pi_{j,t}(\omega) = \sum_{i,k} \mathcal{E}_{kj,t} P^k_{ji,t}(\omega) Y^k_{ji,t}(\omega) - \mathcal{MC}_{j,t}\, Y_{j,t}(\omega) \tag{11}$$

with the convention that $\mathcal{E}_{jj,t} := 1$. In that expression, $Y^k_{ji,t}(\omega) = C^k_{ji,t}(\omega) + X^k_{ji,t}(\omega)$ is the demand for domestic variety ω from country j invoiced in currency k in country i, both for consumption and as an input in production, while $Y_{j,t}(\omega) = \sum_{i,k} Y^k_{ji,t}(\omega)$ is the total demand across destination markets i and invoicing currencies k. $\mathcal{MC}_{j,t}$ denotes the nominal marginal cost of country j firms in their home currency. Given Eq. (9), it is given by:

$$\mathcal{MC}_{j,t} = \frac{1}{\alpha^\alpha (1-\alpha)^{1-\alpha}} \cdot \frac{W^{1-\alpha}_{j,t} P^\alpha_{j,t}}{e^{a_{j,t}}}. \tag{12}$$

The optimality conditions for hiring labor are given by,

$$(1-\alpha)\frac{Y_{j,t}}{L_{j,t}} = \frac{W_{j,t}}{\mathcal{MC}_{j,t}}, \qquad L_{j,t}(h) = \left(\frac{W_{j,t}(h)}{W_{j,t}}\right)^{-\vartheta} L_{j,t}, \tag{13}$$

with the aggregate nominal wage $W_{j,t}$ defined as $W_{j,t} = \left[\int W_{j,t}(h)^{1-\vartheta} dh\right]^{\frac{1}{1-\vartheta}}$, while the demand for intermediate inputs is determined by,

$$\alpha \frac{Y_{j,t}}{X_{j,t}} = \frac{P_{j,t}}{\mathcal{MC}_{j,t}}, \qquad X_{ij,t}(\omega) = \gamma_{ij} \psi \left(D_{j,t} \frac{P_{ij,t}(\omega)}{P_{j,t}}\right) X_{j,t}. \tag{14}$$

2.3 Pricing

Firms choose prices at which to sell in j and in international markets i, with prices reset infrequently. As in Galí (2008), we consider a Calvo pricing environment where firms are randomly allowed to reset prices with probability $1-\delta_p$. A core focus of this paper is on the implications of various pricing choices by firms, in particular under dominant currency pricing. Consequently, we assume that firms can set their prices either in the producer currency (j), in the destination currency (i), or in the dominant currency ($\$$).

Denote θ^k_{ji} the fraction of exports from region j to region i that are priced in currency k, with $\sum_k \theta^k_{ji} = 1$ for any pair $\{i, j\}$. We allow for all pricing combinations but will focus on subsets. The benchmark of PCP corresponds to the case where $\theta^j_{j,i} = 1$ for every $i \neq j$. The case of LCP corresponds to $\theta^i_{ji} = 1$ for every $i \neq j$. Under DCP, $\theta^\$_{ji} = 1$ for every $i \neq j$. Lastly, we assume that all domestic prices are sticky in the home currency, an assumption consistent with a large body of evidence: $\theta^j_{jj} = 1$ for every j.

Consider the pricing problem of a firm from country j selling in country i and invoicing in currency k, and denote $\bar{P}^k_{ji,t}(\omega)$ its reset price. This reset price satisfies the following optimality condition:

$$\mathbb{E}_t \sum_{s=t}^{\infty} \delta_p^{s-t} \Theta_{j,t,s} Y^k_{ji,s|t}(\omega)(\sigma^k_{ji,s}(\omega) - 1) \left(\mathcal{E}_{kj,s} \bar{P}^k_{ji,t}(\omega) - \frac{\sigma^k_{ji,s}(\omega)}{\sigma^k_{ji,s}(\omega) - 1} \mathcal{MC}_{j,s} \right) = 0. \quad (15)$$

In this expression, $Y^k_{ji,s|t}(\omega)$ is the quantity sold in country i invoiced in currency k at time s by a firm that resets prices at time $t \leq s$ and $\sigma^k_{ji,s}(\omega)$ is the elasticity of demand. This expression implies that $\bar{P}^k_{ji,t}(\omega)$ is preset as a markup over expected future marginal costs expressed in currency k, $\mathcal{MC}_{j,s}(\omega)/\mathcal{E}_{kj,s}$, over the duration of the price spell. Observe that because of strategic complementarities, the mark-up over expected future marginal costs is not constant.

2.4 Testable Implications

Before we close the model, we can already outline a number of testable implications of our framework for the joint behavior of exchange rates, export and import prices, and quantities. We explore them empirically in Section 3.

Using lower cases to denote the log of variables (e.g., $p_{ij} = \ln P_{ij}$), country j's import price inflation for goods originating from country i can be expressed as:

$$\Delta p_{ij,t} = \sum_k \theta_{ij}^k \left(\Delta p_{ij,t}^k + \Delta e_{kj,t}\right),$$

where the summation is over invoicing currencies. Under Calvo pricing, $\Delta p_{ij,t}^k = (1-\delta_p)\left(\bar{p}_{ij,t}^k - p_{ij,t-1}^k\right)$, and $\bar{p}_{ij,t}^k$ is the (log) reset-price defined in Eq. (15). If all goods from i to j are either producer-priced (PCP), locally-priced (LCP) or priced in the dominant currency (DCP), $\theta_{ij}^i + \theta_{ij}^j + \theta_{ij}^\$ = 1$ and we obtain:

$$\Delta p_{ij,t} = \theta_{ij}^i \Delta e_{ij,t} + \theta_{ij}^\$ \Delta e_{\$j,t} + (1-\delta_p) \sum_k \theta_{ij}^k \left(\bar{p}_{ij,t}^k - p_{ij,t-1}^k\right). \tag{16}$$

In the very short run, $\delta_p \to 1$, and we can ignore the last term of the previous equation: changes in bilateral import prices and in the bilateral terms of trade $TOT_{ij} = P_{ij}/(P_{ji}\mathcal{E}_{ij})$ only depend on the bilateral nominal exchange rates, the dollar exchange rate, and the share of trade invoiced in different currencies.

On the quantity side a log-linear approximation (around a symmetric steady state) of Eqs. (5) and (14) yields,

$$\Delta y_{ij,t} = -\sigma_{ij}\left(\Delta p_{ij,t} - \Delta p_{j,t}\right) + \Delta y_{j,t}^d,$$

where σ_{ij} is the elasticity of demand and $y_{j,t}^d$ is the (log) of aggregate demand in country j.

Proposition 1 (pass-through)**.** *When prices are fully rigid and pre-determined in their currency of invoicing ($\delta_p \to 1$), pass-through into bilateral import prices expressed in currency j and quantities from country i to country j (controlling for destination prices $p_{j,t}$ and demand $y_{j,t}^d$) are given by:*

$$\Delta p_{ij,t} = \theta_{ij}^i \Delta e_{ij,t} + \theta_{ij}^\$ \Delta e_{\$j,t} \tag{17}$$

$$\Delta y_{ij,t} = -\sigma_{ij}\left(\theta_{ij}^i \Delta e_{ij,t} + \theta_{ij}^\$ \Delta e_{\$j,t}\right) \tag{18}$$

- *In the case of PCP, $\theta_{ij}^i = \theta_{ji}^j = 1$ and*

$$\begin{aligned}
\Delta p_{ij,t} &= \Delta e_{ij,t}, \qquad \Delta p_{ji,t} = -\Delta e_{ij,t} \\
\Delta tot_{ij,t} &= \Delta p_{ij,t} - (\Delta p_{ji,t} + \Delta e_{ij,t}) = \Delta e_{ij,t}. \\
\Delta y_{ij,t} &= -\sigma_{ij} \Delta e_{ij,t}
\end{aligned}$$

- *In the case of LCP,* $\theta_{ij}^{j} = \theta_{ji}^{i} = 1$ *and*

$$\begin{aligned}\Delta p_{ij,t} &= 0, \qquad \Delta p_{ji,t} = 0 \\ \Delta tot_{ij,t} &= \Delta p_{ij,t} - (\Delta p_{ji,t} + \Delta e_{ij,t}) = -\Delta e_{ij,t} \\ \Delta y_{ij,t} &= 0.\end{aligned}$$

- *In the case of DCP,* $\theta_{ij}^{\$} = \theta_{ji}^{\$} = 1$ *and*

$$\begin{aligned}\Delta p_{ij,t} &= \Delta e_{\$j,t}, \qquad \Delta p_{ji,t} = \Delta e_{\$i,t} \\ \Delta tot_{ij,t} &= \Delta p_{ij,t} - (\Delta p_{ji,t} + \Delta e_{ij,t}) = 0 \\ \Delta y_{ij,t} &= -\sigma_{ij,t}\Delta e_{\$j,t}.\end{aligned}$$

It should be clear that the predictions for prices, when prices are yet to change, do not depend on what drives the exchange rate variation, that is, whether it arises from monetary policy shocks, financial shocks or other shocks. Empirically, we should expect those countries relying more heavily on dollar pricing to display greater sensitivity to the dollar exchange rate, even when controlling for the bilateral exchange rate between countries i and j.[7] We summarize the testable implications of DCP below.

Testable Implications. *(Import Price and Quantity Pass-Through)*

1. *The bilateral terms of trade should be insensitive to bilateral exchange rates.*

2. *For non-U.S. countries exchange rate pass-through into import prices (in home currency) should be high and driven by the dollar exchange rate as opposed to the bilateral exchange rate. Countries that rely more heavily on dollar import invoicing should see more of this effect. For the U.S., on the contrary, pass-through into import prices should be low.*

3. *For non-U.S. countries, import quantities should be driven by the dollar exchange rate as opposed to the bilateral exchange rate. U.S. import quantities should be less responsive to dollar exchange rate movements as compared to non-U.S. countries.*

[7]Note that if the source of the shock generates co-movement across exchange rates, the resulting collinearity would show up in the regressions as large standard errors around the point estimates on each bilateral exchange rate. As we report below, this is not an issue.

4. *When all countries' currencies uniformly depreciate relative to the dollar, it should lead to a decline in trade between the rest of the world (i.e. excluding the U.S.).*

The first three implications follow directly from Proposition 1. The last implication is obtained from the aggregation of import volumes across country-pairs where the U.S. is neither the origin nor the destination country. Denote $\mathbb{R}$ the set of such country-pairs: $\mathbb{R} \equiv \{(i,j), i \neq j, i \neq \$, j \neq \$\}$. Let ω_{ij} denote country j total non-commodity import value from country i in some reference year, normalized so that $\sum_{\mathbb{R}} \omega_{ij} = 1$. We conceptualize the rest-of-the-world aggregate trade bundle, $y_{\mathbb{R},t}$, as a Cobb-Douglas aggregate of individual-country bilateral (log) gross imports with weights ω_{ij}: $y_{\mathbb{R},t} := \sum_{\mathbb{R}} \omega_{ij} y_{ij,t}$. *Ceteris paribus*, under DCP, a *uniform* depreciation relative to the dollar $\Delta e_{\$,t} > 0$, leads to a decline in non-commodity trade in the rest of the world:

$$\Delta y_{\mathbb{R},t} = \sum_{\mathbb{R}} \omega_{ij} \Delta y_{ij,t} = -\left(\sum_{\mathbb{R}} \omega_{ij} \sigma_{ij,t} \right) \Delta e_{\$,t} < 0. \tag{19}$$

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

As the horizon increases, the frequency of price adjustment increases and the pass-through predictions depend also on the response of reset prices $\bar{p}^k_{ij,t}$ to exchange rates. We demonstrate in Section 4.2 that the divergent predictions across the different paradigms hold at longer than annual frequencies in the presence of strategic complementarities in pricing and imported input use.[8]

[8]This result does not depend on the exogeneity of the currency of invoicing. Some of the ingredients from our model, namely imported input use in production and strategic complementarities in pricing, are precisely those that would give rise endogenously to dominant currency in pricing. This is demonstrated by Gopinath et al. (2010) in a partial equilibrium environment and Mukhin (2018) in a general equilibrium environment. Nonetheless, our testable predictions continue to hold, even after endogenizing the currency choice: as shown in Gopinath et al. (2010), firms choose to price in currencies in which their reset prices are most stable, i.e., desired medium-run pass-through into the price (expressed in the invoicing currency) is low. In other words, our empirical findings will continue to be relevant in an environment with endogenous currency choice.

Lastly, as the horizon increases the impact of exchange rate fluctuations on prices and quantities depend on the source of the shock. The ideal test would be to examine the joint response of exchange rates, prices, and quantities to an exogenous shock such as a monetary policy shock. The problem is that in the data exchange rate fluctuations have little to do with monetary policy shocks or other identified policy shocks. Instead exchange rates appear to be driven by a 'residual' that the literature names 'financial shocks.' Practically this shows up as low power in testing the channel from identified exogenous shocks to exchange rates and to trade.

2.5 Closing the Model and Contrasting Shock Transmission

Before turning to our empirical results, this subsection demonstrates the differential transmission of monetary policy (MP) shocks across different pricing paradigms in a Small Open Economy (SOE). Then, using a 3-country Large Open Economy (LOE) framework, it further documents the asymmetry in monetary policy spillovers under DCP, depending on whether the MP shocks originate in the dominant currency country or elsewhere. We show that when countries follow a Taylor rule: (i) The inflation-output trade-off in response to a monetary policy shock for a small open economy worsens under DCP relative to PCP. (ii) MP shocks in the dominant country have strong spillovers to MP in the rest-of-the world and reduce rest-of-world and global trade, while MP shocks in non-dominant currency countries generate only weak spillovers and little impact on world trade. Details of the simulations are provided in an online appendix.

2.5.1 Closing the Model

To evaluate shock transmission, we need to close the model. This requires that in addition to the equilibrium conditions specified in Section 2 we spell out the processes for interest rates and impose market clearing conditions. We assume that the nominal interest rate in each country i is set by its monetary authority and follows a Taylor rule with inertia:

$$i_{i,t} - i^* = \rho_m(i_{i,t-1} - i^*) + (1 - \rho_m)\left(\phi_M \pi_{i,t} + \phi_Y \tilde{y}_{i,t}\right) + \varepsilon_{i,t}.$$

In this expression, ϕ_M captures the sensitivity of policy rates to consumer price inflation $\pi_{i,t} = \Delta \ln P_{i,t}$, ϕ_Y measures the sensitivity to the output gap $\tilde{y}_{i,t}$, ρ_m captures the inertia in setting policy rates, while the target nominal interest rate is assumed equal to the steady state international borrowing rate i^*. $\varepsilon_{i,t}$ evolves according to an $AR(1)$ process, $\varepsilon_{i,t} = \rho_\varepsilon \varepsilon_{i,t-1} + \epsilon^m_{i,t}$ where $\epsilon^m_{i,t}$ are serially independently distributed innovations.[9]

[9]In Section 4.2 we examine moments of the stationary distribution for a small open economy. As is well known, in the absence of further assumptions the SOE model just described when solved around a well behaved steady state with $\beta(1 + i^*) = 1$ is non-stationary in that the level of real debt and therefore other real variables are permanently changed even in response to transitory shocks. To induce stationarity we follow Schmitt-Grohe and Uribe (2003) and assume the

Goods, labor and domestic bond market-clearing conditions require $Y_{i,t}(\omega) = \sum_j (C_{ij,t}(\omega) + X_{ij,t}(\omega))$, $N_{i,t} = L_{i,t}$, and $B_{i,t}(s') = 0, \forall s' \in \mathcal{S}$. The remaining market clearing conditions depend on whether we consider a small open economy (SOE) or a large open economy (LOE) environment. In the SOE case, all foreign variables are taken as exogenous and not impacted by shocks in the SOE. In the LOE case, we impose the additional requirement that $\sum_j B^{\$}_{j,t} = 0$.

2.5.2 Calibration

Preference aggregator. We adopt the Klenow and Willis (2016) functional form for the demand function $\Upsilon(.)$. This gives rise to the following demand for individual varieties:

$$Y_{ij,t}(\omega) \equiv C_{ij,t}(\omega) + X_{ij,t}(\omega) = \gamma_i \left(1 + \epsilon \ln \frac{\sigma - 1}{\sigma} - \epsilon \ln Z_{ij,t}(\omega)\right)^{\sigma/\epsilon} (C_{j,t} + X_{j,t})$$

where $Z_{ij,t}(\omega) \equiv D_{j,t} \frac{P_{ij,t}(\omega)}{P_{j,t}}$ as previously defined and σ and ϵ are two parameters that determine the elasticity of demand and its variability as follows:

$$\sigma_{ij,t}(\omega) = \frac{\sigma}{\left(1 + \epsilon \ln \frac{\sigma-1}{\sigma} - \epsilon \ln Z_{ij,t}(\omega)\right)}, \qquad \Gamma_{ij,t}(\omega) = \frac{\epsilon}{\left(\sigma - 1 - \epsilon \ln \frac{\sigma-1}{\sigma} + \epsilon \ln Z_{ij,t}(\omega)\right)}.$$

In a symmetric steady state $Z_{ij,t}(\omega) = (\sigma - 1)/\sigma$, the elasticity of demand is σ while the elasticity of the mark-up is $\Gamma = \epsilon/(\sigma - 1)$. Strategic complementarities and variable markups arise when $\epsilon > 0$, while $\epsilon = 0$ corresponds to the constant elasticity case.

Parameter values. Table 1 lists parameter values employed in the simulation. The time period is a quarter. Several parameters are set to values standard in the literature (see e.g., Galí, 2008). Following Christiano et al. (2011) we set the wage stickiness parameter $\delta_w = 0.85$ corresponding roughly to a year and a half average duration of wages. The steady state elasticity of substitution between varieties

dollar interest rate in country $i \neq \$$ is an increasing function of its external debt, $i^{\$}_{i,t} = i_{\$,t} + \psi(e^{(B^{\$}_{i,t+1}/P_{\$}) - \bar{B}^{\$}_i} - 1) + \epsilon^{\$}_{i,t}$, where $\psi > 0$ measures the responsiveness of the dollar rate to the country's real dollar debt holdings $B^{\$}_{i,t+1}/P_{\$}$ where $P_{\$}$ is exogenous from the SOE perspective. $\bar{B}^{\$}_i$ is the exogenous steady-state real dollar debt holdings. This is a standard assumption in the small open economy literature to induce stationarity in a log-linearized environment. Because of the dependence on aggregate debt individual households do not internalize the effect of their borrowing choices on the interest rate. In this section we study the impulse response to a small one time shock and consequently the model with or without the stationarity assumption delivers almost identical results, as also shown by Schmitt-Grohe and Uribe (2003).

Parameter values for calibrated model

	Parameter	Value	Parameter		Value
Household Preferences			Demand		
Discount factor	β	0.99	Elasticity	σ	2.00
Risk aversion	σ_c	2.00	Super-elasticity	ϵ	1.00
Frisch elasticity of N	φ^{-1}	0.50	Home-bias	γ	0.70
Disutility of labor	κ	1.00	Rigidities		
Labor demand elasticity	ϑ	4.00	Wage	δ_w	0.85
Steady state NFA	$\bar{B}^{\$}$	0	Price	δ_p	0.75
Production			Monetary Rule		
Intermediate share	α	2/3	Inertia	ρ_m	0.50
(log) Productivity	a	1	Inflation sensitivity	ϕ_M	1.5
			Output gap sensitivity	ϕ_Y	0.50/4
			Shock persistence	ρ_ε	0.50
			SS. interest rate	i^*	$(1/\beta)-1$

Table 1: Parameter values for calibrated model.

σ is assumed in the model to be the same across and within regions. Accordingly, we calibrate to an average of these elasticities measured in the literature. Specifically, Broda and Weinstein (2006) obtain a median elasticity estimate of 2.9 for substitution across imported varieties, while Feenstra et al. (2010) estimate a value close to 1 for the elasticity of substitution across domestic and foreign varieties. Thus, we set $\sigma = 2$.

To parameterize ϵ, which controls the strength of the strategic complementarities, we rely on estimates from the micro pass-through literature that converges on very similar values for Γ despite the differences in data and methodology. Following Amiti et al. (2016), Amiti et al. (2014), Gopinath and Itskhoki (2010) we set $\Gamma = 1$. Because in steady state $\Gamma = \epsilon/(\sigma - 1)$ this implies $\epsilon = 1$. The home bias share is set to 0.7. This implies steady-state spending on imported goods in the consumption bundle and intermediate input bundle equal to thirty percent.[10]

2.5.3 Small Open Economy

In this section we contrast the impulse responses to a monetary policy shock in a SOE (labeled H) under different pricing regimes. Fig. 1 plots the impulse response to a *25 basis point exogenous cut in*

[10]For the SOE case we assume exogenous rest-of-the world demand such that exports as a ratio of GDP is 45%. The specific value of this ratio is not essential to the results.

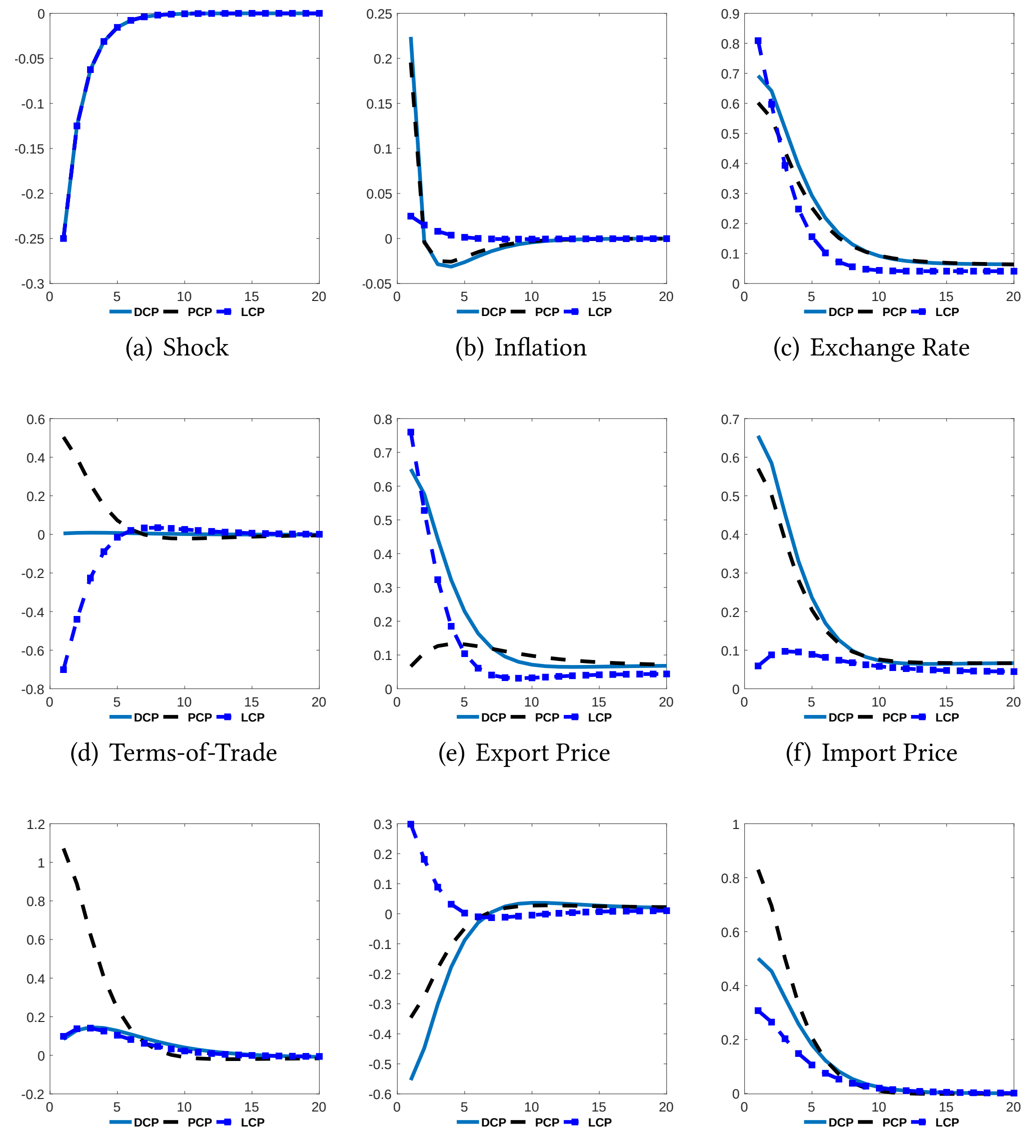
domestic interest rates (Fig. 1(a)). In each sub-figure, we contrast the response under three regimes: Dominant Currency Paradigm (DCP), Producer Currency Pricing (PCP), and Local Currency pricing (LCP).

