

An Equilibrium Model of the International Price System[†]

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What explains the central role of the dollar in world trade? Will the US currency retain its dominant status in the future? This paper develops a quantitative general equilibrium framework with endogenous currency choice that can address these questions. Complementarities in price setting and input-output linkages across firms generate complementarities in currency choice making exporters coordinate on the same currency of invoicing. The dollar is more likely to play this role because of the large size of the US economy, a widespread peg to the dollar, and the history dependence in currency choice. Calibrated using the world input-output tables and exchange rate moments, the model can successfully replicate the key empirical facts about the use of currencies at the global level, across countries, and over time. According to the counterfactual analysis, the peg to the dollar in other economies ensures that the US currency is unlikely to lose its global status because of the falling US share in the world economy, but can be replaced by the renminbi in case of a negative shock in the US economy. If the peg is abandoned, the world is likely to move to a new equilibrium with multiple regional currencies. (JEL D21, E31, E42, F14, F31, F33)

One of the most intriguing facts in international economics is the asymmetric use of currencies in world trade and the dominance of the dollar in the international price system (Gopinath 2016). Indeed, the share of dollar currency pricing (DCP) in imports and exports is disproportionately high in both emerging economies—where it often reaches one—and many developed countries including Japan, South Korea, and several European economies (see online Appendix Figure A3). In contrast, the euro (ECP) plays the role of a regional currency accounting for most of the trade within eurozone, but almost zero share in trade between third countries. The use of

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other currencies is marginal and is usually lower than the trade shares of the corresponding economies. Although these invoicing patterns are highly persistent and with few exceptions do not change much at the horizon of a few decades, the history of the twentieth century shows that they are not immanent and that the international price system can undergo major transformations with one dominant currency (dollar) replacing the other (pound sterling). These facts raise several policy-relevant questions: Why do firms coordinate on one vehicle currency instead of using producer currencies (PCP) and/or local currencies (LCP)? What explains the central role of the dollar? Will the US currency retain its dominant status in the future? Is it more likely to be replaced by the euro, by the renminbi, or are we heading to a world with multiple regional currencies?

This paper studies these questions both *theoretically* and *quantitatively* by developing a tractable general equilibrium framework with endogenous currency choice. I build on the conventional sticky-price open-economy model by Gali and Monacelli (2005) and augment it with three additional ingredients. First, rather than taken as exogenous, the currency of invoicing is optimally chosen by individual exporters to bring their prices—which are sticky and cannot adjust in response to shocks—closer to the optimal level (Engel 2006). Second, I allow for price linkages across firms that arise from the use of intermediates in production and complementarities in price setting. These linkages are strongly supported by the data, especially for large firms that account for most of international trade, and are important to explain several other puzzles in international economics (see, e.g., Amiti, Itskhoki, and Konings 2014; Burstein and Gopinath 2012). Finally, the countries are heterogeneous in terms of size, inflation, and exchange rate regime.

Solving analytically for the equilibrium currency choice, I show that the model can explain key stylized facts about the international price system. Because of price linkages, each firm wants to synchronize its price with the prices of suppliers and competitors, which generates strategic complementarities in currency choice and gives rise to an equilibrium with exporters coordinating on one dominant currency. Two fundamental factors—the large size of the US economy and the use of the dollar as an anchor currency by other countries—make the dollar the most likely candidate for a vehicle currency. Intuitively, the size advantage implies that foreign firms use more US intermediates and compete with a larger number of US firms, which makes their prices more sensitive to the dollar exchange rate and increases the odds that they choose DCP when selling goods both in the US and in other markets. The anchor-currency advantage, on the other hand, means that many countries stabilize their exchange rates against the dollar (see Ilzetzi, Reinhart, and Rogoff 2019) making it the best substitute for a large number of currencies and increasing its chances to become a vehicle currency. This mechanism is further amplified by the fact that many developing countries have high inflation, which makes their currencies hardly suitable for invoicing.

The international price system is shaped, however, not only by fundamental factors, but also by its history: because of strategic complementarities, no exporter wants to change the currency of invoicing before other firms do, giving rise to path dependence. The hysteresis is even stronger if firms have to pay fixed costs when switching to a new currency. This result can account for the delayed transition from the pound to the dollar during the twentieth century and the wide use of the

dollar in the modern economy, despite increasing competition from the euro and the renminbi.