Exchange rate and inflation. Following the monetary shock, domestic interest rates decline but less than one-to-one as the exchange rate $\mathcal{E}_{\$H}$ depreciates by around 0.8% (Fig. 1(c)) raising inflationary pressures on the economy (Fig. 1(b)). This in turn dampens the fall in nominal interest rates via the monetary policy rule. As seen in Fig. 1(b) the increase in inflation in the case of DCP and PCP far exceeds that of LCP since exchange rate movements have a smaller impact on the domestic prices of imported goods when import prices are sticky in local currency.

Terms-of-trade. The exchange rate depreciation is associated with almost a one-to-one depreciation of the terms-of-trade in the case of PCP and a one-to-one appreciation in the case of LCP (Fig. 1(d)). In contrast, under DCP, the terms-of-trade depreciate negligibly and remain stable because both export and import prices are stable in the dominant currency.

Exports and imports. With stable export and import prices in the dominant currency under DCP, the home currency price of exports and imports rises with the exchange rate depreciation as depicted in Figs. 1(e) and 1(f). This in turn generates a significant decline in trade-weighted imports (0.43%), despite the expansionary effect of monetary policy, and only a modest increase in trade-weighted exports (0.1%) (Figs. 1(g) and 1(h)). This contrasts with the PCP benchmark that generates a large increase in exports and with the LCP benchmark that generates an increase in imports (from the demand expansion). The decline in imports in the case of PCP is lower than that under DCP because of export expansion under PCP and the use of imported inputs.

Output. As depicted in Fig. 1(i) the expansionary impact on output is muted under DCP relative to PCP, with the lowest impact under LCP. Under DCP, there is an expenditure switching effect from



(a) Shock (b) Inflation (c) Exchange Rate

(d) Terms-of-Trade (e) Export Price (f) Import Price

(g) Export Quantity (h) Import Quantity (i) Output

Figure 1: Impulse response to a monetary policy shock in a SOE

imports towards domestic output that is absent under LCP, while DCP misses out on the expansionary impact on exports under PCP. Comparing Figs. 1(b) and 1(i), the inflation-output trade-off in response to expansionary monetary policy worsens under DCP relative to both PCP and LCP (where output does not expand much, but inflation increases the least). In the case of DCP, inflation rises by 0.35% on impact and output by 0.56%, a ratio of 0.4. In the case of PCP, that ratio is almost halved to $0.2/0.8 = 0.25$. The ratio is lowest for LCP at 0.07.

2.5.4 Large Open Economies

For the LOE case we consider three economies, U, G and R. These economies are symmetric, except for international pricing and bond markets in which the the dollar (the currency of U) is dominant.[11] Assuming 100% dollar pricing in international trade, we focus on the asymmetry in the transmission of monetary policy shocks that originate in U, relative to those in G/R.

Monetary policy shock in dominant currency country. We first consider a *positive 25 basis point shock to the nominal interest rate in* U. The impulse responses to this monetary tightening are plotted in Fig. 2. The outcomes in G and R are the same for all variables, including their exchange rates, both of which depreciate by 0.65% relative to the dollar on impact.

The rise in interest rates in U leads to a decline in output (-0.6%, Figure 2(e)), an appreciation of the dollar (0.65%, Figure 2(c)), and a fall in inflation (-0.02%, Fig. 2(d)). The decline in inflation is, however, negligible (in contrast to PCP) because dollar pricing generates a low pass-through of the dollar appreciation into the price of imported goods, as seen in Fig. 2(g). On the other hand, the pass-through into export prices (in the destination currency) is high, as depicted in Fig. 2(h), which in turn generates a significant decline in exports (Fig. 2(i)). Imports decline because of the decline in overall demand given MP tightening so overall, the trade balance to GDP deteriorates mildly. The terms of trade (Fig. 2(f)) are largely unchanged.

The monetary tightening in U has a larger effect on inflation on impact in G/R (0.2%, Fig. 2(d)) than in U because the depreciation has high pass-through into import prices of the former countries. This in turn generates an endogenous increase in interest rates (0.15%, Fig. 2(b)) in G/R via the Taylor rule, leading to a mild contraction in output (-0.03%, Fig. 2(e)). Despite the depreciation of the G/R exchange rates relative to the dollar, their exports to U decline (-0.4%, Fig. 2(j)) because dollar prices

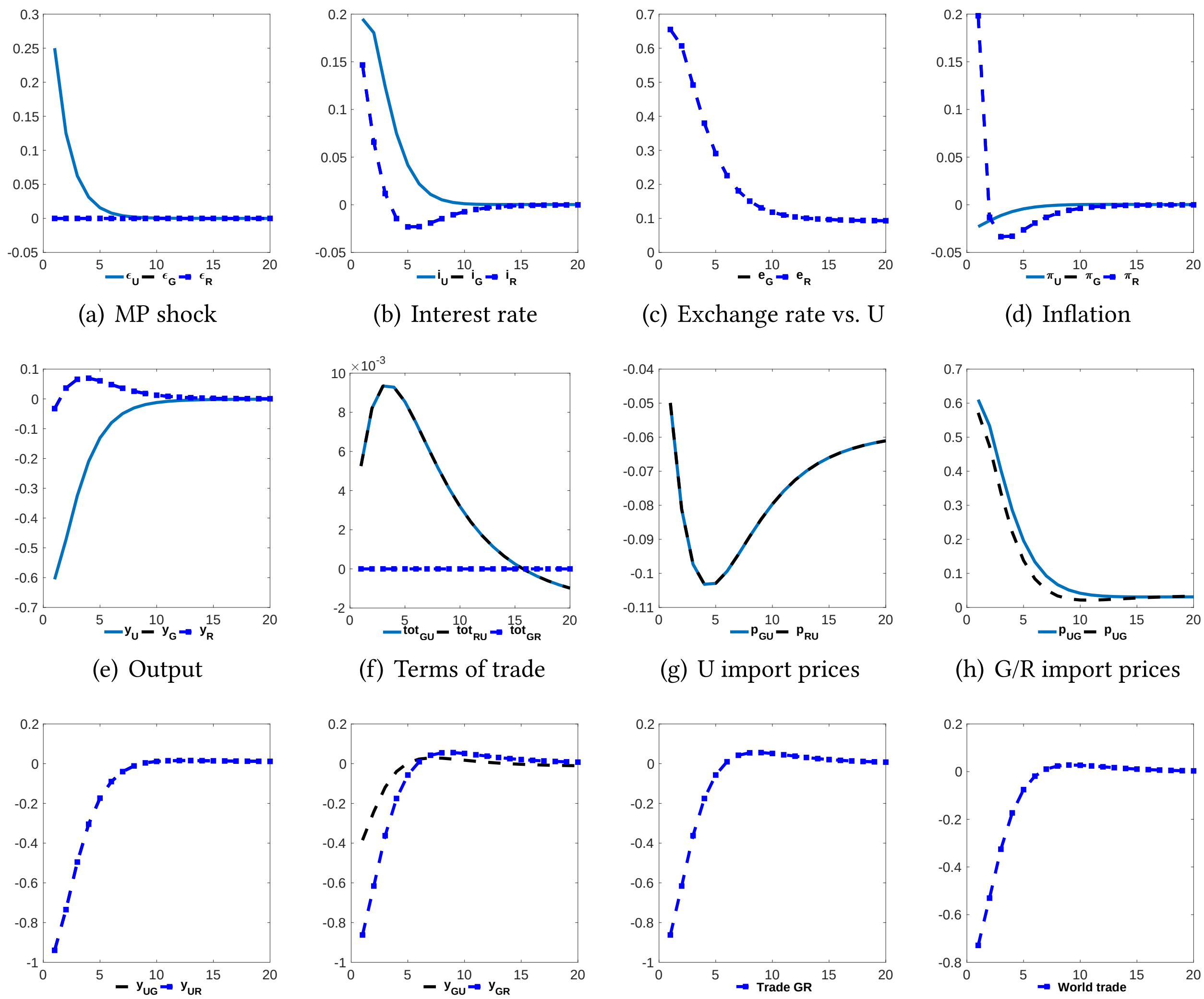
[11] We simulate the model also for the case when there is a full set of Arrow-Debreu securities traded. The impulse responses, qualitatively and quantitatively, are very close. This is intuitive because under perfect foresight, the noncontingent bond is sufficient to complete the market, i.e., the equilibrium conditions of the cases with complete markets and incomplete markets with a bond are the same. When an unanticipated shock hits, only the initial period's equilibrium conditions differ across the two cases.

to U change by little so there is no significant positive expenditure switching effect, and the decline in overall demand in U generates a decline in exports to U. Also, because of dollar pricing, there is a sharp decline in exports from G to R (-0.85%, Fig. 2(j)) and vice versa. This is because the depreciation of these countries' currencies relative to the dollar makes all imports more expensive, leading to a switch in expenditures away from imported goods. This is then further accentuated by the (mild) negative impact on consumption from the rise in interest rates in response to the inflationary effect.

As follows from the previous discussion, a monetary tightening in U and the accompanying uniform appreciation of the dollar relative to other countries generate a decline in rest-of-world trade (-0.83%, Fig. 2(k)), defined as the sum of quantities traded between G and R. It also causes a decline in global trade (-0.73%, Fig. 2(l)), defined as the sum of export quantities from all countries.

Monetary policy shock in non-dominant currency country. We next consider a *25 basis point monetary tightening in a non-dominant currency country*. Without loss of generality, we set this to be G. As depicted in Fig. 3(c), G's currency appreciates uniformly relative to U and R on impact, and by a magnitude similar to that in Fig. 2(c). This is because, despite the endogenous change in interest rates in each country (Fig. 3(b) differs from Fig. 2(b)), the change in the interest rate differential between countries is quite similar, which is what matters for the exchange rate change.

The transmission of the shock to interest rates in G (Fig. 3(b)) is partly muted because the decline in inflation is endogenously contained through the Taylor rule. The negative impact on inflation of -0.2% (Fig. 3(d)) contrasts with the much smaller effect of a MP shock in U on U's inflation (Fig. 2(d)). This differential response arises from the strong pass-through of the appreciation of G's currency into its import prices. The rise in interest rates in G leads to a decline in output (-0.6%, Fig. 3(e)). While pass-through into import prices (in G's currency) is high (-0.6%, Fig. 3(h)), pass-through into export prices (in destination currency) is low. Consequently, there is only a small negative impact on exports from G (-0.05%, Fig. 3(j)), in contrast to the large negative impact of a MP tightening in U on U's exports (Fig. 2(i)). While exports are not responsive, there is a significant increase in imports

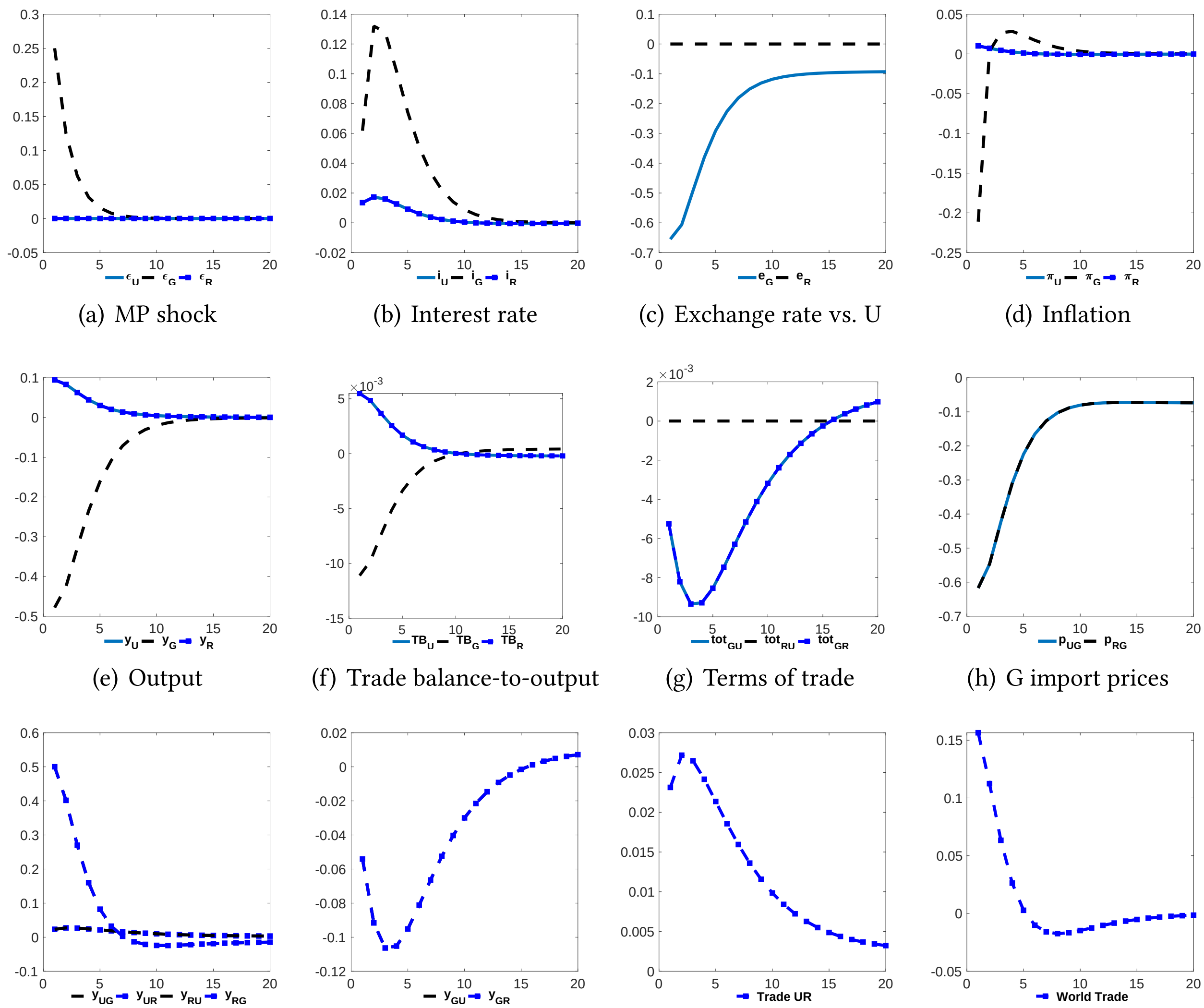


(a) MP shock (b) Interest rate (c) Exchange rate vs. U (d) Inflation

(e) Output (f) Terms of trade (g) U import prices (h) G/R import prices

(i) U export volume (j) G/R export volume (k) ROW trade (l) World trade

Figure 2: Impulse responses to a 25 basis point monetary tightening in U. Rest-of-world trade is defined as the sum of quantities traded between G and R. World trade is defined as the sum of export quantities from all countries.



(a) MP shock (b) Interest rate (c) Exchange rate vs. U (d) Inflation

(e) Output (f) Trade balance-to-output (g) Terms of trade (h) G import prices

(i) U/R export volume (j) G export volume (k) ROW trade (l) World trade

Figure 3: Impulse responses to a 25 basis point monetary tightening in G. Rest-of-world trade is defined as the sum of quantities traded between U and R. World trade is defined as the sum of export quantities from all countries.

into G from U, and R through the expenditure switching channel following the depreciation of their currencies relative to G's (Fig. 3(i)). The terms of trade are stable, as in the case of the MP shock in U (Fig. 3(g)).

Since exports from U and R to G increase significantly, while exports out of G decline only marginally, the monetary tightening in G is associated with an expansion in global trade (Fig. 3(l)), and almost no effect on rest-of-world trade (gross trade between U and R, Fig. 3(k)).

3 Global Empirical Evidence

This section tests the model predictions derived in Section 2.4, using bilateral trade volumes and unit values for a large number of countries. We show that, consistent with DCP, the U.S. dollar plays an outsized role in driving international trade prices and quantities. We first document that bilateral terms of trade are essentially uncorrelated with bilateral exchange rates. Next, we demonstrate that the bilateral (importer vs. exporter) exchange rates matter less than the exchange rate vis-à-vis the U.S. dollar for pass-through and trade elasticities of the average country in our sample. We also find the euro to be much less important than the dollar. The effects of the dollar are stronger when the importing country has a higher fraction of trade invoiced in dollars. The dollar's role is greatest for trade between emerging market pairs, consistent with their higher reliance on dollar pricing. Finally, we show that the overall strength of the U.S. dollar is a key predictor of gross trade and producer/consumer price inflation in the rest of the world.

3.1 Data

The core of our data set consists of panel data on bilateral trade values and volumes from Comtrade. UN Comtrade provides detailed annual customs data for a large set of countries at the HS 6-digit product level with information about the destination country, dollar value, quantity, and weight of imports and exports. This dataset makes it possible to compute volume changes over time for each product, and use the value data to infer unit values. Once unit values are calculated, we compute chained Fisher price indices to aggregate up from the product level to the bilateral country level. We focus entirely on data for non-commodity goods, except noted otherwise. Given the inherent difficulty in drawing a line between commodities and non-commodities, we define commodities fairly broadly as HS chapters 1–27 and 72–83, which comprise animal, vegetable, food, mineral, and metal products.

The biggest challenge for constructing price and volume indices using customs data is the so-called unit value bias. Unit values, calculated by dividing observed values by quantities, are not actual prices. Even when there is no price change, unit values can change due to compositional shifts. To take a stab at correcting for this bias, we follow the methodology developed by Boz et al. (2019). Specifically, we eliminate 6-digit products with a unit value variance higher than a threshold as those observations are more likely to be biased. To check whether this provides a sufficient fix, we compare our Comtrade estimated price indices with those reported by the BLS based on actual import prices for the U.S. We find that our indices track the BLS import price indices fairly well. Results of this comparison, further details of Comtrade data construction as well as sources of other macroeconomic data are provided in the online appendix A.1.

3.2 Terms of Trade and Exchange Rates

We first relate bilateral terms of trade to bilateral exchange rates using panel regressions (testable implication 1). In this subsection, a cross-sectional unit is defined to be an *unordered* country pair, so that both trade flows between two countries i and j are associated with the cross-sectional unit $\{i, j\}$. Recall that p_{ij} denotes the (log) price of goods exported from country i to country j measured in currency j, e_{ij} the (log) bilateral exchange rate between country i and country j expressed as the price of currency i in terms of currency j and $tot_{ij} = p_{ij} - p_{ji} - e_{ij}$ the (log) bilateral terms of trade, defined as the ratio of import prices to export prices (measured in the same currency). Moreover, let ppi_{ij} denote the (log) ratio of the producer price index (PPI) in country i divided by PPI in country j, with indices expressed in the same currency.

Terms of trade and exchange rates

	unweighted		trade-weighted	
	(1)	(2)	(3)	(4)
	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$
$\Delta e_{ij,t}$	0.0369***	-0.00938	0.0813***	0.0218
	(0.00863)	(0.0130)	(0.0235)	(0.0317)
PPI	no	yes	no	yes
R-squared	0.008	0.011	0.028	0.042
Observations	24,270	19,847	24,270	19,847
Dyads	1,347	1,200	1,347	1,200

Table 2: The first (resp., last) two columns use unweighted (resp. trade-weighted) regressions. All regressions include two ΔER lags and time FE. S.e. clustered by dyad. The number of dyads is about half that in Table 3 since here the two ordered country tuples (i, j) and (j, i) are collapsed into one cross-sectional unit $\{i, j\}$. *** p<0.01, ** p<0.05, * p<0.1.

We consider regressions of the following form:

$$\Delta tot_{ij,t} = \lambda_{ij} + \delta_t + \sum_{k=0}^{2} \beta_k \Delta e_{ij,t-k} + \sum_{k=0}^{2} \theta_k \Delta ppi_{ij,t-k} + \varepsilon_{ij,t}, \tag{20}$$

where λ_{ij} and δ_t are dyad (i.e., country pair) and time fixed effects. Regression Eq. (20) relates the growth rate of the bilateral terms of trade to the growth rate of the bilateral nominal exchange rate (and lags). As discussed in Section 2.4, if exporting firms set prices in their local currencies as in PCP and prices are sticky, the contemporaneous exchange rate coefficient β_0 should equal 1. If instead exporting firms set prices in the destination currency as in LCP and prices are sticky, the contemporaneous exchange rate coefficient should be -1. If most prices are invoiced in U.S. dollars and are sticky in nominal terms, the coefficients β_k should be close to zero. As indicated in Eq. (20), some of our specifications control for lags 0–2 of the growth rate of the ratio of PPI in both countries, since firms' optimal reset prices should fluctuate with domestic cost conditions.

We consider both unweighted and trade-weighted regressions. To obtain trade weights, for each dyad and year, we compute the share of world non-commodities trade value (in dollars) attributable to that dyad. Then, for each dyad, we compute the average share across the years 1992–2015.

In line with DCP, we find that bilateral exchange rates are virtually uncorrelated with bilateral terms of trade. The results of the panel regressions are shown in Table 2. If we do not control for relative PPI, the regression results indicate that the contemporaneous effect of the exchange rate on the terms of trade is positive. While the sign is consistent with PCP, the magnitude is not, as the 95% confidence interval equals [0.02, 0.05] in the unweighted regression, and [0.04 , 0.13] in the weighted regression.[12] The coefficients on the lags (not reported) are also small in magnitude. When controlling for relative PPI, the point estimates of the coefficients on the bilateral exchange rate shrink further toward zero, and confidence intervals remain narrow. Hence, our results lend strong support to DCP: the terms of trade are unresponsive to bilateral exchange rates.

Although the lack of correlation could in principle be consistent with a world of 50% PCP and 50% LCP, the next subsections refute that possibility. In addition, while the lack of correlation is consistent with any currency being a dominant currency, we provide evidence next that the major dominant currency is indeed the dollar. The stability of the terms of trade for the average country in our sample cannot be explained by a model with flexible prices and strategic complementarities in pricing as in Atkeson and Burstein (2008) and Itskhoki and Mukhin (2017) because, as we show next, the import pass-through into destination country prices at-the-dock is high, while that into consumer or producer prices, reported in online appendix A.2.2, is an order of magnitude smaller, contrary to the presence of strong complementarities in pricing.

Lastly, online appendix A.2.1 demonstrates that the terms of trade are nearly uncorrelated with the bilateral exchange rate across all advanced/emerging economy trade flows.

3.3 Exchange Rate Pass-through Into Prices

Next, we relate international prices and exchange rates (testable implication 2). Exchange rate pass-through regressions are reduced-form regressions that relate price changes to exchange rate changes and other control variables relevant for pricing. We follow the literature and estimate the standard

[12] Attenuation bias is not a worry in this context, since the explanatory variables of interest (exchange rates) are precisely measured, except perhaps for time aggregation issues at the annual frequency.

pass-through regression as described in Burstein and Gopinath (2014). In the rest of this section, the cross-sectional unit is an *ordered* country pair (i, j). We estimate

$$\Delta p_{ij,t} = \lambda_{ij} + \delta_t + \sum_{k=0}^{2} \beta_k \Delta e_{ij,t-k} + \sum_{k=0}^{2} \beta_k^{\$} \Delta e_{\$j,t-k} \\ + \sum_{k=0}^{2} \eta_k \Delta e_{ij,t-k} \times S_j + \sum_{k=0}^{2} \eta_k^{\$} \Delta e_{\$j,t-k} \times S_j + \theta' X_{i,t} + \varepsilon_{ij,t}, \tag{21}$$

where λ_{ij} and δ_t are dyadic and time fixed effects. $X_{i,t}$ are other country i controls, namely the change in the (log) producer price index of the exporting country i measured in currency i (and two lags).[13] We have modified the textbook pass-through regression by including the dollar exchange rate, i.e., the log price $e_{\$j}$ of a U.S. dollar in currency j, alongside the bilateral exchange rate, as suggested in Section 2.4. Lastly, we interact the bilateral and dollar exchange rates with the importing country's dollar invoicing share S_j. We consider different versions of this general specification, omitting dollar exchange rates and/or interaction terms.

As a benchmark, the estimates from bilateral pass-through regressions on bilateral exchange rates (i.e., omitting the dollar exchange rates and interaction terms) are reported in columns (1) and (4) of Table 3. The two columns correspond to unweighted and trade-weighted regressions, respectively.[14] According to the regression estimates, when country j's currency depreciates relative to country i by 10%, import prices in country j rise by 8%, suggestive of close to complete pass-through at the one year horizon.[15] The second and third lags (not reported) are economically less important.

Columns (2) and (5) report estimates from regressions that include the dollar exchange rate in addition to the bilateral one. Including the dollar exchange rate sharply reduces the relevance of the bilateral exchange rate. It knocks the coefficient on the bilateral exchange rate from 0.76 to 0.16 in the unweighted regression, and from 0.77 to 0.34 in the weighted regression. Instead, almost all of

[13]Online appendix A.2.5 shows that our results are robust to adding importer PPI and GDP growth as additional control variables.

[14]Henceforth, the trade weights are given by the average (across the years 1992–2015) share of world non-commodities trade value attributable to an *ordered* dyad (i, j).

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

Exchange rate pass-through into prices

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

Table 3: The first (resp., last) three columns use unweighted (resp. trade-weighted) regressions. All regressions include two ΔER lags, lags 0–2 of exporter ΔPPI, and time FE. S.e. clustered by dyad. *** p<0.01, ** p<0.05, * p<0.1.

the effect is absorbed by the dollar exchange rate.[16] Notice that, due to our inclusion of time fixed effects, the apparent dominance of the dollar cannot be an artifact of special conditions that may apply in times when the dollar appreciates or depreciates against *all* other currencies, for example due to global recessions or flight to safety in asset markets. Online appendix A.2.5 shows that our results are robust to the choice of time sample, including removing the post-2008 period.

The cross-dyad heterogeneity in pass-through coefficients is related to the propensity to invoice imports in dollars. Columns (3) and (6) interact the dollar and bilateral exchange rates with the share of invoicing in dollars at the importer country level, as in regression Eq. (21). Notice that we do not have data on the fraction of *bilateral* trade invoiced in dollars, so we use the importer's country-level share as a proxy. As expected, the import invoicing share plays an economically and statistically

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

significant role for the dollar pass-through. Depending on whether we use trade weights or not, the regression results indicate that increasing the dollar invoicing share by 10 percentage points causes the contemporaneous dollar pass-through to increase by 3.5–7.6 percentage points. The R^2 values of the panel regressions are substantially improved by adding the invoicing share interaction terms.

Figs. 4 and 5 depict the regression results visually in the form of impulse response functions. Fig. 4 shows the impulse responses of the bilateral import price *level*. The top row shows unweighted regression results, the bottom row uses trade weights as described above. The left column shows the bilateral pass-through in the specifications without the dollar exchange rate, while the right column compares the bilateral and dollar pass-throughs in specifications with both exchange rates. Fig. 5 illustrates the pass-through heterogeneity as a function of the invoicing share S_j, as implied by the regression specifications with interactions. The figure focuses on three dollar shares: $S_j = 0.13$ (corresponding to Switzerland), $S_j = 0.59$ (Turkey), and $S_j = 0.88$ (Argentina). As depicted in Fig. 5, dollar pass-through is highest for Argentina with the largest dollar invoicing share and the least for Switzerland with its low dollar share. In the trade-weighted regressions (bottom row of Fig. 5), dollar pass-through is lower than bilateral pass-through for Switzerland, and that ranking is flipped for the case of Turkey and Argentina.

Online appendix A.2.1 shows that dollar dominance holds up qualitatively across flows between different country groups, advanced or emerging. Although flows between emerging markets exhibit stronger dollar dominance, our results are not limited to flows involving emerging markets.[17]

3.4 Trade Volume Elasticity

Having demonstrated the outsized role of the U.S. dollar for international prices, we now show that the dollar also dominates the bilateral exchange rate when predicting bilateral trade volumes (testable implication 3). Table 4 shows the results from panel regressions of trade volumes on bilateral and dollar exchange rates. Let y_{ij} denote the log volume of goods exported from country i to country

[17] These facts are in line with the results in Table 3 for regressions that interact with the dollar invoicing share, since emerging markets tend to have higher dollar invoicing shares.

Average price pass-through

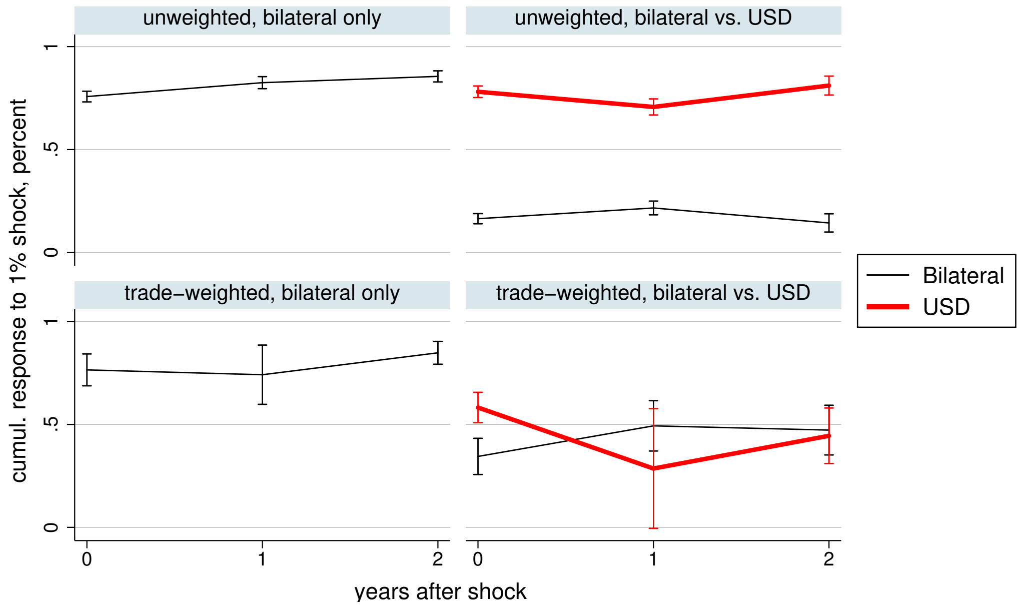


Figure 4: Impulse responses of bilateral price level to bilateral $e_{ij,t}$ and USD $e_{\$j,t}$ exchange rates. Based on the regressions in Table 3 without interactions. Top row: unweighted regression, bottom row: trade-weighted. Left column: specifications (1) and (4), right column: specifications (2) and (5). Error bars: 95% confidence intervals, clustering by dyad.

Price pass-through as a function of invoicing share

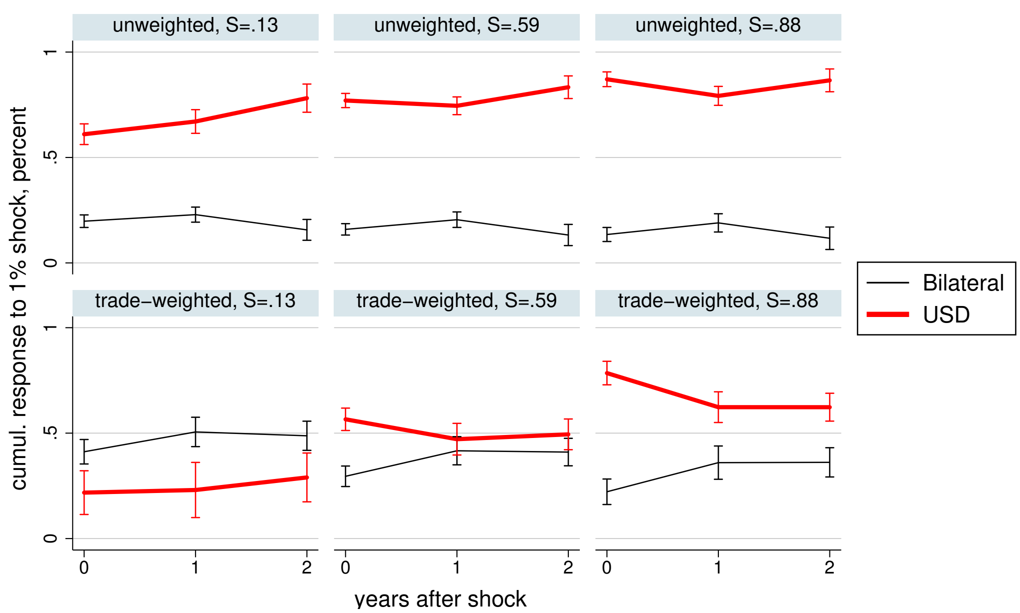


Figure 5: Impulse responses of bilateral price level to bilateral $e_{ij,t}$ and USD $e_{\$j,t}$ exchange rates, as a function of importer's dollar invoicing share S_j. Based on regression specifications (3) and (6) in Table 3 with interactions. Top row: unweighted regression, bottom row: trade-weighted. Error bars: 95% confidence intervals, clustering by dyad.

Trade elasticity with respect to exchange rate

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

Table 4: The first (resp., last) three columns use unweighted (resp. trade-weighted) regressions. All regressions include two ΔER lags, lags 0–2 of importer ΔGDP, and time FE. S.e. clustered by dyad. *** p<0.01, ** p<0.05, * p<0.1.

j. Our volume regressions take the same form as in the price pass-through regression, Eq. (21), except that the dependent variable is now the log growth rate $\Delta y_{ij,t}$ of bilateral trade volumes, and the extra controls $X_{j,t}$ (here indexed by j rather than i) consist of the log growth rate of real GDP (and two lags) for the importing country j. These regressions do not capture structural demand elasticity parameters, since we do not attempt to control for all relevant relative prices, and the importer's GDP growth is an imperfect proxy for the level of import demand. In particular, we cannot simply add importer $\times$ year fixed effects since these would absorb the dollar exchange rate. Hence our results will invariably conflate expenditure switching and shifts in aggregate import demand. The correct interpretation is to view these regressions as predictive relationships that may inform potential structural estimation exercises. Nevertheless, we will refer to the coefficients on exchange rates as "trade elasticities" for simplicity.

The volume regressions underline the dominant role played by the U.S. dollar. As in the case of

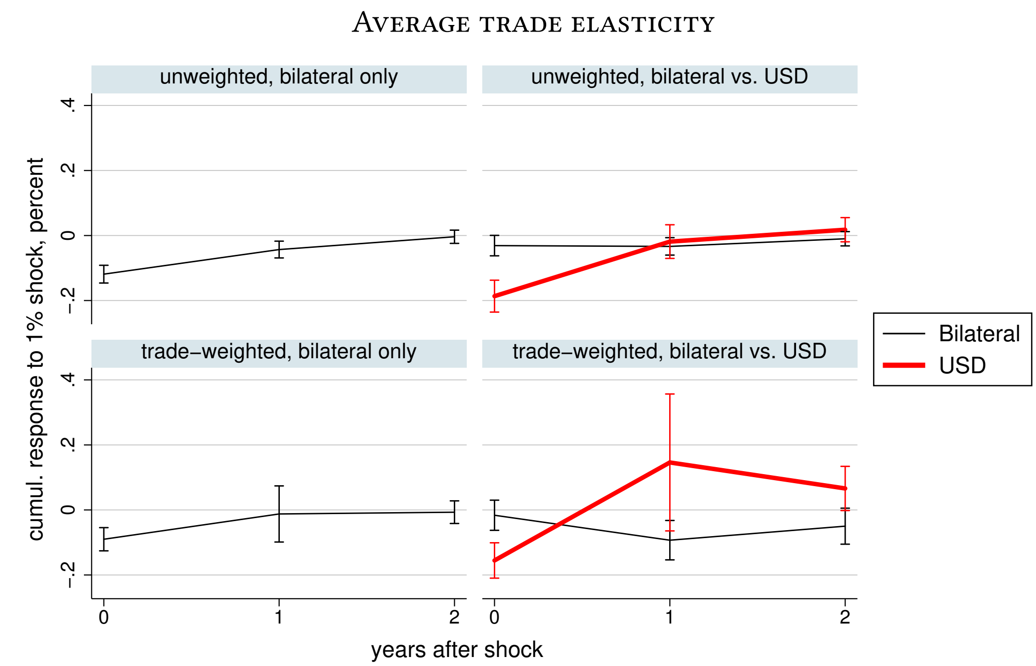


Figure 6: Impulse responses of bilateral volume to bilateral $e_{ij,t}$ and USD $e_{\$j,t}$ exchange rates. Based on regressions in Table 4 without interactions. Top row: unweighted regression, bottom row: trade-weighted. Left column: specifications (1) and (4), right column: specifications (2) and (5). Error bars: 95% confidence intervals, clustering by dyad.

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

Fig. 6 visually depicts the regression results in the form of impulse responses. The figure shows the response of the level of bilateral trade volume to exchange rate shocks. The right column shows results from regressions with both bilateral and dollar exchange rates. It is apparent from the figure that the dollar exchange rate has a much more negative impact effect than the bilateral exchange rate. Yet, the figure also shows that the effect of either exchange rate on the level is essentially neutral at horizons of 1–2 years. One potential explanation is that the ratio of import prices and domestic prices adjust with a lag to exchange rate changes, implying that a year after the initial shock, relative prices

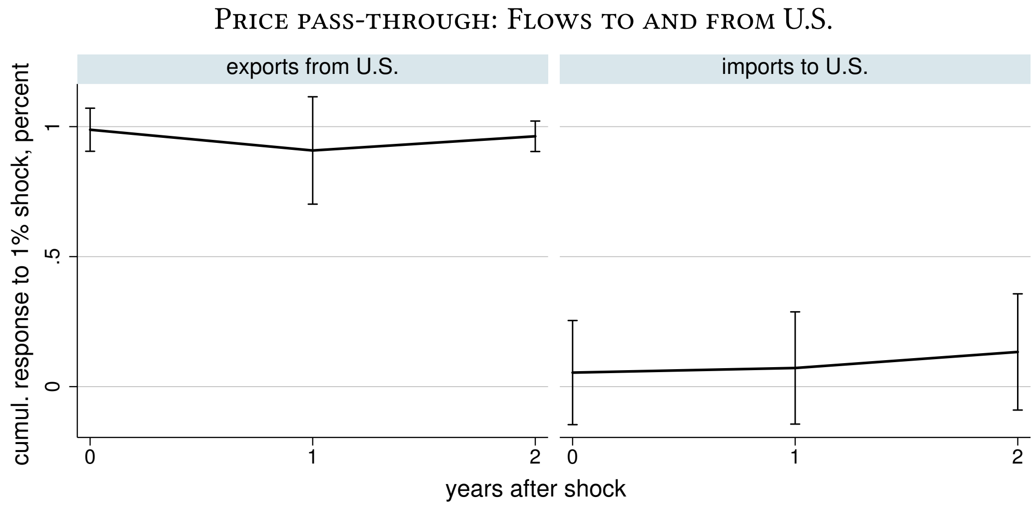


Figure 7: Impulse response of bilateral price level to bilateral exchange rate $e_{ij,t}$. Left column: U.S. exports, right column: U.S. imports. Error bars: 95% confidence intervals, clustering by dyad and applying small-sample "LZ2-BM" adjustment in Imbens and Kolesár (2016).

faced by consumers are mostly unchanged compared to the period before the shock. However, we show in online appendix A.2.5 that this particular finding is driven by the early years in our sample, as results on the 2002–2015 subsample point toward a large and persistent negative effect of dollar appreciations on the volume of bilateral trade.

Online appendix A.2.1 confirms that the contemporaneous trade elasticity of the dollar dominates the bilateral exchange rate elasticity in most breakdowns of emerging/advanced economy trade flows. Overall, the data indicates that a substantially negative dollar elasticity, coupled with a smaller bilateral exchange rate elasticity, is a common feature to emerging and advanced economy trade flows.

3.5 Trade Flows to and from the U.S.

The data is consistent with an additional key prediction of DCP: trade flows with the U.S. are special (testable implications 2-3). Specifically, we show that bilateral exchange rate pass-through into U.S. export prices (in the destination currency) is complete and immediate, while U.S. import prices (in dollars) are insensitive to bilateral exchange rates. Moreover, U.S. import volumes are insensitive to the bilateral exchange rate, as predicted by theory.

Trade elasticity: U.S. vs. non-U.S. imports

	unweighted (1) $\Delta y_{ij,t}$	trade-weighted (2) $\Delta y_{ij,t}$
$\Delta e_{ij,t}$	-0.121***	-0.107***
	(0.0141)	(0.0194)
$\Delta e_{ij,t} \times$ ImpUS	0.124***	0.117***
	(0.0329)	(0.0318)
R-squared	0.069	0.180
Observations	52,272	52,272
Dyads	2,807	2,807

Table 5: "ImpUS" is in indicator for whether importing country is the U.S. Both regressions include two ΔER lags, lags 0–2 of importer ΔGDP, and time FE, as well as interactions of these variables with ImpUS. S.e. clustered by dyad. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Fig. 7 shows impulse response functions of import prices for goods flowing from or to the U.S. These figures are obtained from panel regressions as in the baseline unweighted fixed effects specifications in Section 3.3, except we drop the dollar exchange rate (but preserve the time fixed effects). Consistent with the very high fraction of U.S. exports and imports being invoiced in dollars (97% and 93%, respectively), bilateral exchange rate pass-through into prices is 100% on impact for U.S. exports and close to zero for U.S. imports.

Table 5 confirms that U.S. import volumes are insensitive to bilateral exchange rates, unlike the imports of the rest of the world from the U.S. We run a fixed effects regression of trade volume growth on lagged bilateral exchange rates, importer GDP, and year fixed effects, as in specifications (1) and (4) of Table 4. Here, however, we additionally interact all right-hand side variables with an indicator for whether the importing country is the U.S. When the importing country is *not* the U.S., the within-year bilateral trade volume response is estimated at -0.12% (unweighted) following a 1% depreciation of the importer currency, similar to the all-country regression in Table 4. In contrast, we find U.S. imports to be completely insensitive to the bilateral exchange rate on impact, with an implied contemporaneous import volume response of 0.003% following a 1% depreciation of the dollar.

The difference between the contemporaneous import elasticity for the U.S. vs. that for the rest of the world is highly significant. Hence, the data indicates that U.S. trade balance adjustment following exchange rate movements occurs primarily through exports rather than imports, a consequence of the predominance of dollar invoicing in U.S. trade.

3.6 Effect of U.S. Dollar on Rest-of-World Trade and Inflation

Underscoring the quantitative significance of DCP, we argue now that the dollar has substantial predictive power for aggregate trade among countries in the rest of the world (testable implication 4). That is, the dollar is important for predicting global trade, even when excluding countries' direct trade with the U.S. Specifically, a 1% U.S. dollar appreciation against all other currencies in the world predicts a 0.6% decline within a year in the volume of total trade between countries in the rest of the world, holding constant various proxies for the global business cycle.

We measure the elasticity of rest-of-world trade volume to the dollar by aggregating up from our richest bilateral panel regression specification. This produces results that exploit our panel data set, unlike a simple annual time series regression of global trade on an effective dollar exchange rate index. Consider the following regression model with bilateral, dollar, and euro exchange rates, as well as interactions with dollar and euro import invoicing shares:

$$\begin{aligned}\Delta y_{ij,t} = & \textstyle\sum_{k=0}^{2} \left(\beta_k + \eta_k(1 - S_j - S_j^{€})\right) \Delta e_{ij,t-k} \\ & + \textstyle\sum_{k=0}^{2} \left(\beta_k^{\$} + \eta_k^{\$} S_j\right) \Delta e_{\$j,t-k} \\ & + \textstyle\sum_{k=0}^{2} \left(\beta_k^{€} + \eta_k^{€} S_j^{€}\right) \Delta e_{€j,t-k} \\ & + \lambda_{ij} + \theta' X_{ij,t} + \varepsilon_{ij,t}. \end{aligned} \tag{22}$$

Here S_j and $S_j^{€}$ are the importer's country-level dollar and euro invoicing shares, respectively, and λ_{ij} is a dyad fixed effect. Because we are interested in the effect of a dollar appreciation against all other currencies, we do not control for time fixed effects. Instead, we control for several proxies for the global business cycle, as described in online appendix A.2.3, except here we exclude world export volume growth. $X_{ij,t}$ also includes lags 0–2 of importer real GDP growth.