I then show that a straightforward extension of the baseline model can be easily taken to the data and used for a rich quantitative analysis. Complementing the analytical results that capture the first-order facts about the international price system, the quantitative extension of the model allows for a more nuanced view with the coexistence of the dominant, regional and local currencies in world trade. I calibrate price stickiness and complementarities in price setting using the values from Nakamura and Steinsson (2008) and Amiti, Itskhoki, and Konings (2019) and estimate the two main inputs of the quantitative model—the country-sector trade flows and the exchange rates moments—directly from the data using the OECD inter-country input-output (ICIO) tables with 63 countries and 32 sectors and the exchange rate series from the IMF International Financial Statistics database. To capture history dependence, the model is estimated and simulated sequentially for years 1995, 2005, and 2015 using as an initial guess the equilibrium invoicing from the previous period. Importantly, the only invoicing moment used in the calibration is the aggregate share of DCP for a subsample of countries in 1995 to choose the value of the fixed costs of currency adjustment.

Confronted with the invoicing data from Georgiadis et al. (2020), the calibrated model shows a surprisingly good fit replicating the key empirical facts about global use of currencies, the cross-sectional variation, and the evolution of invoicing in time. The share of DCP in total exports of 53 economies with available invoicing data is 52 percent in the model against 53 percent in the data. Moreover, the model explains 80 percent of the cross-country variation in DCP, including relatively low shares in the Eurozone countries, high shares in the United States and most emerging economies, and the intermediate values in the United Kingdom and Japan. The cross-sectional fit for the euro and home currencies is even better, exceeding 90 percent. This success of the structural model with endogenous currency choice contrasts with the naïve predictions based on trade shares and the role of commodities, which can explain neither the global dominance of the dollar, nor its cross-country variation. Using the granular invoicing data for Switzerland, I also show that the model captures the differences in currency shares across sectors. In addition, the model closely reproduces the evolution of the price system in 1995–2015, generating stable currency shares for most countries and a negative trend in DCP for selected European economies that switched to the euro.

Lastly, I take advantage of the quantitative general equilibrium framework to do counterfactuals about the future of the international price system under alternative scenarios. Interestingly, the model predicts that the rise of China and other emerging economies does not imperil, and can even strengthen, the dominance of the dollar if these countries maintain their current peg to the US currency. Given the complementarities and the adjustment costs, firms are unlikely to abandon the dollar as long as it remains a close substitute to other currencies. On the flip side, the status of the anchor currency bears its own risks, making the DCP equilibrium more sensitive to negative shocks in the US economy: an increase in the US inflation rate—e.g., due to rising government debt or the loss of the safe-asset status of treasuries—makes exporters look for an alternative unit of account and switch to the renminbi as the dollar's closest substitute. Finally, I consider a case where China abandons its peg

to the dollar and several emerging economies follow suit, adopting the renminbi as a new anchor currency. This counterfactual mirrors the history of the twentieth century, when many countries joined the Bretton Woods system with a peg to the pound or gold, but left it with a peg to the dollar (see Gourinchas 2021). Under this scenario, history dependence is strong enough to prevent the renminbi from becoming the new dominant currency, but it is not sufficient for the dollar to retain its global status, and therefore, the world moves to a new equilibrium with multiple regional currencies in line with the predictions of Eichengreen (2011).

Related Literature.—There are three main strands in the literature that use different frictions to explain the dominant status of the dollar in international trade. First, there is a long tradition in economics, going back to Krugman (1980), that emphasizes the *transaction costs* in exchange markets: coordination on a single currency raises the chances of a “double coincidence of wants” (Matsuyama, Kiyotaki, and Matsui 1993) and increases the “thickness” of markets (Rey 2001, Devereux and Shi 2013, Chahrour and Valchev 2021). These theories explain the widespread use of the dollar as a medium of exchange but have little to say about its role as an invoicing currency. Second, the use of the dollar as a unit of account can be due to *financial frictions*: firms try to synchronize the risks on their contracts (Drenik, Kirpalani, and Perez 2018) and borrow in a cheaper currency (Gopinath and Stein 2021).

This paper belongs to the third strand in the literature, one that emphasizes *nominal frictions* and has two important advantages. First, Gopinath, Itskhoki, and Rigobon (2010) provide direct empirical evidence in favor of this mechanism, which allows them to discriminate against alternative theories. Second, it is price stickiness that makes currency choice relevant for monetary policy in most existing open-economy models (Gopinath et al. 2020) and so it is natural to use the same friction as a starting point to think about firms’ invoicing decisions.