The object of interest is the response of rest-of-world (i.e., ex-U.S.) aggregate trade volume to a 1% appreciation of the dollar relative to all other currencies, holding constant the global business cycle. As in Eq. (19) of Section 2.4, we consider the weighted average trade elasticity to a dollar appreciation, where we average over all trading pairs in the world, excluding the U.S. Consistent with the focus on importers in the rest of this section, our empirical specification in Eq. (22) assumes that the trade elasticity is heterogeneous across importers but homogeneous across exporters. That is, in the notation of Eq. (19), the trade elasticity at lag k with respect to the dollar exchange rate is given by $\sigma_{ij} = \sigma_j = \beta_k^{\$} + \eta_k^{\$} S_j$. Let w_j denote country j's total non-commodity import value from all countries except the U.S. in some reference year, normalized so that $\sum_{j \neq \$} w_j = 1$.[18] Then the *ceteris paribus* effect of a 1% dollar appreciation on $\sum_{j \neq \$} w_j \Delta y_{ij,t}$, the weighted growth of rest-of-world imports from destination i, is given by

$$\sum_{j \neq \$} w_j (\beta_k^{\$} + \eta_k^{\$} S_j) = \beta_k^{\$} + \eta_k^{\$} \sum_{j \neq \$} w_j S_j$$

k years after the appreciation, and this quantity is by assumption the same for each exporter i other than the U.S. Thus, to measure the response of rest-of-world aggregate imports to a dollar appreciation, we simply use the estimated Eq. (22) to compute the impulse response of trade volume for an importer j whose U.S. dollar invoicing share happens to equal $\sum_{j \neq \$} w_j S_j$, the weighted average dollar invoicing share.[19]

Fig. 8 shows that rest-of-world aggregate import volume contracts markedly following an appreciation of the dollar against all other currencies. A 1% *ceteris paribus* dollar appreciation leads to a 0.6% contraction in rest-of-world trade volume within the year (regardless of whether we use unweighted or trade-weighted regressions), and this contractionary effect persists out to at least two years. Recall that the regression controls for various proxies for the global business and financial

[18]"All countries" refers to the world aggregate in Comtrade, not only the countries in our regression sample. Note that the weight w_j is different from the weights used in the trade-weighted regressions in Table 4 and elsewhere.

[19]In practice, w_j depends on the year in which import values are measured, but online appendix A.2.5 shows that the weighted average $\sum_{j \neq \$} w_j S_j$ fluctuates little around a mean of 0.40 in the 2002–2015 sample, so we use that value.

Response of rest-of-world aggregate trade to USD appreciation, 2002–2015

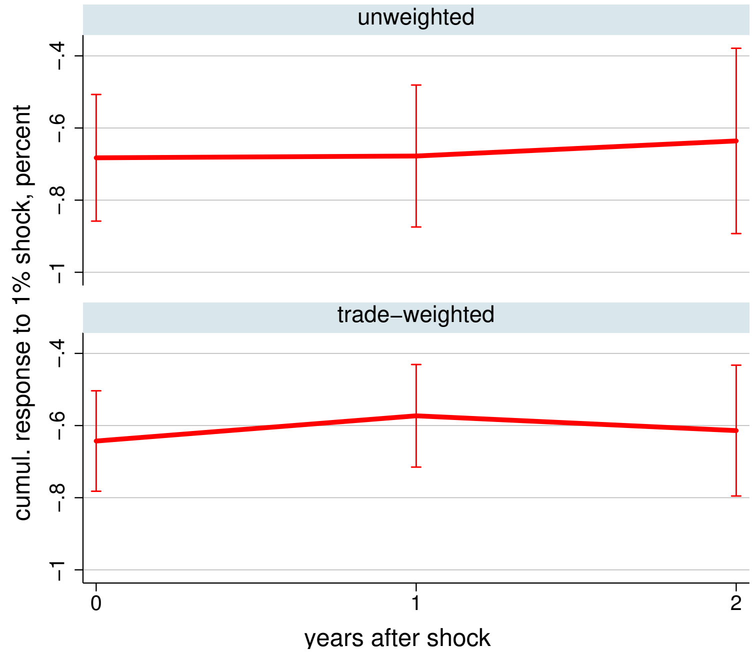


Figure 8: Impulse responses of rest-of-world aggregate trade volume to a 1% U.S. dollar appreciation against all other currencies, holding constant all other exchange rates and the global business cycle. Top row: unweighted regression, bottom row: trade-weighted. Error bars: 95% confidence intervals, clustering by dyad.

cycles. While our regression specification cannot be interpreted structurally, the magnitude of the predictive effect underscores the importance of the dollar's role in world trade. Online appendix A.2.4 shows that the large negative predictive effect of a dollar appreciation on world trade is robust to controlling for the exchange rates of the Swiss franc and Japanese yen. Hence, the central finding in this subsection is not an artifact of conflating periods of overall dollar appreciation with periods of global flight to safety.

Finally, country-level regressions reveal significant dollar pass-through to foreign consumer and producer prices that increases with countries' dollar invoicing share in imports. Earlier work by Gopinath (2015) provides back-of-the-envelope calculations of dollar exchange rate spillovers on foreign consumer and producer prices based on estimated country-level import price pass-through and the import content of consumption. We take a more direct approach and regress countries' CPI or PPI on the dollar exchange rate as well as its interaction with the dollar invoicing share in imports using a specification with country and time fixed effects, detailed in online appendix A.2.2. We find the average pass-through of the dollar into CPI (resp., PPI) to be 11% (resp., 28%) within the year, and is higher for countries with a higher dollar invoicing share of imports.

3.7 Robustness

Our results are robust to many different variations, some of which have already been mentioned in previous sections alongside the description of our benchmark results and summarized here. First, our results are robust when considering trade flows within/across advanced or emerging market economies (see online appendix A.2.1). In particular, our results are not limited to flows involving emerging markets.

Second, our results are robust to excluding the global financial crisis and to controlling for the euro exchange rate. Online appendix A.2.5 documents that our headline results are not driven by the global financial crisis starting in 2008. The estimated average exchange rate pass-through and trade elasticity computed on the 1992–2007 sample are almost identical to our baseline Figs. 4 and 6. When computing the effect of a uniform U.S. dollar appreciation on rest-of-world trade as in Section 3.6, we find even stronger effects during the pre-crisis period 2002–2007.

Third, online appendix A.2.3 shows that the euro exchange rate is much less quantitatively important than the dollar exchange rate in price and volume regressions. Lastly, online appendix A.2.4 shows that the large negative predictive effect of a dollar appreciation on world trade is robust to further controlling for the exchange rates of the Swiss franc and Japanese yen.

4 Firm Level Empirical Evidence

We now move from aggregate bilateral data on trade volume and value to firm level customs data on exports and imports for a small open economy, Colombia. While the global evidence has the virtue of covering 91% of world trade, it lacks granularity and the indices are at the annual frequency. To assuage any concerns that our findings may be contaminated by composition effects this section demonstrates that the findings in Section 3 hold when we define prices and quantities at the firm-

10-digit product-country (origin or destination)-quarter (or year) level. In addition we show that the DCP model matches the dynamic path of price pass-through in the data unlike the competing paradigms. The details of the data are relegated to online appendix A.3.

The Colombian currency (peso) is a commodity currency and fluctuations in its value are strongly negatively correlated with fluctuations in commodity prices.[20] Fig. 9 displays the relation between the Colombian peso (peso price of the dollar, solid line) and the overall (log) terms-of-trade (dashed line), defined as the log difference between import and export prices. This terms-of-trade is driven primarily by commodity prices. The correlation between the two series is 0.62 and a regression of the overall terms of trade on the peso/dollar exchange rate yields a coefficient on the exchange rate of 1.15 (R^2 of 0.38). If we focus instead on the non-commodity terms-of-trade (dots-and-dash line) we find that the terms-of-trade is far more stable with a regression coefficient of 0.33 (R^2 of 0.36), consistent with the predictions of the model under DCP.[21]

In the rest of our empirical analysis we focus on manufactured goods, consistent with the approach in Section 3, excluding products in the petrochemicals and basic metals industries. We follow the ISIC Rev. 3.1 classification to define which products are manufactures.[22]

4.1 Results

We estimate the same pass-through regression of exchange rates into import and export prices (measured in pesos) as in Section 3, Eq. (21), omitting interaction terms and time effects, since the latter would absorb the dollar exchange rate. We include firm-industry-country fixed effect, which subsume dyad fixed effects, as well as quarter dummies to account for seasonality.[23] We add the contemporaneous effect and eight lags of the quarterly log change in the nominal exchange rate of the *peso*

[20]The Colombian peso officially switched to a floating status in 1999. Commodity prices can be considered as exogenous to the economy: while mining output makes up 58.4% of total exports for Colombia, it is small relative to world commodity markets. For example, Colombia's oil production was 1.1% of world oil production in 2014.

[21]The TOT(manuf) is constructed by excluding 'traditional' exports/imports such as oil, coal, metals, coffee, bananas or flowers. Although it does not consist exclusively of manufactured goods, these represent more than 90 percent of the basket.

[22]As a robustness check we also use the subsample of differentiated products only (instead of the full set of manufactures presented) constructed using the classification of goods by Rauch (1999). This is available in online appendix A.4.

[23]We also estimate the regression controlling for contemporaneous and eight lags of quarterly log changes in the producer price index in Colombia and in the origin/destination country and our estimates are practically unchanged.

Exchange rate and terms of trade for Colombia

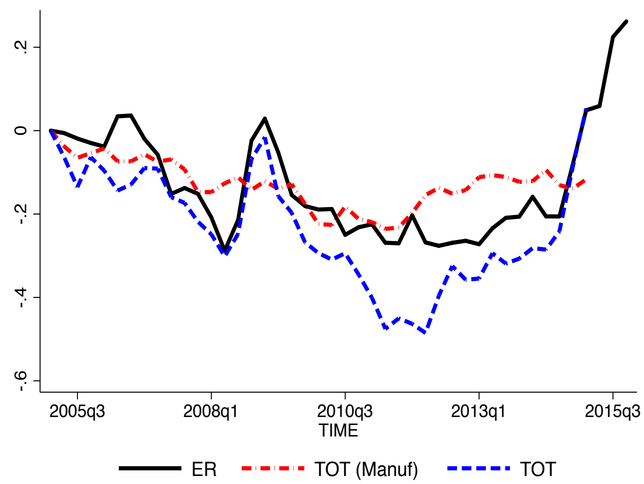


Figure 9: Data from Banco de la República. TOT is calculated using the PPI of all imports and exports. TOT (Manuf) is calculated using the PPI for 'non-traditional' imports and exports, that exclude products such as oil, coal and metals, and include mostly manufactured goods.

relative to the dollar regardless of origin or destination country. The cumulative estimates $\sum_{s=0}^{k} \beta_s$ and two standard error bands with standard errors clustered at the quarter-year level are plotted in Fig. 10. It reports the pass-through into export and import prices (columns) to/from dollarized and non-dollarized countries (rows).

Consistent with DCP, all pass-throughs start out close to one and decline slowly over time. This is the case for both export and import prices and for dollar and non-dollar destinations/origins. In the case of export prices to dollar destinations the contemporaneous estimate is 0.84 and then the cumulative pass-through slowly decreases after two years to 0.56. The estimates are similar in the case of non-dollar destinations. In the case of import prices from dollar origins pass-through is very high, around 1 and the cumulative effect declines to 0.8. For non-dollar origins the estimated pass-through starts at around 0.87 and decreases to 0.49 after two years.

The second set of regressions replicates the regressions in Section 3 by aggregating data to the annual frequency (the unit of observation remains firm-10-digit product-country-origin/destination). The estimates are reported in Table 6 for the various specifications. The results re-confirm the find-

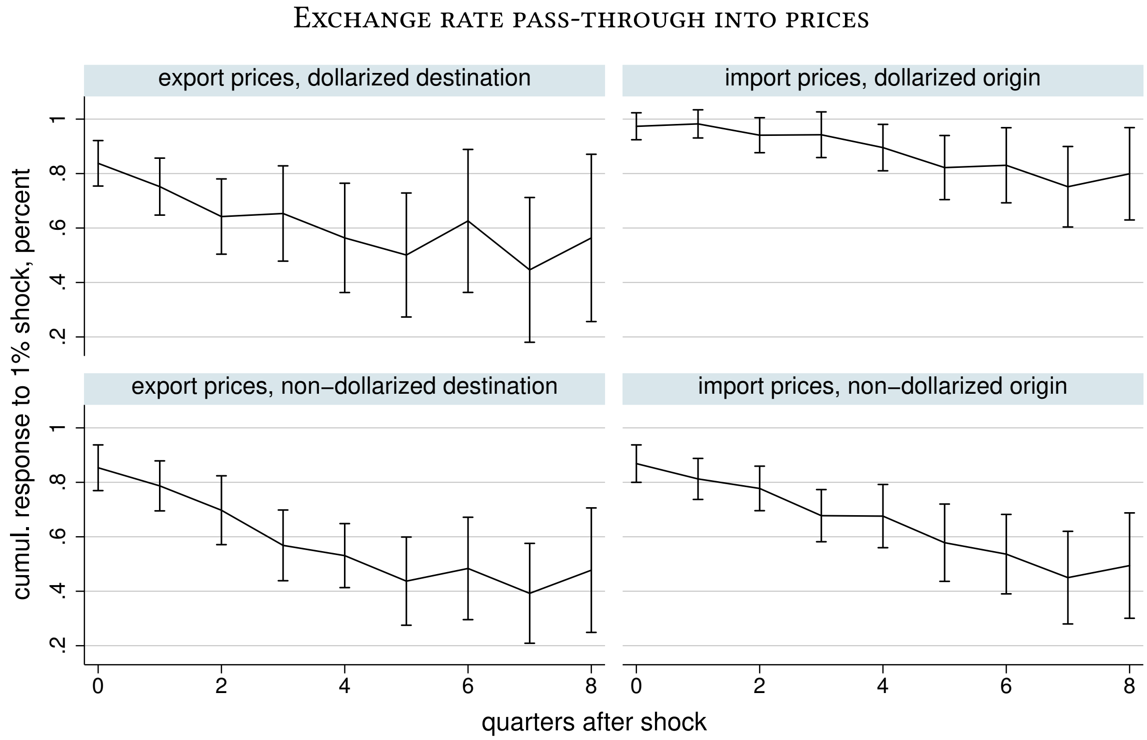


Figure 10: Exchange rate pass-through into export and import prices, to/from dollarized and non-dollarized economies. All regressions include Firm-Industry-Country fixed effects and quarterly dummies. 95% confidence intervals shown with s.e. clustered at the quarter-year level. The sample includes all manufactured products excluding petrochemicals and basic metals industries. Dollarized economies include USA, Puerto Rico, Panama, Ecuador and El Salvador. Non-dollarized economies include all other partners, except economies with currencies pegged to the dollar and Venezuela.

ings in Section 3 of the important role of the dollar in pass-through regressions. Robustness checks are presented in online appendix A.4.

Table 7 reports the results from annual quantity regressions. Starting with the dollarized economies, the pass-through to export quantities is insignificantly different from zero. On the other hand, for imports from dollarized economies there is a pronounced decline in quantities imported across all specifications. In the case of the non-dollarized economies, the decline in imports is also significantly negative and, importantly, the relevant exchange rate is the peso/dollar exchange rates as opposed to the bilateral exchange rate. For exports we again have that the relevant exchange rate is the peso/dollar exchange rate.

Exchange rate pass-through into prices, annual data

	dollarized economies		non-dollarized economies			
	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta p_{H,t}$	$\Delta p_{H,t}$	$\Delta p_{H,t}$	$\Delta p_{H,t}$	$\Delta p_{H,t}$	$\Delta p_{H,t}$
Exports						
$\Delta e_{iH,t}$			0.673***	0.0616	0.523***	0.0726
			(0.0937)	(0.0474)	(0.120)	(0.0452)
$\Delta e_{\$H,t}$	0.696***	0.828***		0.667***		0.633***
	(0.0331)	(0.0355)		(0.0507)		(0.0602)
PPI	no	yes	no	no	yes	yes
R-squared	0.288	0.290	0.303	0.305	0.308	0.310
Observations	169,792	159,041	206,226	206,226	139,318	139,318
Imports						
$\Delta e_{iH,t}$			0.750***	0.315***	0.506***	0.275***
			(0.116)	(0.0777)	(0.127)	(0.0837)
$\Delta e_{\$H,t}$	0.977***	1.007***		0.528***		0.534***
	(0.0177)	(0.0309)		(0.0650)		(0.0510)
PPI	no	yes	no	no	yes	yes
R-squared	0.225	0.225	0.287	0.290	0.291	0.293
Observations	529,584	529,260	931,993	931,993	808,304	808,304

Table 6: All regressions include Firm-Industry-Country fixed effects. S.e. clustered at the year level. The sample includes all manufactured products excluding petrochemicals and basic metals industries. The results are robust to the inclusion of the peso/euro exchange rate as a potential alternative dominant currency, and to the inclusion of two ΔER lags. If we limit the sample to differentiated products only, results are qualitatively unchanged. *** p<0.01, ** p<0.05, * p<0.1.

Trade elasticity with respect to exchange rate, annual data

	dollarized	non-dollarized	
	(1)	(2)	(3)
	$\Delta y_{H,t}$	$\Delta y_{H,t}$	$\Delta y_{H,t}$
Exports			
$\Delta e_{iH,t}$		-0.763***	-0.0553
		(0.212)	(0.314)
$\Delta e_{\$H,t}$	-0.425		-1.007**
	(0.370)		(0.322)
Euro ER	yes	no	yes
R-squared	0.225	0.250	0.245
Observations	159,041	139,318	120,316
Imports			
$\Delta e_{iH,t}$		-0.703***	-0.319
		(0.217)	(0.246)
$\Delta e_{\$H,t}$	-0.959***		-0.922***
	(0.407)		(0.245)
Euro ER	yes	no	yes
R-squared	0.184	0.236	0.254
Observations	529,276	808,409	519,002

Table 7: All regressions control for PPI, importer GDP, and Firm-Industry-Country fixed effects. S.e. clustered at the year level. See also caption for Table 6. *** p<0.01, ** p<0.05, * p<0.1.

4.2 Matching Model and Data

In this section we simulate data for a small open economy calibrated to match the Colombian economy (denoted H) that trades with the dominant currency area (denoted \$ in this section) and the rest-of-the world R. The model is identical to the one described in Section 2 except that we modify the budget constraint slightly to include shocks to oil earnings. Specifically the budget constraint takes the form:

$$P_{j,t}C_{j,t} + \mathcal{E}_{\$j,t}(1+i^{\$}_{j,t-1})B^{\$}_{j,t} + B_{j,t} \quad = \quad W_{j,t}(h)N_{j,t}(h) + \Pi_{j,t} + \mathcal{E}_{\$j,t}B^{\$}_{j,t+1}$$

$$+\sum_{s'\in\mathcal{S}} Q_{j,t}(s')B_{j,t+1}(s') + \mathcal{E}_{\$j,t}\zeta_t.$$

where ζ_t is the dollar value of the endowment of oil. A decline in ζ_t captures a decline in the price of oil. We capture the relation between $\mathcal{E}_{\$H,t}$ and $\mathcal{E}_{RH,t}$ using the following reduced form relation between the two real exchange rates (in logs):

$$e_{RH,t} + p_{R,t} - p_{H,t} = \eta\left(e_{\$H,t} + p_{\$,t} - p_{H,t}\right) + \varepsilon_{R,t} \tag{23}$$

In Eq. (23), $p_{i,t}$ denotes the (log) consumer price level in country $i \in \$, R$ in its respective currencies, $\varepsilon_{R,t}$ captures idiosyncratic fluctuations in the \$-R exchange rate while η captures the co-movement between the two real exchange rates. With this flexible specification, we can explore separately how fluctuations in $\mathcal{E}_{\$H,t}$ and $\mathcal{E}_{RH,t}$ impact prices and quantities in H, under different pricing paradigms.[24]

The model therefore features three sources of fluctuations: productivity shocks a_t, endowment shocks ζ_t that capture the exogenous fluctuations in the price of oil, and exogenous shocks to the \$-R exchange rate $\varepsilon_{R,t}$. These shocks follow autoregressive processes:

$$\zeta_t - \bar{\zeta} = \rho_\zeta(\zeta_{t-1} - \bar{\zeta}) + \epsilon_{\zeta,t} \tag{24}$$

$$a_t = \rho_a a_{t-1} + \epsilon_{a,t} \tag{25}$$

$$\varepsilon_{R,t} = \rho_R \varepsilon_{R,t-1} + \epsilon_{R,t} \tag{26}$$

where $\bar{\zeta}$ is the steady state value of the commodity price, and $\epsilon_{\zeta,t}$ are serially independently distributed innovations. We allow the productivity and commodity price innovations to be correlated, and denote $\rho_{a,\zeta} = \text{corr}(\epsilon_{a,t}, \epsilon_{\zeta,t})$.

We use a combination of calibration and estimation to parameterize the model, the details of which are provided in online appendix A.5. We match several moments in the data, including price pass-through regression coefficients as well as estimated parameters in the time series processes

[24] An alternative set-up would be to allow for the small open economy to borrow internationally in both \$ and R currencies. Then, even if interest rates in the \$ and R do not change, shocks that drive a wedge in the UIP conditions (commonly used to capture risk-premia shocks) for each of the two currencies will generate fluctuations in $\mathcal{E}_{\$H,t}/\mathcal{E}_{RH,t}$.

for Colombia's real exchange rate, value added and commodity prices. The estimated model is very close to DCP. The export invoicing shares for Colombia are measured in the data directly and is 100% for exports to \$ and 93% for exports to R. The estimated import invoicing shares are 100% for imports from \$ and 93% for those from R. We simulate the parametrized model and plot the pass-through estimates from the estimated model, and counterfactual DCP, PCP and LCP models against the estimates from the data. In the case of the latter three we force the invoicing shares to take the extreme values of each of the paradigms, keeping all other parameter values unchanged.

Dynamics of pass-through. Fig. 11 reports the values for price pass-through for dollar destinations and Fig. 12 for non-dollar destinations. In each figure, export price pass-through are reported in the left column, and import price pass-through in the right column. Each row corresponds to a different model: the estimated model (top row), a full DCP counterfactual (second row), a PCP counterfactual (third row) and a LCP counterfactual (last row). Large solid circles for the pass-through of export and import prices to/from various destinations at impact represent values that were used in moment matching. The pass-through at other lags were not used in estimating parameters.

As is evident, the estimated model replicates the pass-through estimates at various lags for export prices to \$ and R and for import prices from \$ quite closely. While the match is less good for import prices from R, we still obtain that pass-through starts high and declines gradually. Inspecting the different rows, it is immediate that the estimated model is very close to DCP, and very different from a PCP or LCP counterfactual. PCP implies low initial pass-through into export prices, which then gradually increases over time, as prices are sticky in the exporting currency. LCP implies low pass-through into import prices, which then increases over time, as prices are sticky in the importing currency. In the case of non-dollar trading partners we similarly observe that DCP outperforms both PCP and LCP.

Relevance of bilateral exchange rates. The estimated model also matches the empirical fact that bilateral exchange rates show up as large and significant when they are the only exchange rate con-

Exchange rate pass-through for dollar origin/destination: Data vs. model

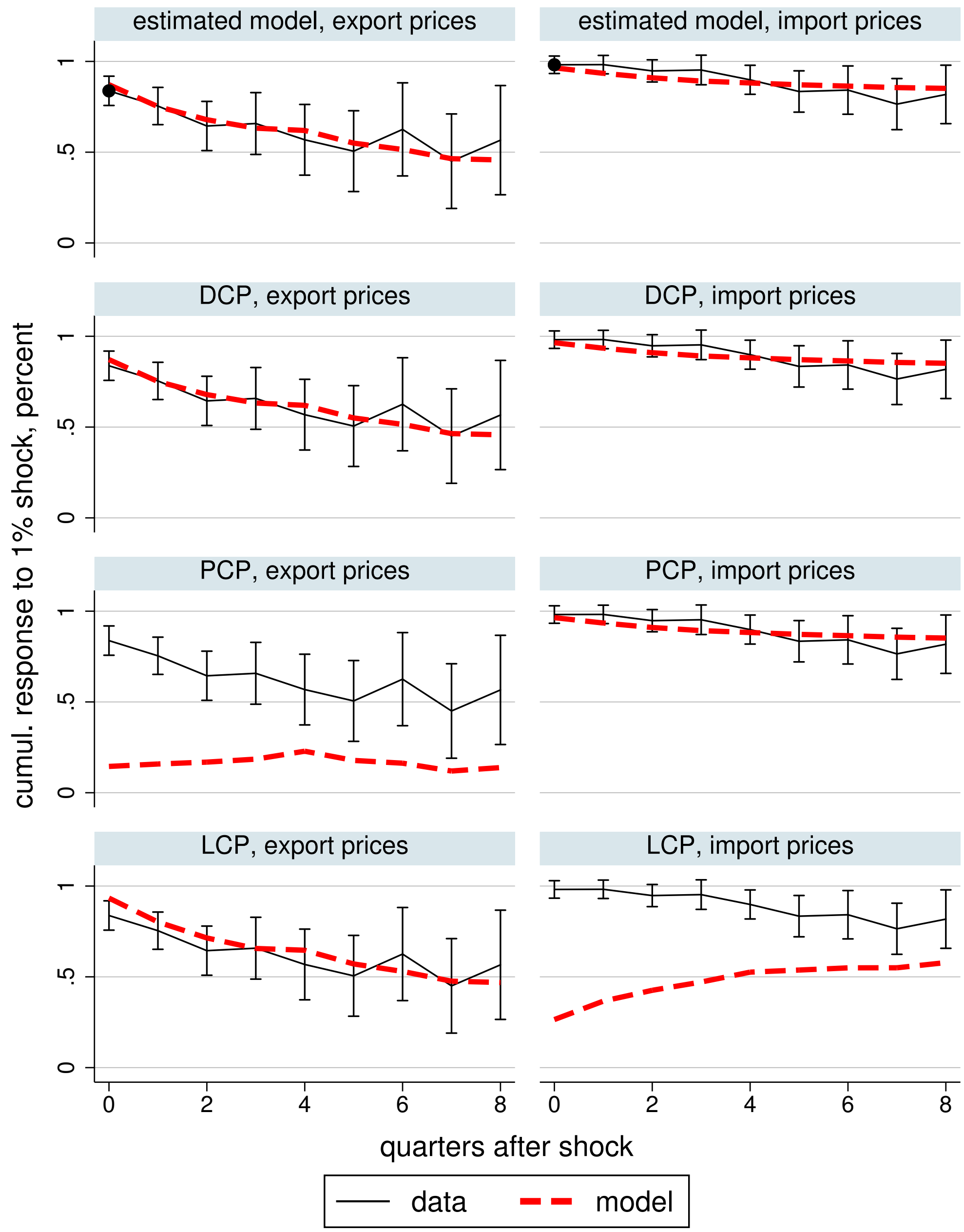


Figure 11: Exchange rate pass-through into export and import prices for Colombia with respect to dollar economies.

Exchange rate pass-through for non-dollar origin/destination: Data vs. model

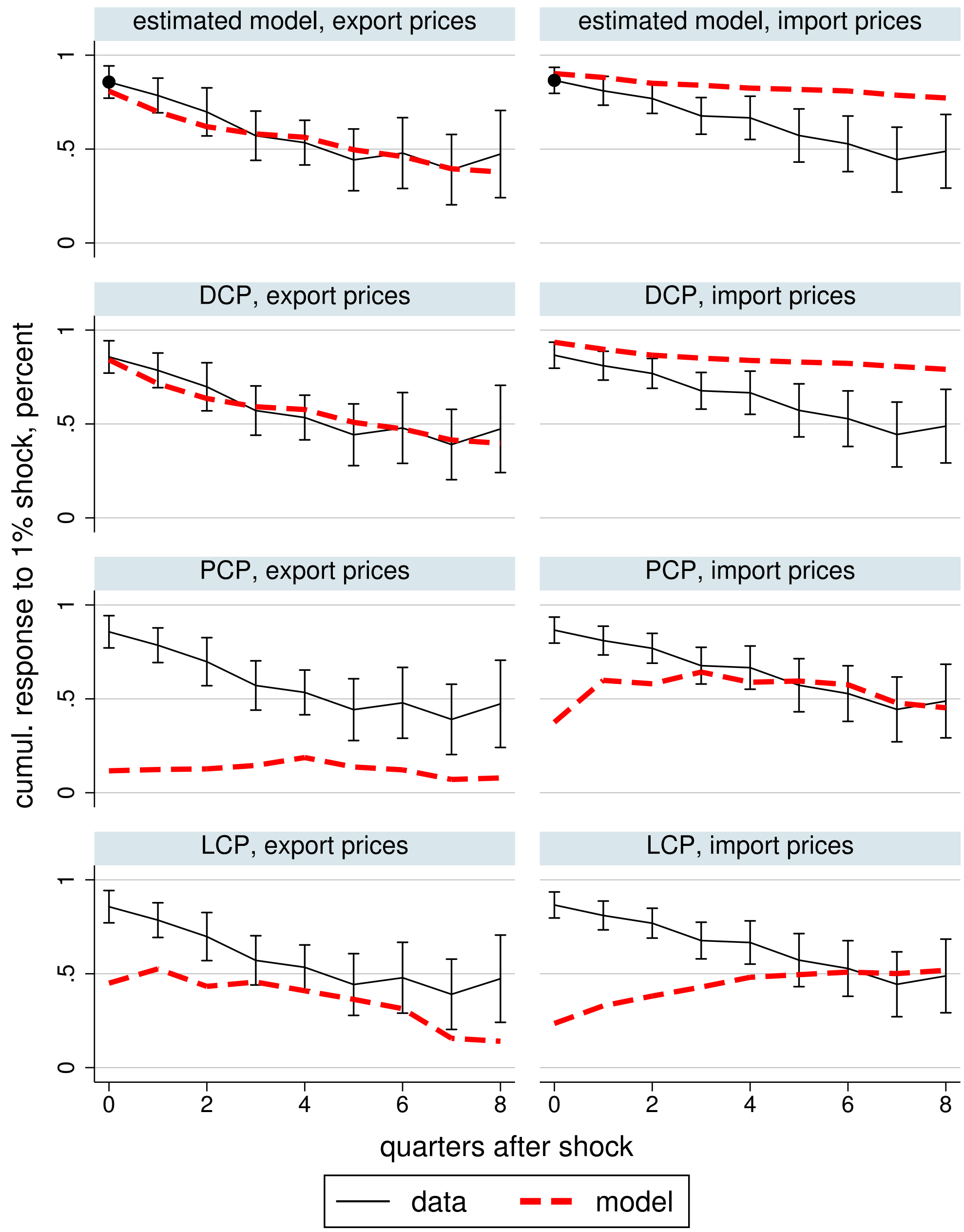


Figure 12: Exchange rate pass-through into export and import prices for Colombia with respect to non-dollar economies.

Exchange rate pass-through into prices: Estimated model

	(1) $\Delta p_{HR,t}$	(2) $\Delta p_{HR,t}$	(3) $\Delta p_{RH,t}$	(4) $\Delta p_{RH,t}$
$\Delta e_{RH,t}$	0.72	0.28	0.68	0.22
$\Delta e_{\$H,t}$		0.66		0.70

Table 8: Exchange rate pass-through into export and import prices to/from non-dollarized economies using model simulated data. Regressions have the bilateral exchange rate and the dollar exchange rate as controls.

Exchange rate pass-through into quantities: Estimated model

	(1) $\Delta y_{H\$,t}$	(2) $\Delta y_{\$H,t}$	(3) $\Delta y_{HR,t}$	(4) $\Delta y_{RH,t}$
$\Delta e_{\$H,t}$	0.26	-1.60	-1.33	-1.19
$\Delta e_{RH,t}$	-0.18	0.28	1.43	-0.11

Table 9: Exchange rate pass-through into export and import quantities to/from dollarized and non-dollarized economies. Regressions have the bilateral exchange rate, the dollar exchange rate, and the level of demand as controls.

trol in price or quantity regressions (for non-dollar destinations and origins), but drop significantly as a predictor of prices once the dollar exchange rate is also included in the specification. This is reported in Table 8 for price pass-through regressions and in Table 9 for trade elasticity regressions.[25] The estimated model generates a weak expansion in exports to \$ destinations following a depreciation and a more pronounced contraction in imports from both \$ and R consistent with the empirical evidence in Table 7. Exports to R are negatively impacted by depreciations relative to the dollar. Here again the dollar exchange rate is a major predictor of quantities for non-dollar regions.

[25] Online appendix A.5 documents that PCP and LCP are unable to match these facts.

Exchange rate pass-through: Role of α and Γ

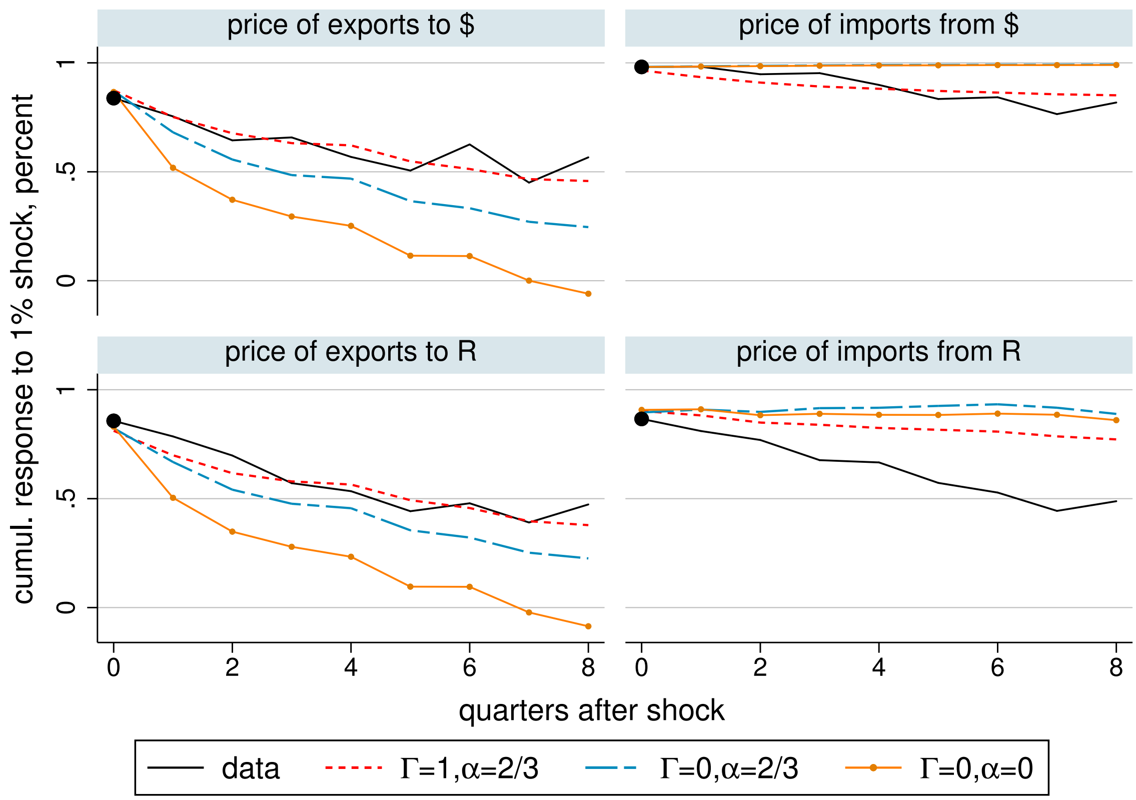


Figure 13: Exchange rate pass-through into export and import prices to/from dollar ($) or non-dollar (R) economies, for varying choices of α and Γ.

Importance of non-zero α and Γ. Finally, Fig. 13 explores the role of strategic complementarities in pricing and imported input use in production for our results. It contrasts the pass-through estimates when Γ (the markup elasticity) and α (the intermediate input share) are both set to 0 relative to the benchmark of $\Gamma = 1$ and $\alpha = 2/3$ (dashed line). This imposes constant mark-ups and a production function with labor only. The left column reports the dynamic pass-through of export prices, and the right column that of import prices. The top row reports export and import prices to/from $\$$ and the bottom row to/from R. Export price pass-through into H prices declines by a half at the one year horizon when Γ and α are both set equal to 0 (line with solid circles), compared to the data and the benchmark model predictions. In the case of import pass-through the difference is smaller (as to be expected given that the marginal cost of foreign firms are taken as exogenous), but in all cases the model's match with the data is the best under the benchmark specification. Strategic complementarities in pricing and imported input use in production are important factors controlling the (slow) dynamic of price pass-throughs.

5 Conclusion

Most trade is invoiced in very few currencies. Building from this key observation, this paper presents a *dominant currency paradigm* characterized by three key features: pricing in a dominant currency, strategic complementarities in pricing and imported input use in production. We integrate these new elements into a model of small or large open economies. The model is used to understand the consequences of home or dominant monetary policy shocks on exchange rates and fluctuations. The model predicts (a) stability in the terms-of-trade; (b) that the dollar (i.e., dominant) exchange rate dominates bilateral exchange rate in price pass-through and trade elasticity regressions outside the U.S.; (c) high and persistent pass-through into export and import prices; (d) that global trade outside the U.S. declines when the dollar appreciates.

We validate empirically these predictions using two sources of data. First, at the aggregate level, we use a newly constructed global bilateral trade dataset that covers 91% of world trade. Then, we test the implications of the theory using micro data at the firm-product-destination-year level from Colombia. All the key implications of the DCP are confirmed empirically, while other pricing paradigms are soundly rejected.

Looking forward, the dominant currency paradigm has striking implications for economic policy and its spillovers. For instance, we demonstrate that the inflation-output trade-off in response to a monetary policy shock is seriously impaired under DCP compared to the usual case of PCP. Monetary policy shocks in the dominant currency country also have strong spillovers to the rest of the world, while the converse is not true: the dominant currency country is largely insulated from the inflationary consequences of fluctuations in its currency, which are absorbed instead into prices and trade in the rest of the world. This has important implications for monetary policy, which are explore at greater length in Casas et al. (2016). For instance, under DCP, a small open economy's optimal monetary policy is no longer able to attain both zero producer price inflation and zero output gap in circumstances where producer currency pricing would.

Our framework takes the invoicing currency choice as given. Yet we have been careful to point out that most of our results would hold even with endogenous currency invoicing. First, some ingredients from our model, namely imported input use in production and strategic complementarities in pricing, are precisely those that would give rise endogenously to dominant currency in pricing. This is demonstrated by Gopinath et al. (2010) in a partial equilibrium environment and more recently by Mukhin (2018) in a general equilibrium setting. Second, Gopinath et al. (2010) show that firms choose to price in currencies in which their reset prices are most stable, i.e., the desired medium-run pass-through into prices (expressed in the invoicing currency) is low. In other words, our empirical findings will continue to be relevant in an environment with endogenous currency choice.

Taking a step back, our paper confirms that the dominance of the U.S. dollar is pervasive, from the structure of external balance sheets (Gourinchas and Rey (2014)), the currency composition of private portfolios (Maggiori et al. (2018)), the choice of anchor currency (Ilzetzki et al. (2017) and trade invoicing, with important and complex interactions which we are only starting to explore (e.g., Gopinath and Stein (2018)).

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A ONLINE APPENDIX: NOT FOR PUBLICATION

A.1 Macro Data

Here we provide further details on the Comtrade, WDI, and FRED data.

A.1.1 Data Construction

Comtrade. UN Comtrade provides detailed annual customs data for a large set of countries at HS 6-digit product level with information about the destination country, USD value, quantity, and weight of imports and exports. This dataset makes it possible to compute volume changes over time for each product, and use the value data to infer unit values. Once unit values are calculated, we compute chained Fisher price indices to aggregate up from the product level to the bilateral country level.[26] We focus entirely on data for non-commodity goods, except noted otherwise. Given the inherent difficulty in drawing a line between commodities and non-commodities, we define commodities fairly broadly as HS chapters 1–27 and 72–83, which comprise animal, vegetable, food, mineral, and metal products.

Coverage of Comtrade at annual frequency over time and across countries is good. The longest time span of the data is 1989–2015, although the coverage varies by dyad. Appendix A.1.2 lists the coverage by country. In 2015, the 55 countries in our sample were responsible for 91.2% and 91.5% of the value of world goods imports and exports, respectively, as recorded in Comtrade. We exclusively use Comtrade data reported by the importing country, as importer-reported data is regarded as being more reliable since imports generate tariff revenues (Feenstra et al., 2005; World Bank, 2010).

The biggest challenge for constructing price and volume indices using customs data is the so-called unit value bias, as argued by Silver (2007). Unit values, calculated simply by dividing observed values by quantities, are not actual prices. Even at the narrowly defined product categories at 6-digit product level, there is likely to be a wide range of products whose prices may not be moving proportionately. The implication is that if there are shifts in quantities traded within the narrowly defined product categories, unit values would be influenced even when there is no price movement. This creates a bias that the employed methodology takes a stab at correcting for by eliminating products whose unit values have a variance higher than a threshold and are more likely to be biased.

The second challenge that arises from using Comtrade data is related to the use of different HS vintages over time. HS classification is updated about every five years to ensure that the available codings accurately reflect the variety of products being traded. This involves introducing codes for new products, eliminating the old ones, and often regrouping existing products. While concordances are readily available to facilitate the matching of HS codes across different HS vintages, this process inevitably leads to a loss of information, especially in the case of data on quantities, because the mapping of products across vintages is rarely one-to-one. To get around this problem, for the years in which there is a transition to a new HS vintage, we compute the indices twice, once under the old vintage (using concordances) and once under the new one. This way, only these transition years would be effected by the loss of information due to matching across vintages. After that year, we switch to working with the new vintage. This method not only minimizes the loss of information but also allows us to include new products in the construction of the indices. Boz et al. (2019) provide further details of this method, including the strategy for dealing with outliers and missing values.

The third potential challenge is associated with the conversion of trade values into and out of dollars. Exchange rate conversion can be made by data compilers at the country level and by Comtrade. United Nation's 2006 Survey of National Compilation and Reporting Practices suggests that almost all countries in our sample use an exchange rate from an official source and most countries use a daily exchange rate at the date of exporting or importing. Those that declare not using daily rates report using monthly exchange rates. All in all, results of this survey suggest exchange rate conversion at the country level to be pretty accurate. As for Comtrade, for those countries reporting in local currency, Comtrade uses an annual exchange rate that weighs monthly exchange rates from the International Financial Statistics of the IMF by monthly trade flows. According to the Explanatory Notes provided by Comtrade, most emerging markets report in dollars and advanced economies report in local

[26] The Fisher price index satisfies a number of tests laid out in index number theory and is flexible enough to provide a good proxy for a large set of functional forms (Gaulier et al., 2008; IMF, 2009).

currency. Because our regressions for different country groups in online appendix A.2.1 show similar results for advanced and emerging country flows, any discrepancies in how annual exchange rate conversions are done by different countries appear to not substantially influence our qualitative findings.

In the final stage, we compare our unit value indices to those provided by the Bureau of Labor Statistics (BLS) for the U.S., the only country, to our knowledge, that collects import price indices based on price surveys by origin. As shown in online appendix A.1.3, this comparison for the U.S. suggests that working with unit values is acceptable, as the growth rates of the two series are broadly aligned for most trading partners. Further, the results on pass-through into U.S. import and export prices using our constructed unit value indices are wholly consistent with the estimates in Casas et al. (2016) and Gopinath and Rigobon (2008) that are based on BLS data. Lastly, Boz et al. (2019) find favorable results when comparing country-level indices with those from the WTO and IMF World Economic Outlook.

Currency invoicing share. For currency invoicing shares we use the data set constructed by Gopinath (2015). The invoicing shares tend to be fairly stable over time so we take their simple averages over the years in which they are reported during 1999–2014. Appendix A.1.2 lists the USD and euro import invoicing share for the 39 countries in our sample with available invoicing data.

World Development Indicator data. The exchange rate is the World Bank's "alternative conversion factor" series (PA.NUS.ATLS), which corrects for redenominations and currency substitution, and is measured as an annual average of daily rates. Producer prices are given by the wholesale price index (FP.WPI.TOTL). Real GDP is measured at market prices in constant U.S. dollars (NY.GDP.MKTP.KD). The GDP deflator is given by the ratio of nominal GDP (NY.GDP.MKTP.CD) and real GDP. Consumer prices are constructed from CPI inflation rates (FP.CPI.TOTL.ZG), or if inflation is not available, CPI levels (FP.CPI.TOTL). We use data for 1989–2015 only. The data was downloaded in September 2016.

FRED data. We obtain the WTI oil price (POILWTIUSDA), VIX (VIXCLS), and 1-year Treasury bill rate (DTB1YR) from the St. Louis Fed's FRED database. Annual series are averages of daily indices.

Country groups. For some exercises below, we look at heterogeneity across advanced and emerging economies. We use the October 2017 IMF World Economic Outlook grouping of advanced economies, and label all other countries as emerging. This yields 31 advanced and 24 emerging economies, as listed in Appendix A.1.2.

A.1.2 Comtrade Country Summary Statistics

Table 10 lists summary statistics on the number of observations for the 55 countries in our merged Comtrade/WDI dataset. The table also lists the advanced or emerging economy classification of each country. Finally, we list the share of imports invoiced in U.S. dollars and euros for the 39 countries for which we observe these measures (cf. Gopinath, 2015).

A.1.3 Comparison of Comtrade and BLS Price Series for the U.S.

Here we compare our unit value indices to survey price indices from the U.S. Bureau of Labor Statistics. The BLS provides U.S. import price indices by locality of origin for Canada, E.U., France, Germany, U.K, Latin America, Mexico, Pacific Rim, China, Japan, ASEAN, Asia Near East, and Asian Newly Industrialized countries. As these price indices are constructed from surveys, their comparison with our unit value based indices can help gauge the effectiveness of our techniques to deal with the unit value bias and other potential mismeasurement inherent in customs data.

To arrive at comparable series, in this subsection we follow BLS in using *Laspeyres* indices of *total* (commodities and non-commodities) goods prices from our Comtrade data set. For regions with multiple countries, we aggregate country level growth rates using Comtrade import values with a two year lag. Still, the series are not fully comparable because BLS' preferred price basis is f.o.b. (free on board) while import values recorded at customs are c.i.f. (cost, insurance and freight), and not all countries included in BLS regions are in our database.