The contribution of this paper is twofold. On the theory side, several ingredients of the model come from the previous literature, including firm’s currency choice under sticky prices (Friberg 1998, Engel 2006), complementarities in currency choice arising from input-output linkages (Novy 2006; Devereux, Shi, and Xu 2010) and price linkages (Bacchetta and van Wincoop 2005, Goldberg and Tille 2008), the effect of monetary policy on invoicing (Corsetti and Pesenti 2002; Devereux, Engel, and Storgaard 2004), and the use of a vehicle currency in international trade (Bhattarai 2009, Cravino 2014). None of these papers, however, are readily available to analyze the global dominance of the dollar or the future of the international price system. Three features of my model distinguish it from the previous literature and make it particularly suitable to address these issues. First, I consider a world with multiple countries, which allows me to distinguish vehicle currencies from PCP and LCP. Second, the model is consistent with the exchange rate disconnect in the data and does not produce a counterfactually high correlation between exchange rates and nominal wages—the moment that plays the central role in firms’ currency choice. Finally and most importantly, I solve for the *equilibrium* invoicing taking into account the effects of exporters’ decisions on each other via input-output linkages and complementarities in price setting.

On the empirical side, the paper complements the reduced-form evidence (see Goldberg and Tille 2008, Drenik and Perez 2021, Georgiadis et al. 2020) with the

structural analysis of the determinants of the currency choice using a calibrated general equilibrium model to explain the global invoicing as well as its variation across countries, sectors, and periods. The important advantage of this approach is that it takes into account the interactions between exogenous factors in their effect on equilibrium invoicing, as well as the complementarities in currency choice across firms that are hard to capture in reduced-form regressions, especially given the limited coverage of the invoicing data.

I. Baseline Model

This section describes the model of currency choice that is based on conventional ingredients and attains a closed-form characterization, yet is rich enough to allow for alternative invoicing regimes depending on parameter values. I keep the environment as simple as possible for tractability reasons and relegate the discussion of extensions to Section III.

A. Environment

Following Gali and Monacelli (2005), consider a world consisting of a continuum of symmetric regions $i \in [0, 1]$. Each region $i \in (n, 1]$ is a small open economy with its own nominal unit of account, in which local wages and prices are expressed. All countries are symmetric except for the United States, which is allowed to be different in two dimensions. First, it is a large economy that includes regions $i \in [0, n]$ and can also be interpreted as a currency union or a set of dollarized countries. Second, as explained in detail below, the second moments of exogenous shocks are such that the volatility of the exchange rates against the dollar are lower than the volatility of other bilateral exchange rates capturing the fact that many countries peg their exchange rates to the dollar (Ilzetzi, Reinhart, and Rogoff 2019).

In each country, there is a representative household, a local government and a continuum of firms with intermediate goods in production, strategic complementarities in price setting and the home bias toward domestically produced goods. For simplicity, there is only one period, risk-sharing and price-setting decisions are made before the realization of shocks, and firms adjust prices afterwards with a given probability. I focus on financial shocks as the key driver of exchange rates, which is consistent with empirical evidence (see Jiang, Krishnamurthy, and Lustig 2018; Engel and Wu 2018) and allows the model to reproduce the exchange rate disconnect from the data (see Itskhoki and Mukhin 2021).

Households in region i have log-linear preferences over consumption and labor

$$(1) \quad E[\log C_i - L_i].$$

Before the realization of shocks, agents can trade internationally a full set of Arrow securities subject to the ex ante budget constraint

$$(2) \quad \sum_h Q^h B_i^h = 0,$$

where Q^h is the price of Arrow security that pays one dollar in a given state of the world indexed by h . To simplify the notation, I suppress index h below with the understanding that all variables are state contingent if not noted otherwise. After the shocks are realized, households collect labor income $W_i L_i$, dividends from local firms Π_i and returns on their assets and spend the proceeds $P_i C_i$ on consumption:

$$(3) \quad P_i C_i = W_i L_i + \Pi_i + e^{-\psi_i} \mathcal{E}_{i0} B_i + \Omega_i,$$

where $\mathcal{E}_{ij}$ is the bilateral nominal exchange rate between regions i and j , which goes up when currency i devalues relative to currency j . Because markets are complete, the assumption that returns on the Arrow securities are in dollars is without loss of generality. I allow for stochastic country-specific wedges in asset returns ψ_i , which can be interpreted as a shock in the local financial markets with the resulting profits (or losses) of the financial sector Ω_i reimbursed lump sum to local households.