Country summary statistics

Country	Adv	As exporter #dyads	As exporter avg T	As importer #dyads	As importer avg T	As importer InvS$^{\$}$	As importer InvS$^{€}$
Africa							
Algeria		20	12.9	46	20.9		0.49
Egypt		53	20.2	50	18.0		
South Africa		51	14.8	53	14.7		
Americas							
Argentina		54	21.0	50	20.6	0.88	0.08
Brazil		54	21.7	50	23.2	0.84	0.11
Canada	✓	54	22.0	53	24.2	0.75	0.05
Chile		52	20.2	48	17.7		
Colombia		52	17.9	49	15.6	0.99	0.00
Mexico		54	21.7	51	23.0		
United States	✓	54	22.0	53	22.8	0.93	0.02
Venezuela		8	17.6	46	17.0		
Asia							
China		54	21.9	53	21.7		
Hong Kong	✓	53	22.1	51	20.7		
India		54	21.9	53	24.0	0.86	0.10
Indonesia		53	21.6	51	21.8	0.81	0.04
Israel	✓	49	22.1	50	15.0	0.73	0.21
Japan	✓	54	22.1	52	25.4	0.71	0.03
Kazakhstan		32	15.2	52	14.6		
Malaysia		53	22.0	50	23.8		
Philippines		54	21.6	47	18.0		
Saudi Arabia		50	19.7	50	15.3		
Singapore	✓	54	22.0	50	23.6		
South Korea	✓	54	22.0	51	23.7	0.81	0.05
Thailand		54	21.8	51	24.7	0.79	0.04
Turkey		54	22.0	52	24.0	0.59	0.31
Vietnam		50	19.6	46	12.1		

(continued on next page)

Country summary statistics (continued)

Country	Adv	As exporter #dyads	As exporter avg T	As importer #dyads	As importer avg T	InvS$^{\$}$	InvS$^{€}$
Europe							
Austria	✓	54	22.2	52	20.7	0.06	0.70
Belgium	✓	53	15.8	53	15.9	0.14	0.82
Czech Republic	✓	53	20.2	53	21.2	0.19	0.68
Denmark	✓	54	22.0	52	24.2	0.25	0.32
Estonia	✓	46	17.0	52	18.0	0.34	0.53
Finland	✓	54	21.9	52	24.9	0.42	0.38
France	✓	54	22.2	53	20.7	0.21	0.75
Germany	✓	54	21.4	53	23.3	0.23	0.75
Greece	✓	54	21.4	51	22.0	0.40	0.58
Hungary		54	22.0	52	21.5	0.27	0.57
Ireland	✓	54	21.9	52	21.7	0.23	0.47
Italy	✓	54	22.2	52	20.7	0.29	0.67
Lithuania	✓	51	16.8	48	19.0	0.51	0.39
Luxembourg	✓	49	15.6	51	13.6	0.16	0.78
Netherlands	✓	54	22.2	53	22.2	0.37	0.46
Norway	✓	54	22.0	51	21.6	0.21	0.29
Poland		54	21.8	52	20.2	0.30	0.58
Portugal	✓	54	21.8	52	25.0	0.22	0.76
Romania		53	21.1	50	19.7	0.31	0.67
Russia		53	21.0	52	17.6		
Slovak Republic	✓	50	18.9	51	20.0	0.12	0.79
Slovenia	✓	54	19.6	52	20.0	0.20	0.75
Spain	✓	54	22.0	54	24.8	0.35	0.58
Sweden	✓	54	22.0	54	21.9	0.25	0.36
Switzerland	✓	54	22.1	54	25.1	0.13	0.53
Ukraine		51	18.8	52	17.2	0.75	0.16
United Kingdom	✓	54	22.2	54	21.6	0.47	0.15
Oceania							
Australia	✓	54	21.8	51	25.4	0.53	0.08
New Zealand	✓	53	20.7	50	23.5		

Table 10: Summary statistics for countries in the merged Comtrade/WDI sample. Adv: advanced economy (IMF WEO). #dyads: number of non-missing dyads that the country appears in. avg T: average number of years per dyad that the country appears in; a dyad-year observation is counted if at least one UVI or volume observation is reported by the importer, and exchange rate data exists for both countries. InvS: share of imports invoiced in USD/euro.

BLS country groups

BLS group	Country ISO codes
ASEAN	BRN* IDN KHM* LAO* MMR* MYS PHL SGP THA VNM*
Asia Near East	ARE* BHR* IRN* IRQ* ISR JOR* KWT* LBN* OMN* QAT* SAU SYR* YEM*
European Union	AUT BEL BGR* CYP* CZE DEU DNK ESP EST FIN FRA GBR GRC HRV* HUN IRL ITA LTU LUX LVA* MLT* NLD POL PRT ROU SVK SVN SWE
Latin America	ARG BRA CHL COL MEX VEN (plus other unspecified Central American, South American, and Caribbean countries*)
Asian New. Ind.	HKG KOR SGP TWN
Pacific Rim	AUS BRN* CHN HKG IDN JPN KOR MAC* MYS NZL PHL PNG* SGP TWN

Table 11: Definition of BLS country groups in Figure 14. Countries marked with an asterisk (*) are not available in the Comtrade sample.

Our indices constructed from Comtrade unit values track the BLS import price indices fairly well, as shown in Figures 14 and 15. These figures compare the linearly detrended logged indices, since our regressions use log growth rates and absorb any disparity in average growth rates in the intercept. The growth rates of our indices for Canada, Japan, Mexico, and the aggregated Latin America and Asia Near East match those of BLS remarkably well. The comparison with some Asian countries suggests that a unit value bias may still be present, causing the unit value series to be somewhat more volatile than the BLS price series. Nevertheless, for every country group and individual country except Germany, the correlation coefficient between the Comtrade and BLS growth rates is high. Finally, the match for European countries seems acceptable, with the year 2008 being an exception. A closer inspection of the case of Germany reveals that a couple of products (transport vehicles) with large import shares experienced substantial unit value decreases that year according to Comtrade, leading our indices to decline while the BLS index shows an increase.

Comtrade and BLS import price indices for U.S.: country groups

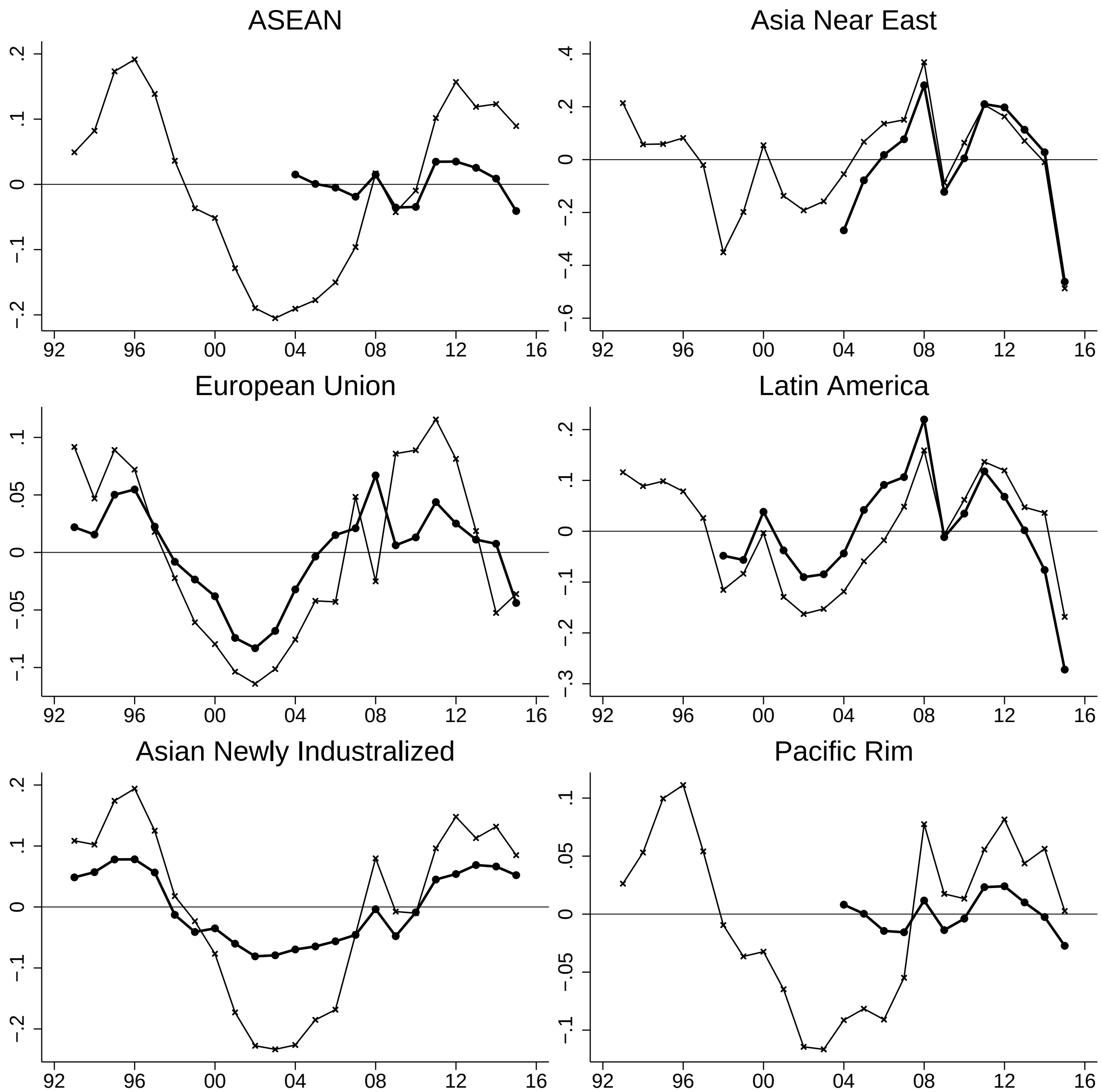

Figure 14: Comparison of BLS Locality of Origin import price indices (thick lines, circles) with our constructed Comtrade analogues (thin lines, crosses). Plotted indices are logged and linearly detrended. The Comtrade sample does not cover all countries in the BLS country groups, cf. Table 11.

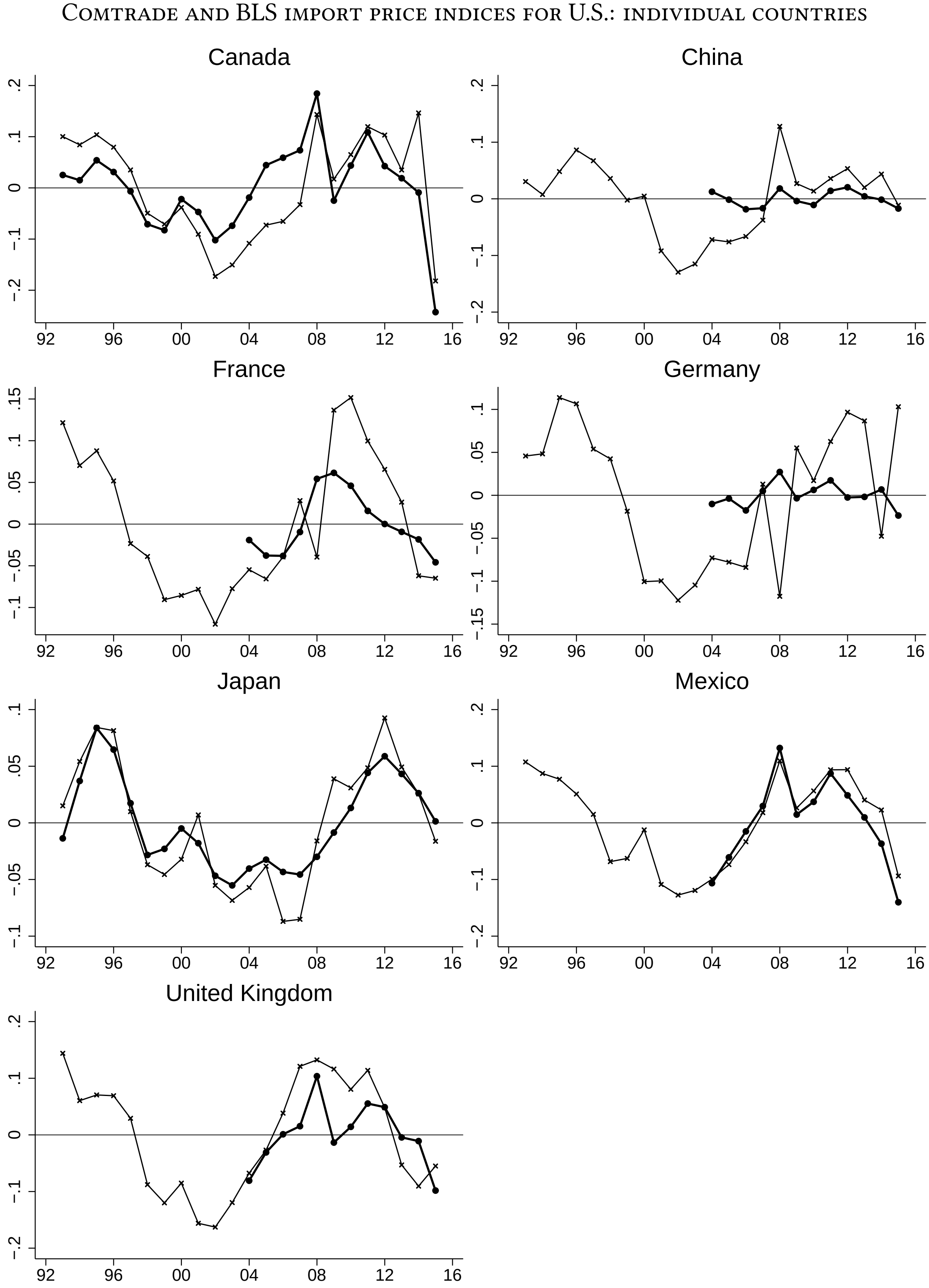

Figure 15: Comparison of BLS Locality of Origin import price indices (thick lines, circles) with our constructed Comtrade analogues (thin lines, crosses). Plotted indices are logged and linearly detrended.

Terms of trade and exchange rates: Country group heterogeneity

	unweighted			trade-weighted		
	(1)	(2)	(3)	(4)	(5)	(6)
	E↔E	E↔A	A↔A	E↔E	E↔A	A↔A
	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$	$\Delta tot_{ij,t}$
$\Delta e_{ij,t}$	0.0189	0.0480***	0.0182	0.0508***	0.111***	0.0220
	(0.0173)	(0.0110)	(0.0256)	(0.0176)	(0.0310)	(0.0473)
PPI	no	no	no	no	no	no
R-squared	0.028	0.011	0.008	0.051	0.078	0.025
Observations	3,527	11,857	8,886	3,527	11,857	8,886
Dyads	217	670	460	217	670	460

Table 12: "E↔A", say, denotes goods flows between Emerging and Advanced economies. The first (resp., last) three columns use unweighted (resp. trade-weighted) regressions, as in specifications (1) and (3) of Table 2. All regressions include two ΔER lags and time FE. S.e. clustered by dyad. *** p<0.01, ** p<0.05, * p<0.1.

A.2 Macro Regressions: Supplementary Results

This section provides supplementary macro regression results, including robustness checks.

A.2.1 Country Group Heterogeneity

Tables 12 to 14 display the heterogeneity in estimates when we apply our terms of trade regressions, exchange rate pass-through regressions and trade elasticity regressions from Sections 3.2 to 3.4 to separate subsamples of advanced and emerging country trade flows. The results are discussed in the main text.

A.2.2 Spillovers From U.S. Dollar to Foreign Inflation

Our results imply that fluctuations in the strength of the dollar, for example those caused by U.S. monetary policy actions, have spillover effects on foreign inflation. We have shown that the dollar exchange rate passes strongly through to bilateral import prices measured in the importer's currency, especially for countries whose imports are heavily invoiced in dollars. Given a non-negligible import content in consumption, this implies that dollar movements will directly affect foreign consumer price index (CPI) inflation, as discussed by Gopinath (2015). If foreign firms behave in a monopolistically competitive way, foreign producer prices will react to changes in foreign import prices, although perhaps with a lag. Hence, the direct effect of dollar movements on foreign CPI inflation may be amplified by endogenous producer responses.

We now provide direct country-level regression evidence on the effects of the U.S. dollar exchange rate on foreign consumer and producer prices. Gopinath (2015) computes back-of-the-envelope estimates of these spillovers based on estimated country-level import price pass-through and the import content of consumption. We instead directly regress countries' CPI or PPI on the dollar exchange rate. Additionally, we investigate the interaction of the dollar exchange rate and the dollar import invoicing share.

Specifically, we consider the country-level panel regression

$$\Delta cpi_{j,t} = \lambda_j + \delta_t + \sum_{k=0}^{2} \beta_k^{\$} \Delta e_{\$j,t-k} + \sum_{k=0}^{2} \eta_k^{\$} \Delta e_{\$j,t-k} \times S_j + \varepsilon_{j,t}, \tag{A.1}$$

Exchange rate pass-through into prices: Country group heterogeneity

	unweighted				trade-weighted			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	E→E	E→A	A→E	A→A	E→E	E→A	A→E	A→A
	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$
$\Delta e_{ij,t}$	0.0980***	0.0514**	0.265***	0.332***	0.150***	0.150***	0.433***	0.373***
	(0.0329)	(0.0225)	(0.0379)	(0.0195)	(0.0391)	(0.0269)	(0.132)	(0.0504)
$\Delta e_{\$j,t}$	0.858***	0.766***	0.710***	0.409***	0.820***	0.498***	0.608***	0.287***
	(0.0353)	(0.0364)	(0.0382)	(0.0284)	(0.0487)	(0.0533)	(0.122)	(0.0487)
R-squared	0.470	0.152	0.530	0.142	0.572	0.252	0.467	0.264
Observations	6,763	10,589	12,318	17,150	6,763	10,589	12,318	17,150
Dyads	435	618	700	894	435	618	700	894

Table 13: "E→A", say, denotes goods flows from Emerging to Advanced economies. The first (resp., last) four columns use unweighted (resp. trade-weighted) regressions as in specifications (2) and (5) of Table 3. All regressions include two ΔER lags, lags 0–2 of exporter ΔPPI, and time FE. S.e. clustered by dyad. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Trade elasticity with respect to exchange rate: Country group heterogeneity

	unweighted				trade-weighted			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	E→E	E→A	A→E	A→A	E→E	E→A	A→E	A→A
	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$
$\Delta e_{ij,t}$	-0.0488	-0.0145	-0.182***	-0.0737	-0.0471	-0.0441**	-0.0377	0.0228
	(0.0333)	(0.0212)	(0.0700)	(0.0481)	(0.0357)	(0.0225)	(0.117)	(0.0518)
$\Delta e_{\$j,t}$	-0.163***	-0.435***	0.00868	-0.340***	-0.208***	-0.251***	-0.0995	-0.302***
	(0.0588)	(0.0749)	(0.0704)	(0.0607)	(0.0641)	(0.0622)	(0.118)	(0.0548)
R-squared	0.093	0.049	0.100	0.082	0.237	0.301	0.218	0.214
Observations	8,239	12,967	12,932	18,134	8,239	12,967	12,932	18,134
Dyads	485	679	719	924	485	679	719	924

Table 14: "E→A", say, denotes goods flows from Emerging to Advanced economies. The first (resp., last) four columns use unweighted (resp. trade-weighted) regressions as in specifications (2) and (5) of Table 4. All regressions include two ΔER lags, lags 0–2 of importer ΔGDP, and time FE. S.e. clustered by dyad. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Dollar pass-through into CPI and PPI, 2002–2015

	(1) $\Delta cpi_{j,t}$	(2) $\Delta cpi_{j,t}$	(3) $\Delta ppi_{j,t}$	(4) $\Delta ppi_{j,t}$
$\Delta e_{\$j,t}$	0.106***	0.0221	0.284***	0.182***
	[0.04, 0.18]	[-0.05, 0.09]	[0.14, 0.43]	[0.05, 0.32]
$\Delta e_{\$j,t} \times S_j$		0.181**		0.237*
		[0.04, 0.33]		[-0.03, 0.51]
R-squared	0.283	0.453	0.532	0.675
Observations	766	544	697	525
Countries	55	39	52	38

Table 15: The first (resp., last) two columns use CPI (resp., PPI) growth as dependent variable. All regressions include two ΔER lags and time FE. 95% confidence intervals clustered by country and corrected for small number of clusters using "LZ2-BM" method of Imbens and Kolesár (2016). *** p<0.01, ** p<0.05, * p<0.1 (only 95% interval shown).

where $\Delta cpi_{j,t}$ is the change in the log CPI in the currency of country j, and λ_j and δ_t are country and year fixed effects, respectively. We also consider specifications with $\Delta ppi_{j,t}$ on the left-hand side, as well as specifications restricting $\psi_k = 0$ for all k. We focus attention on the post-2002 (post-euro) sample, since full-sample regression results are unduly influenced by a handful of countries' high-inflation/high-depreciation episodes in the 1990s.[27]

Table 15 displays the contemporaneous dollar pass-through into CPI and PPI. The first two columns shows results for CPI pass-through, and the second two show those for PPI pass-through. Columns (1) and (3) do not interact exchange rate changes with the dollar invoicing share, while columns (2) and (4) do. The table displays 95% confidence intervals rather than standard errors because the small number of countries (clusters) necessitates the use of small-sample corrections (Imbens and Kolesár, 2016). The average pass-through of the dollar into CPI (resp., PPI) is 11% (resp., 28%) within the year. The dollar pass-through is larger for countries that have a substantial fraction of imports invoiced in dollars. The contemporaneous interaction term is statistically significant at the 10% level for both the CPI and PPI specifications, and also at the 5% level for the CPI specification. Hence, it appears that countries which invoice more in dollars experience higher dollar pass-through into consumer and producer prices. We caution, though, that the *magnitude* of the pass-through is imprecisely estimated when controlling for country and time fixed effects.

A.2.3 The Dollar Versus the Euro

We now compare the explanatory power of the dollar exchange rate with that of the euro. We show that the dollar dominates both the bilateral exchange rate and the euro in regression specifications that include all three exchange rates.

The panel regressions in Section 3 do not directly imply that the U.S. dollar is a uniquely important vehicle currency. In our regression specifications *without* interactions, we would have obtained exactly the same coefficient estimates if we had used the euro exchange rate, say, in place of the dollar exchange rate, since we control for time fixed effects.[28] Nevertheless, our specifications *with* interactions indicated that the dollar plays a special

[27] The results are very similar if we use the full 1992–2015 sample but drop country-year observations for which the arithmetic CPI inflation rate exceeds 30% annually (0.26 log inflation rate).

[28] To see this formally, note that one can rewrite the (log) change in the euro exchange rate as $\Delta e_{€j,t} = \Delta e_{€\$,t} + \Delta e_{\$j,t}$ and the first term is absorbed by the time fixed effects.

role. Now we directly compare the explanatory power of the dollar against that of the euro in panel regressions that do not control for time fixed effects but instead control for observed global real and financial variables.

To measure bilateral price pass-through from the dollar and the euro, we run panel regressions of the form

$$\Delta p_{ij,t} = \lambda_{ij} + \sum_{k=0}^{2} \beta_k \Delta e_{ij,t-k} + \sum_{k=0}^{2} \beta_k^{\$} \Delta e_{\$j,t-k} + \sum_{k=0}^{2} \beta_k^{€} \Delta e_{€j,t-k} + \theta' X_{ij,t} + \varepsilon_{ij,t}, \tag{A.2}$$

where $e_{€j,t}$ denotes the log euro exchange rate in units of currency j per euro. Notice that we omit time fixed effects, as is necessary to identify $\beta_k^{\$}$ and $\beta_k^{€}$ separately. In addition to lags 0–2 of exporter PPI log growth, the controls $X_{ij,t}$ consist of the contemporaneous values of global real GDP growth, global GDP deflator inflation, global export volume growth, growth in the WTI oil price deflated by the global GDP deflator, and the log VIX. The time sample for regressions in this subsection is 2002–2015 due to the introduction of the euro in 1999 and our use of lagged exchange rate changes.

Fig. 16 shows that the euro pass-through into prices is negligible on average, while the dollar pass-through remains high when we control for the euro. The figure displays the regression results in the form of impulse responses of the bilateral price level; corresponding regression tables are available in online appendix A.2.5.

Similarly, the dollar exchange rate has the largest predictive power for trade volumes. We run panel regressions similar to Eq. (A.2), except with volume growth $\Delta y_{ij,t}$ on the left-hand side, and we replace exporter PPI with lags 0–2 of importer real GDP growth in the list of controls $X_{ij,t}$. Fig. 17 shows impulse responses of the level of bilateral trade volume to the bilateral, dollar, and euro exchange rates. The dollar exchange rate is the only one of the three that has a quantitatively large negative association with trade volumes.[29]

Tables 16 and 17 display the euro regression results in table form. Specifications (1) and (4) focus on the bilateral and euro exchange rates, specifications (2) and (5) add the dollar exchange rate, and specifications (3) and (6) include interactions with the dollar and euro import invoicing shares. $S_j^{€}$ is the importing country's share of imports invoiced in euros from Gopinath (2015). The interactions are statistically and economically significant and mostly have the expected signs in the price pass-through regressions: A higher share of euro (resp., dollar) invoicing implies a higher pass-through from the euro (resp., dollar) exchange rate.

A.2.4 Trade Elasticity of Dollar Versus Other Major Currencies

The large negative predictive effect of a uniform dollar appreciation on world trade documented in Section 3.6 is robust to controlling for other major exchange rates. Table 18 shows trade elasticity regressions as in Eq. (22), except that we drop interaction terms but add the exchange rates of the importer versus the Swiss franc and versus the Japanese yen. We drop interaction terms here because we do not have extensive data on the currency invoicing shares of the franc and the yen. The first and third columns in the table show the contemporaneous trade elasticity coefficients of the bilateral, dollar, and euro exchange rates, without controlling for the franc and the yen exchange rates. The second and fourth columns then add the franc and the yen exchange rates. The sample is the post-euro period of 2002–2015. Evidently, adding the franc and the yen exchange rates as controls does nothing to diminish the large negative effect of the dollar on bilateral trade volumes. In fact, the trade-weighted specification exhibits an even more negative dollar elasticity when the franc and the yen are added as controls, although the standard error on the dollar coefficient is substantially larger in this specification (the coefficient remains highly significant). Moreover, according to the regression results, it is only a uniform U.S. dollar appreciation that has a large negative effect on world trade, whereas uniform appreciations of the other major currencies do not predict substantial drops in trade volumes. Finally, note that the R-squared of the regression hardly increases when the franc and yen are added as controls.

A.2.5 Regression Details and Robustness Checks

Post-2002 results. Exchange rate pass-through into prices has been stable over our sample period, while trade elasticities may have become larger in absolute value in the latter part of the sample. We compute results

[29] The different long-run level effect of the dollar in Figs. 6 and 17 is due to the difference in time sample, as discussed in online appendix A.2.5.

Price pass-through from dollar and euro exchange rates

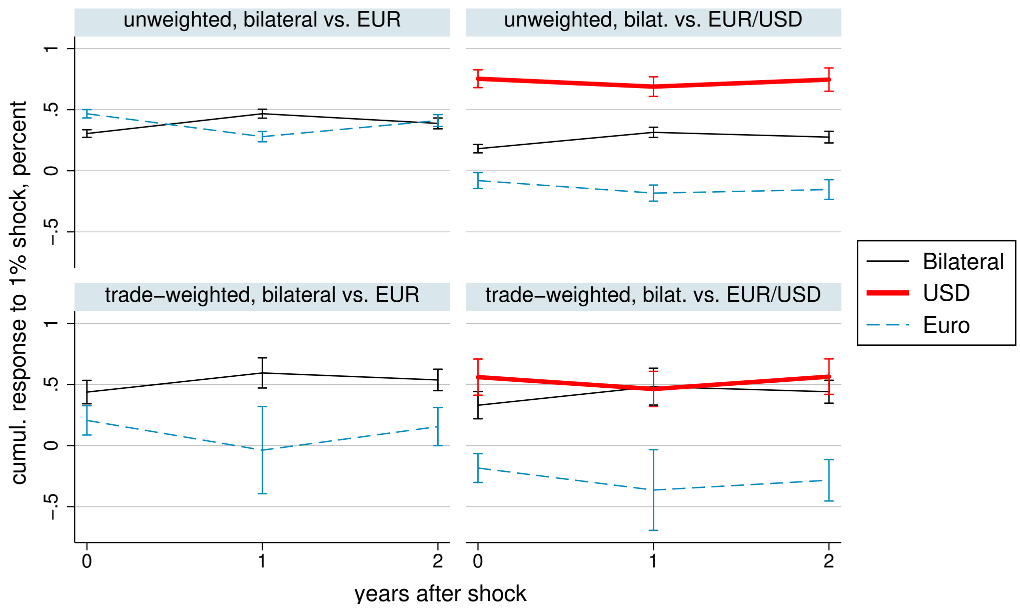

Figure 16: Impulse responses of bilateral price level to bilateral $e_{ij,t}$, USD $e_{\$j,t}$, and euro $e_{€j,t}$ exchange rates. Based on regressions in Table 16, on-line appendix A.2.5. Top row: unweighted regression, bottom row: trade-weighted. Left column: specifications with only bilateral and euro ER, right column: specifications adding USD. Error bars: 95% confidence intervals, clustering by dyad.

Trade elasticity for dollar and euro exchange rates

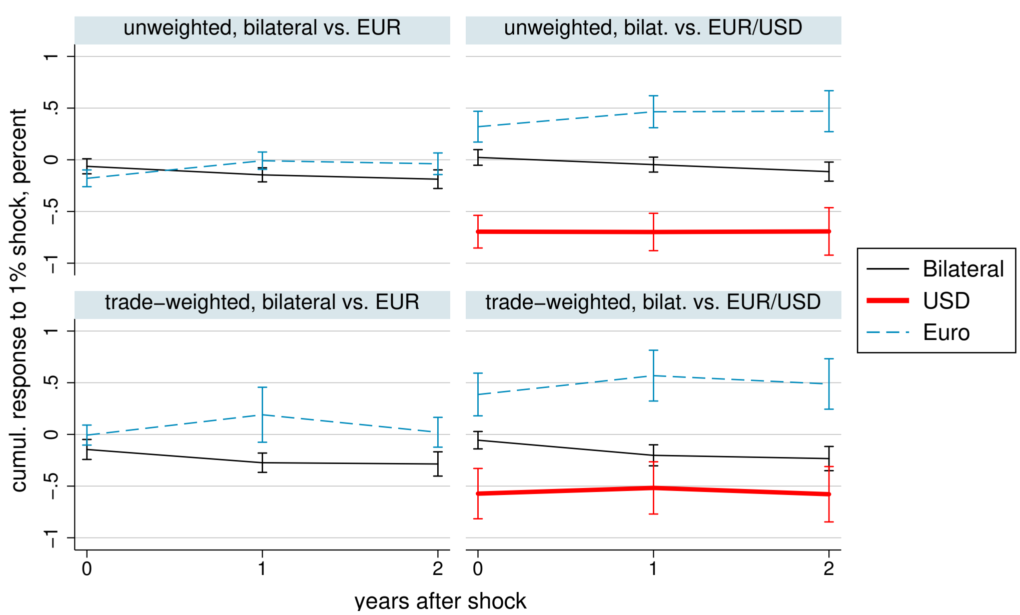

Figure 17: Impulse responses of bilateral volume to bilateral $e_{ij,t}$, USD $e_{\$j,t}$, and euro $e_{€j,t}$ exchange rates. Based on regressions in Table 17, on-line appendix A.2.5. Top row: unweighted regression, bottom row: trade-weighted. Left column: specifications with bilateral and euro ER, right column: specifications adding USD. Error bars: 95% confidence intervals, clustering by dyad.

Euro vs. dollar exchange rate pass-through into prices

	unweighted			trade-weighted		
	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$
$\Delta e_{ij,t}$	0.305***	0.181***	0.207***	0.438***	0.331***	0.551***
	(0.0159)	(0.0174)	(0.0695)	(0.0490)	(0.0567)	(0.156)
$\Delta e_{ij,t} \times (S_j + S_j^{€})$			-0.0357			-0.361**
			(0.0784)			(0.174)
$\Delta e_{\$j,t}$		0.754***	0.614***		0.561***	0.379***
		(0.0373)	(0.0405)		(0.0755)	(0.0672)
$\Delta e_{\$j,t} \times S_j$			0.510***			0.769***
			(0.0439)			(0.151)
$\Delta e_{€j,t}$	0.467***	-0.0800**	-0.347***	0.207***	-0.184***	-0.384***
	(0.0175)	(0.0332)	(0.0430)	(0.0612)	(0.0601)	(0.0726)
$\Delta e_{€j,t} \times S_j^{€}$			0.694***			0.709***
			(0.0821)			(0.122)
R-squared	0.131	0.143	0.210	0.102	0.112	0.293
Observations	33,802	33,802	24,463	33,802	33,802	24,463
Dyads	2,647	2,647	1,900	2,647	2,647	1,900

Table 16: The first (resp., last) three columns use unweighted (resp. trade-weighted) regressions. All regressions include two ΔER lags, lags 0–2 of exporter ΔPPI, and global controls as described in the text. S.e. clustered by dyad. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

for the subsample 2002–2015, roughly corresponding to the second half of our data set, and also corresponding to the sample used for the euro regressions in Section A.2.3. Figures 18 and 19 show price and volume impulse responses for the 2002–2015 subsample that correspond to the full-sample results in Figures 4 and 6 in Section 3. The price pass-through impulse responses of bilateral and dollar exchange rates are similar to the full-sample results. However, the post-2002 USD cumulative trade elasticity (unweighted) is substantially negative at lags of 1 and 2 years, whereas the level effect is close to zero at lags 1 and 2 on the full sample.

Pre-2007 results. Our headline results are not driven by the global financial crisis starting in 2008. Figures 20 and 21 show the average exchange rate pass-through and trade elasticity computed on the 1992–2007 sample. The results are almost identical to our baseline Figures 4 and 6. Figure 22 shows the effect of rest-of-world trade of a uniform USD appreciation, using only 2002–2007 data. Here the results are even stronger than in the baseline Figure 8.

Weighted average dollar invoicing share. Figure 23 depicts the weighted average dollar import invoicing share $\sum_{j\neq \text{US}} w_j S_j$ used in Section 3.6, where the ex-U.S. non-commodity import value weights w_j have been computed for each year in our sample. Notice that the weighted average fluctuates tightly around a mean of 0.40.

Additional controls. Table 19 shows that our pass-through regressions results are qualitatively robust to adding importer PPI growth and importer real GDP growth as additional controls. We use two lags of the log changes of each of these indices. Although our baseline specification in Section 3.3 is common in the literature, the addition of importer PPI and GDP controls can be justified by models with strategic complementarity in pricing and country-specific demand shifts. While the overall level of both bilateral and USD pass-through is somewhat lower when the controls are added, our qualitative conclusions regarding the dominance of the USD exchange rate and the relationship with dollar invoicing are as pronounced in Table 19 as in Table 3.

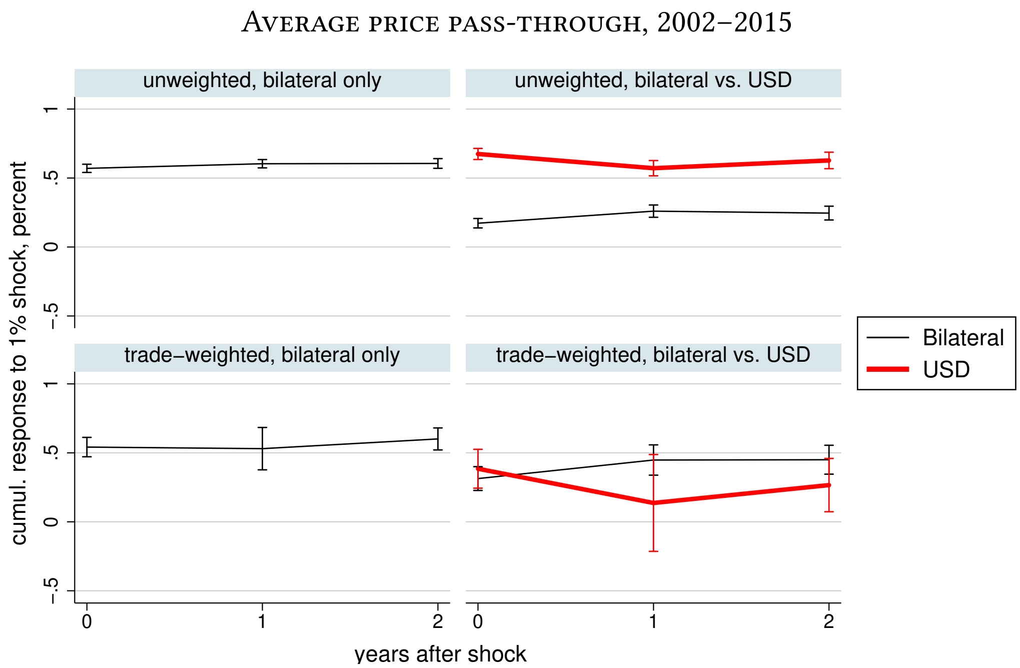

Figure 18: Figure 4 computed on post-2002 data, but with same weights.

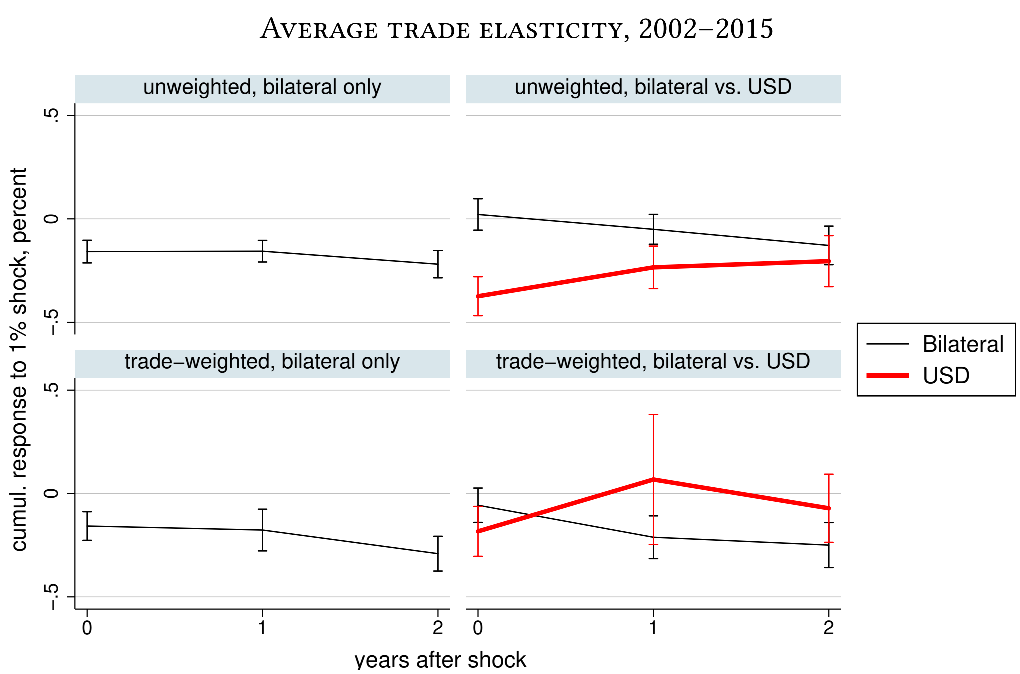

Figure 19: Figure 6 computed on post-2002 data, but with same weights.

Average price pass-through, 1992–2007

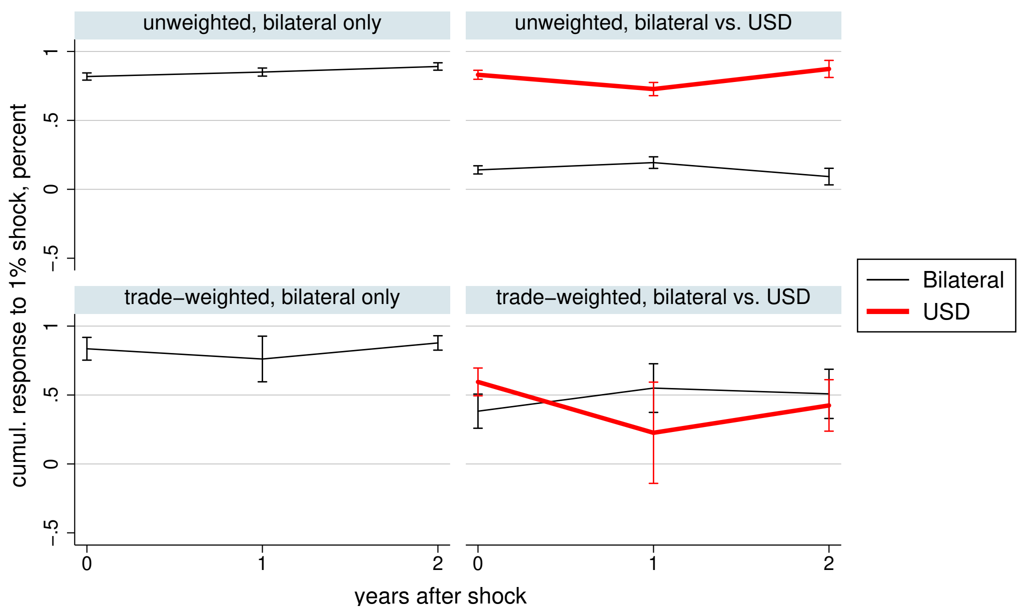

Figure 20: Figure 4 computed on pre-2007 data, but with same weights.

Average trade elasticity, 1992–2007

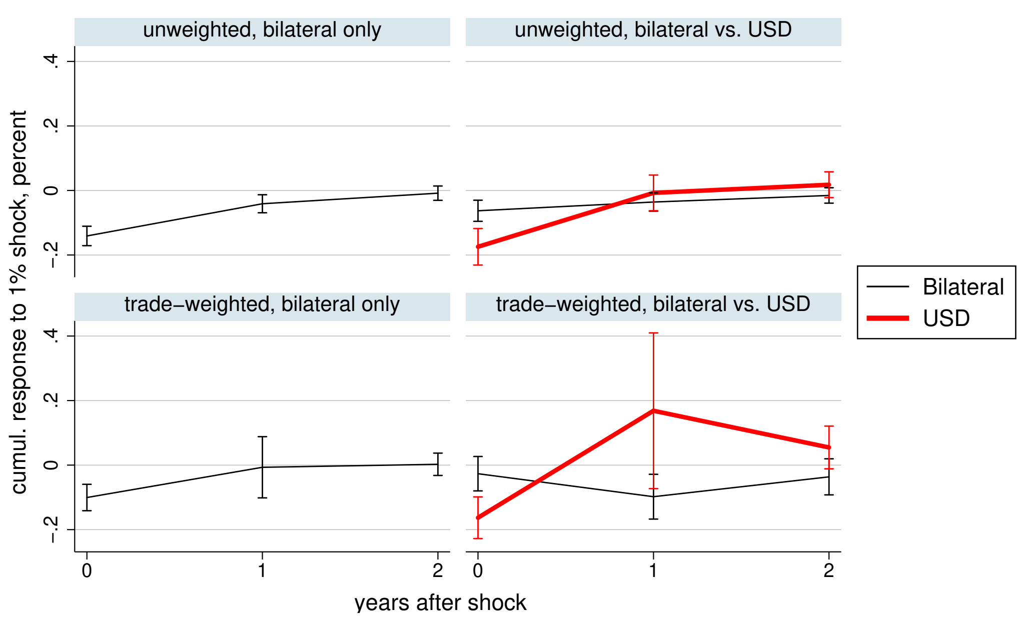

Figure 21: Figure 6 computed on pre-2007 data, but with same weights.

Euro vs. dollar trade elasticity

	unweighted		trade-weighted	
	(1)	(2)	(3)	(4)
	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$
$\Delta e_{ij,t}$	-0.0631*	0.0229	-0.146***	-0.0560
	(0.0371)	(0.0386)	(0.0493)	(0.0429)
$\Delta e_{\$j,t}$		-0.695***		-0.573***
		(0.0806)		(0.124)
$\Delta e_{€j,t}$	-0.179***	0.320***	-0.00647	0.386***
	(0.0413)	(0.0759)	(0.0494)	(0.105)
R-squared	0.068	0.071	0.197	0.203
Observations	37,437	37,437	37,437	37,437
Dyads	2,807	2,807	2,807	2,807

Table 17: The first (resp., last) two columns use unweighted (resp. trade-weighted) regressions. All regressions include two ΔER lags, lags 0–2 of importer ΔGDP, and global controls as described in the text. S.e. clustered by dyad. *** p<0.01, ** p<0.05, * p<0.1.

Response of rest-of-world aggregate trade to USD appreciation, 2002–2007

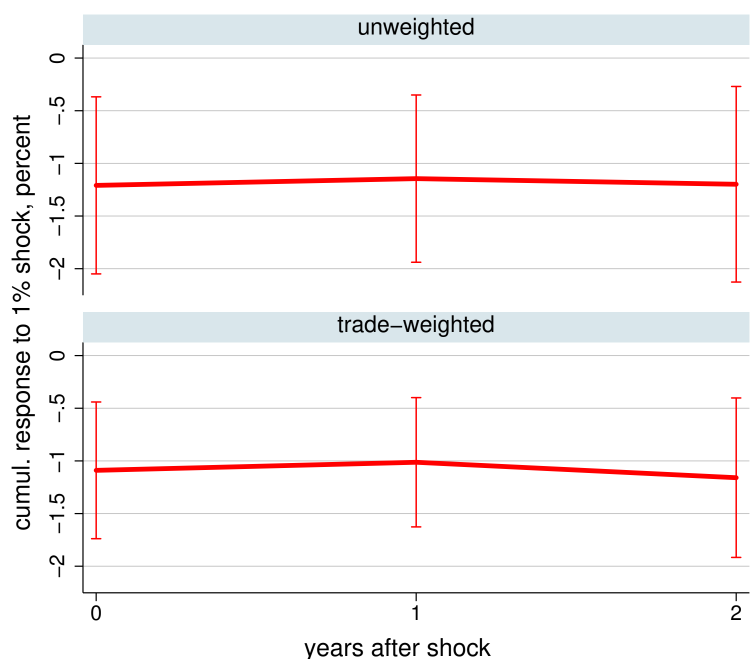

Figure 22: Figure 8 computed on pre-2007 data, but with same weights.

Trade elasticity for dollar and other major currencies

	unweighted		trade-weighted	
	(1)	(2)	(3)	(4)
	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$	$\Delta y_{ij,t}$
$\Delta e_{ij,t}$	0.0177	0.0215	-0.0595	-0.0566
	(0.0385)	(0.0387)	(0.0422)	(0.0424)
$\Delta e_{\$j,t}$	-0.765***	-0.880***	-0.719***	-1.988***
	(0.0805)	(0.287)	(0.0795)	(0.566)
$\Delta e_{€j,t}$	0.393***	0.331*	0.529***	1.146***
	(0.0755)	(0.191)	(0.0856)	(0.349)
$\Delta e_{\text{CHF}j,t}$		-0.0277		-0.127
		(0.134)		(0.169)
$\Delta e_{\text{YEN}j,t}$		0.203		0.786*
		(0.195)		(0.418)
R-squared	0.070	0.071	0.200	0.206
Observations	37,437	37,437	37,437	37,437
Dyads	2,807	2,807	2,807	2,807

Table 18: $e_{\text{CHF}j,t}$ and $e_{\text{YEN}j,t}$ denote the log price of the Swiss franc and Japanese yen, resp., in the importer's currency. The first (resp., last) two columns use unweighted (resp., trade-weighted) regressions. All regressions include two ΔER lags, lags 0–2 of importer ΔGDP, and the same global controls as in Appendix A.2.3. S.e. clustered by dyad. *** p<0.01, ** p<0.05, * p<0.1.

Weighted average dollar invoicing share over time

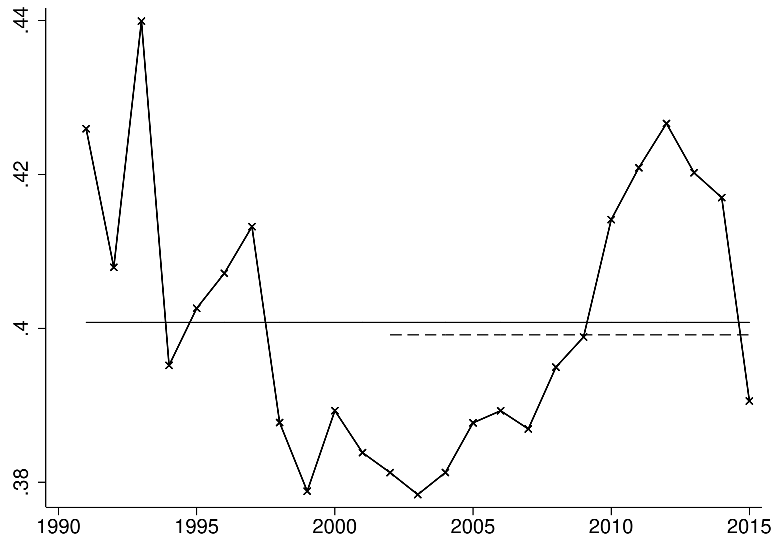

Figure 23: Weighted average dollar import invoicing share $\sum_{j \neq \text{US}} w_j S_j$, using import value weights w_j computed in different reference years (along horizontal axis). Horizontal lines show the mean on the 1992–2015 and 2002–2015 samples.

Exchange rate pass-through into prices: Additional controls

	unweighted			trade-weighted		
	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$	$\Delta p_{ij,t}$
$\Delta e_{ij,t}$	0.519***	0.163***	0.214***	0.550***	0.328***	0.456***
	(0.0117)	(0.0133)	(0.0177)	(0.0471)	(0.0480)	(0.0352)
$\Delta e_{ij,t} \times S_j$			-0.0869***			-0.272***
			(0.0252)			(0.0495)
$\Delta e_{\$j,t}$		0.706***	0.524***		0.464***	0.103
		(0.0183)	(0.0298)		(0.0347)	(0.0639)
$\Delta e_{\$j,t} \times S_j$			0.303***			0.643***
			(0.0360)			(0.0951)
R-squared	0.388	0.411	0.528	0.361	0.382	0.650
Observations	42,243	42,243	32,916	42,243	42,243	32,916
Dyads	2,502	2,502	1,853	2,502	2,502	1,853

Table 19: The first (resp., last) three columns use unweighted (resp. trade-weighted) regressions. All regressions include two ΔER lags, lags 0–2 of exporter ΔPPI, lags 0–2 of importer ΔPPI, lags 0–2 of importer ΔGDP, and time FE. S.e. clustered by dyad. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

A.3 Firm level data for Colombia

The data are from the customs agency (DIAN), and the department of statistics (DANE), and include information on the universe of Colombian importers and exporters. We have access to the data through the Banco de la República. The data include the trading firm's tax identification number, the 10-digit product code (according to the Nandina classification system, based on the Harmonized System), the FOB value (in U.S. dollars) and volume (net kilograms) of exports (imports), and the country of destination (origin), among other details.[30] The data are available on a monthly basis, and for our analysis we aggregate exports and imports at the annual or quarterly level. As in Section 3, macroeconomic country controls are from the World Development Indicators. Our estimations cover the period between 2005 and 2015. We define prices and quantities at the firm,10-digit product, country (origin or destination), year (or quarter) level. Prices are given by the FOB value per net kilogram, and quantities are given by total net kilograms. Exchange rates are the annual or quarterly average.

Further, starting in 2007, our exports data include information on the invoicing currency of each transaction. In Table 20 we present the distribution of currencies, broken down by destination groups. It is evident that the vast majority of Colombian exports are priced in dollars. Even for exports to the euro zone, the overwhelming invoicing currency is the dollar. Although some transactions are negotiated in euros, Colombian pesos, or Venezuelan bolívares among other currencies, the U.S. dollar accounts for over 98% of all exports. Moreover, the distribution is very similar if we look at the value of exports negotiated in each currency instead of the number of transactions. In this regard the Colombian economy is representative of a large number of economies that rely extensively on dollar invoicing.

[30] In the case of imports, there are cases where the imported good was produced in one country but actually arrived to Colombia from a third country. This case is most commonly seen for goods produced in China arriving to Colombia from either the United States or Panama. To avoid introducing unnecessary noise in our empirical work, we only use for our regressions those observations where the country of origin and purchase are the same.

Currency distribution by destination

Destination	Currency	All Exports	Manufactures
US	US Dollar	99.71%	99.93%
	Euro	0.02%	0.03%
	Colombian Peso	0.27%	0.03%
Dollar economies	US Dollar	99.73%	99.91%
	Euro	0.03%	0.04%
	Colombian Peso	0.23%	0.03%
CAN	US Dollar	99.75%	99.90%
	Euro	0.07%	0.07%
	Colombian Peso	0.18%	0.03%
Latin America	US Dollar	99.18%	99.34%
	Euro	0.13%	0.13%
	Colombian Peso	0.22%	0.03%
	Bolívar (Ven)	0.44%	0.45%
	Mexican Peso	0.02%	0.02%
	Colón (CR)	0.01%	0.01%
European Union	US Dollar	90.73%	86.19%
	Euro	8.64%	13.28%
	Colombian Peso	0.31%	0.21%
	Sterling Pound	0.28%	0.26%
Euro zone	US Dollar	88.78%	84.48%
	Euro	10.80%	15.22%
	Colombian Peso	0.39%	0.25%
	Sterling Pound	0.01%	0.01%
All destinations	US Dollar	98.28%	98.39%
	Euro	0.72%	0.70%
	Colombian Peso	0.67%	0.52%
	Venezuelan Bolívar	0.27%	0.33%
	Sterling Pound	0.02%	0.01%

Table 20: Data from DIAN/DANE. Exports of coke, refined petroleum products, and nuclear fuel (ISIC 23), and basic metals (ISIC 27) excluded from "Manufactures". Distribution calculated as number of invoices in each currency.

Exchange rate pass-through into prices, annual data (dollarized economies)

	(1) $\Delta p_{H,t}$	(2) $\Delta p_{H,t}$	(3) $\Delta p_{H,t}$	(4) $\Delta p_{H,t}$	(5) $\Delta p_{H,t}$	(6) $\Delta p_{H,t}$
Exports						
$\Delta e_{\$H,t}$	0.696***	0.828***	0.859***	0.823***	0.798***	0.819***
	(0.0331)	(0.0355)	(0.0414)	(0.0373)	(0.0450)	(0.0606)
PPI	no	yes	yes	yes	yes	yes
Euro ER	no	no	yes	no	no	yes
ΔER lags	no	no	no	yes	no	no
Sample	M	M	M	M	D	D
R-squared	0.288	0.290	0.290	0.290	0.303	0.303
Observations	169,792	159,041	159,041	159,041	98,831	98,831
Imports						
$\Delta e_{\$H,t}$	0.977***	1.007***	1.035***	1.016***	0.969***	0.971***
	(0.0177)	(0.0309)	(0.0430)	(0.0192)	(0.0352)	(0.0357)
PPI	no	yes	yes	yes	yes	yes
Euro ER	no	no	yes	no	no	yes
ΔER lags	no	no	no	yes	no	no
Sample	M	M	M	M	D	D
R-squared	0.225	0.225	0.225	0.225	0.250	0.250
Observations	529,584	529,260	529,260	529,260	275,968	275,968

Table 21: All regressions include Firm-Industry-Country fixed effects. S.e. clustered at the year level. The sample includes all manufactured (M) products excluding petrochemicals and metal industries in columns (1)-(4) and only differentiated (D) products in columns (5)-(6). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

A.4 Micro Regressions: Supplementary Results

This section provides supplementary regression results using the Colombian firm-level data, including robustness checks.

Tables 21-24 display the results of the price pass-through and trade elasticity regressions presented in Section 4.1, including PPI, the peso/euro exchange rate, and two ΔER annual lags as additional controls. All regressions include Firm-Industry-Country fixed effects. Our pass-through regressions results are robust to the inclusion of these controls, and qualitative results are unchanged when we use the subsample of differentiated products only (instead of the full set of manufactures) constructed using the classification of goods by Rauch (1999).[31]

[31] In our reported estimates, we follow Rauch's conservative classification, although the results are virtually unchanged if we use the liberal definition instead.

Exchange rate pass-through into prices, annual data (non-dollarized economies)

	(1) $\Delta p_{H,t}$	(2) $\Delta p_{H,t}$	(3) $\Delta p_{H,t}$	(4) $\Delta p_{H,t}$	(5) $\Delta p_{H,t}$	(6) $\Delta p_{H,t}$	(7) $\Delta p_{H,t}$	(8) $\Delta p_{H,t}$
				Exports				
$\Delta e_{iH,t}$	0.673***	0.0616	0.523***	0.0726	0.0737	0.0576	0.0634	0.0510
	(0.0937)	(0.0474)	(0.120)	(0.0452)	(0.0510)	(0.0370)	(0.0832)	(0.115)
$\Delta e_{\$H,t}$		0.667***		0.633***	0.672***	0.652***	0.644***	0.655***
		(0.0507)		(0.0602)	(0.0667)	(0.0603)	(0.0860)	(0.104)
PPI	no	no	yes	yes	yes	yes	yes	yes
Euro ER	no	no	no	no	yes	no	no	yes
ΔER lags	no	no	no	no	no	yes	no	no
Sample	M	M	M	M	M	M	D	D
R-squared	0.303	0.305	0.308	0.310	0.300	0.310	0.324	0.315
Observations	206,226	206,226	139,318	139,318	120,316	139,318	85,659	74,090
				Imports				
$\Delta e_{iH,t}$	0.750***	0.315***	0.506***	0.275***	0.238**	0.255***	0.293**	0.248**
	(0.116)	(0.0777)	(0.127)	(0.0837)	(0.0889)	(0.0777)	(0.103)	(0.0954)
$\Delta e_{\$H,t}$		0.528***		0.534***	0.607***	0.572***	0.535***	0.601***
		(0.0650)		(0.0510)	(0.0707)	(0.0365)	(0.0647)	(0.0822)
PPI	no	no	yes	yes	yes	yes	yes	yes
Euro ER	no	no	no	no	yes	no	no	yes
ΔER lags	no	no	no	no	no	yes	no	no
Sample	M	M	M	M	M	M	D	D
R-squared	0.287	0.290	0.291	0.293	0.320	0.293	0.312	0.337
Observations	931,993	931,993	808,304	808,304	518,898	808,304	419,717	272,060

Table 22: All regressions include Firm-Industry-Country fixed effects. S.e. clustered at the year level. The sample includes all manufactured (M) products excluding petrochemicals and metal industries in columns (1)-(6) and only differentiated (D) products in columns (7)-(8). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Trade elasticity with respect to exchange rate, annual data (dollarized economies)

	(1)	(2)	(3)	(4)	(5)
	$\Delta y_{H,t}$	$\Delta y_{H,t}$	$\Delta y_{H,t}$	$\Delta y_{H,t}$	$\Delta y_{H,t}$
Exports					
$\Delta e_{\$H,t}$	-0.580*	-0.425	-0.559	-0.406	-0.00635
	(0.294)	(0.370)	(0.368)	(0.353)	(0.404)
Euro ER	no	yes	no	no	yes
ΔER lags	no	no	yes	no	no
Sample	M	M	M	D	D
R-squared	0.225	0.225	0.225	0.232	0.232
Observations	159,041	159,041	159,041	98,831	98,831
Imports					
$\Delta e_{\$H,t}$	-1.206***	-0.959**	-1.205**	-1.235***	-0.973*
	(0.282)	(0.407)	(0.466)	(0.325)	(0.468)
Euro ER	no	yes	no	no	yes
ΔER lags	no	no	yes	no	no
Sample	M	M	M	D	D
R-squared	0.184	0.184	0.184	0.205	0.205
Observations	529,276	529,276	529,276	275,974	275,974

Table 23: All regressions control for PPI, importer GDP, and include Firm-Industry-Country fixed effects. S.e. clustered at the year level. The sample includes all manufactured (M) products excluding petrochemicals and metal industries in columns (1)-(3) and only differentiated (D) products in columns (4)-(5). *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Trade elasticity with respect to exchange rate, annual data (non-dollarized economies)

	(1) $\Delta y_{H,t}$	(2) $\Delta y_{H,t}$	(3) $\Delta y_{H,t}$	(4) $\Delta y_{H,t}$	(5) $\Delta y_{H,t}$	(6) $\Delta y_{H,t}$	(7) $\Delta y_{H,t}$
				Exports			
$\Delta e_{iH,t}$	-0.763***	0.0193	-0.0553	-0.0330	-0.992***	-0.136	-0.200
	(0.212)	(0.260)	(0.314)	(0.271)	(0.261)	(0.333)	(0.390)
$\Delta e_{\$H,t}$		-1.077***	-1.007**	-1.032***		-1.152***	-0.977**
		(0.265)	(0.322)	(0.265)		(0.282)	(0.342)
Euro ER	no	no	yes	no	no	no	yes
ΔER lags	no	no	no	yes	no	no	no
Sample	M	M	M	M	D	D	D
R-squared	0.250	0.252	0.245	0.252	0.258	0.260	0.252
Observations	139,318	139,318	120,316	139,318	85,659	85,659	74,090
				Imports			
$\Delta e_{iH,t}$	-0.703***	-0.212*	-0.319	-0.204	-0.763***	-0.223	-0.314
	(0.217)	(0.110)	(0.246)	(0.114)	(0.241)	(0.129)	(0.251)
$\Delta e_{\$H,t}$		-0.962***	-0.922***	-0.941***		-1.023***	-0.957***
		(0.224)	(0.245)	(0.250)		(0.281)	(0.277)
Euro ER	no	no	yes	no	no	no	yes
ΔER lags	no	no	no	yes	no	no	no
Sample	M	M	M	M	D	D	D
R-squared	0.236	0.237	0.254	0.237	0.263	0.264	0.286
Observations	808,409	808,409	519,002	808,409	419,784	419,784	272,126

Table 24: All regressions control for PPI, importer GDP, and include Firm-Industry-Country fixed effects. S.e. clustered at the year level. The sample includes all manufactured (M) products excluding petrochemicals and metal industries in columns (1)-(4) and only differentiated (D) products in columns (5)-(7). *** p<0.01, ** p<0.05, * p<0.1.

Parameter values

	Parameter	Value
Measured		
Export Invoicing Shares		
to U.S.	$\theta^{\$}_{H\$}$	1.00
to R	$\theta^{\$}_{HR}, \theta^{R}_{HR}$	0.93,0.07
Shocks		
commodity prices	σ_ζ, ρ_ζ	0.09, 0.74
Estimated		
Home bias	γ_{HH}	0.88
from U.S.	$\gamma_{\$H}$	0.06
from R	γ_{RH}	0.06
Exports		
to U.S.	$D_\$$	-2.38
to R	D_R	-0.87
Oil endowment	$\bar{\zeta}$	0.27
Import Invoicing Shares		
from U.S.	$\theta^{\$}_{\$H}$	1.00
from R	$\theta^{\$}_{RH}, \theta^{R}_{RH}$	0.93, 0.07
e_{RH} process	η, ρ_R, σ_R	0.74, 0.82,0.016
a process	$\sigma_a, \rho_a, \rho_{a,\zeta}$	0.13,0.49,-0.18

Table 25: Other parameter values as reported in the text.

A.5 Structural Estimation On Colombian Data

We use a combination of calibration and estimation to parameterize the model, reported in Table 25 while other parameter values are as reported in Table 1. The export invoicing shares are measured in the data directly. We calibrate the process for commodity price shocks in equation (24) to match the autocorrelation and standard deviation of HP-filtered commodity prices.[32] The values for $\bar{\zeta}$, $D_\$$, D_R, γ_{HH}, are chosen such that in steady state the model matches the Colombian data for the share of oil exports in total exports of 58%, a 10% share of oil exports over GDP, and the share of manufacturing exports going to the U.S. of 18%. We also match a steady state debt to GDP of 31% for Colombia. We set the interest elasticity to real dollar debt to equal 0.001.

We estimate the remaining parameters using a minimum distance estimator that minimizes the sum of squared deviations from moments in the data. Specifically, we minimize,

$$\mathbf{m}(\vec{\tau})\Omega^{-1}\mathbf{m}^{\mathbf{T}}(\vec{\tau})$$

where $\vec{\tau} = \{\theta^{\$}_{\$H}, \theta^{\$}_{RH}, \theta^{R}_{RH}, \eta, \sigma_r, \rho_R, \sigma_a, \rho_a, \rho_{a,\zeta}\}$ is a vector of nine parameters. To estimate these parameters we use the following eleven moments $\mathbf{m}(\vec{\tau})$ that theory suggests are informative. We estimate all parameters jointly and consequently all moments matter for all parameter values. The most informative moment for each parameter is described next.

[32] Specifically, we use the IMF's price index for all primary commodities, at the quarterly frequency, from 2000Q1 to 2016Q2. We HP filter the log of the index and compute the autocorrelation and the standard deviation of the cyclical component.

Moment matching

	$\hat{\beta}^{\$}_{0,\$H}$	$\hat{\beta}^{\$}_{0,RH}$	$\hat{\beta}^{H}_{0,RH}$	$\hat{\eta}$	$\hat{\sigma}_R$	$\hat{\rho}_R$	$\hat{\rho}_{a,\zeta}$	$\hat{\sigma}_a$	$\hat{\rho}_a$	$\hat{\beta}^{\$}_{0,HR}$	$\hat{\beta}^{\$}_{0,RH}$
Data	0.97	0.89	0.18	0.54	0.018	0.78	0.84	0.023	0.64	0.85	0.87
Model	0.97	0.80	0.13	0.54	0.017	0.78	0.87	0.026	0.64	0.81	0.90

Table 26: Moments in the data and in the estimated model. The difference between the second and last column is that the former estimate is from a regression that controls for the bilateral ER alongside the dollar ER. The latter is from a regression with only the dollar ER.

- Import Invoicing Shares: To estimate the import invoicing shares,
  - $\theta^{\$}_{\$H}$: We use the contemporaneous estimate β_0 from the pass-through regression for import prices from dollar countries.
  - θ^{R}_{RH} and $\theta^{\$}_{RH}$: We use the coefficients from regressing the quarterly change in import prices from non-dollar destinations on the peso/dollar and peso/origin country exchange rates.[33] $\Delta p_{RH,t} = \beta_{\$} \cdot \Delta e_{\$H,t} + \beta_R \cdot \Delta e_{RH,t} + \epsilon_t$
- Relation between e_{RH} and $e_{\$H}$: To estimate η and σ_R we construct the real exchange rate for Colombia relative to the U.S. and the (export share weighted) real exchange rate for Colombia relative to its other trading partners. We use these series to estimate the two equations (23) and (26) which we rewrite here:

$$\begin{aligned} e_{RH,t} + p_{R,t} - p_{H,t} &= \eta \left(e_{\$H,t} + p_{\$,t} - p_{H,t}\right) + \varepsilon_{R,t} \\ \varepsilon_{R,t} &= \rho_R \varepsilon_{R,t-1} + \epsilon_{R,t} \end{aligned}$$

  We use the empirical estimate for $\hat{\eta}$, $\hat{\rho}_R$ and the standard deviation of $\epsilon_{R,t}$ to obtain η, ρ_R, σ_R.
- Process for a and ζ: We match moments for the standard deviation (0.023) and autocorrelation (0.62) of manufacturing value added. We also match the contemporaneous correlation (0.84) of value added and commodity prices. Note that a refers to productivity, so we infer the process for a from matching moments of value added in the model and data.
- Additional Moments: We match the time zero coefficient on pass-through from $\mathcal{E}_{\$H}$ into export and import prices for R goods.

The weighting matrix Ω^{-1} is a diagonal matrix where the entries are the inverse of the variance of the data moments. The estimated values from this minimization are reported in Table 25 and the moment match between the model and data are reported in Table 26. As Table 25 reports the data strongly points towards DCP with almost all of the import invoicing share in dollars.

[33] In the data we also control for the peso/euro exchange rate.

Exchange rate pass-through into prices: Data and estimated model

	(1) $\Delta p_{HR,t}$	(2) $\Delta p_{HR,t}$	(3) $\Delta p_{RH,t}$	(4) $\Delta p_{RH,t}$
		Data		
$\Delta e_{RH,t}$	0.67***	0.06	0.750***	0.32***
	(0.09)	(0.05)	(0.12)	(0.08)
$\Delta e_{\$H,t}$		0.68***		0.53***
		(0.05)		(0.07)
		Estimated model		
$\Delta e_{RH,t}$	0.72	0.28	0.68	0.22
$\Delta e_{\$H,t}$		0.66		0.70
		DCP		
$\Delta e_{RH,t}$	0.71	0.23	0.67	0.17
$\Delta e_{\$H,t}$		0.71		0.75
		PCP		
$\Delta e_{RH,t}$	0.49	0.26	0.92	0.88
$\Delta e_{\$H,t}$		0.36		0.06
		LCP		
$\Delta e_{RH,t}$	0.98	0.93	0.44	0.19
$\Delta e_{\$H,t}$		0.08		0.39

Table 27: Exchange rate pass-through into export and import prices to/from non-dollarized economies, in the data and the model. Both regressions have only the bilateral exchange rate and the dollar exchange rate as controls. Data regressions include Firm-Industry-Country fixed effects, with s.e. clustered at the year level. The last three sets of results show the model-implied pass-through coefficients for the three extreme pricing assumptions, keeping all other parameters fixed at the values in Table 26.