Firms in region i produce a continuum of unique tradable products indexed by $\omega \in [0, 1]$ using technology that combines labor L_i and intermediate goods X_i :

$$(4) \quad Y_i(\omega) = A_i \left(\frac{L_i(\omega)}{1 - \phi} \right)^{1-\phi} \left(\frac{X_i(\omega)}{\phi} \right)^{\phi}, \quad \phi < 1.$$

The bundle of intermediates X_i used in production is the same as that consumed by households and includes both local and foreign varieties, which are combined via a homothetic aggregator:

$$(5) \quad \Phi \left(\left\{ \frac{Y_{ji}(\omega)}{X_i} \right\}_{j,\omega}, \gamma \right) = 1,$$

where $Y_{ji}(\omega)$ denotes exports of product ω from country j to country i and the home bias $1 - \gamma$ reflects either trade costs or preferences for domestic goods, $\gamma \in (0, 1)$. Note that when $n > 0$, a positive fraction of global trade happens between regions within the United States. As a result, the home bias is higher in the United States than in small economies. I assume $\Phi(\cdot)$ is the Kimball (1995) aggregator (see equation (A1) in the online Appendix) to allow for complementarities in price setting, which as explained below, are important for firms' currency choice.

For each country of destination, exporters choose the currency of invoicing, which they use to set the price before the realization of shocks. I use a one-period version of Calvo (1983) pricing, assuming that the price can be updated ex post with probability $1 - \lambda$.¹ While any currency can be used for invoicing in international trade, it is assumed that local firms set prices exclusively in domestic currency—perhaps due to legal reasons. Online Appendix A.3.2 relaxes this assumption and derives additional results when domestic firms optimally choose the currency of invoicing.

Government in each country is responsible for setting monetary policy. Following the primal approach, I formulate the monetary policy in terms of the target, namely,

¹ The currency choice is robust to the nature of nominal rigidities—including staggered price setting (Section III), Rotemberg (1982) friction, and menu costs (see Gopinath, Itskhoki, and Rigobon 2010)—and to replacing the assumption that currency choice is made unilaterally by suppliers with Nash bargaining between buyers and sellers.

the process for the aggregate demand $M_i \equiv C_i P_i$ as in Carvalho and Nechio (2011), and abstract from the particular implementation of this policy, which can be done either with an interest-rate rule or a money-supply rule.

Equilibrium Conditions require that labor supply equals total demand of all firms:

$$(6) \quad L_i = \int_0^1 L_i(\omega) d\omega.$$

Produced goods are sold locally and exported abroad to be used in production and consumption:

$$(7) \quad Y_i = (1 - \gamma) Y_{ii} + \gamma \int_0^1 Y_{ij} dj.$$

Finally, the market clearing in the international asset markets implies

$$(8) \quad \int_0^1 B_i di = 0.$$

Shocks that have no effect on nominal exchange rates in this setting—including shocks to productivity, government spending, and terms-of-trade—do not change the trade-off between setting prices in different currencies, and therefore are suppressed for brevity. Furthermore, I assume that monetary policy fully stabilizes nominal demand and revisit the case of positive inflation in Section IIIA. This leaves financial shocks ψ_i as the only source of volatility in exchange rates. Assume that these shocks can be decomposed into a common global component $\bar{\psi}$ and an idiosyncratic currency-specific component $\psi_i - \bar{\psi}$ that is uncorrelated across countries (but not regions). The volatility of the latter is assumed to be lower for the United States than for other economies; i.e., $\rho \equiv \frac{\text{var}(\psi_0 - \bar{\psi})}{\text{var}(\psi_i - \bar{\psi})} \leq 1$ for $\forall i > n$, which can be rationalized in three ways. First, a better diversification of the US economy implies that it is subject to granular shocks less than countries that specialize in production and exports of a few commodities and manufacturing goods (Gabaix 2011, Gaubert and Itskhoki 2021). Second, the large size of the US economy can result in stronger spillovers and comovement with other economies (Hassan 2013). My preferred interpretation of the condition, however, is that non-US economies use foreign exchange interventions and capital controls to stabilize their exchange rates against the dollar, giving rise to a global component $\bar{\psi}$ that is negatively correlated with ψ_0 (Ilzetzki, Reinhart, and Rogoff 2019).²

DEFINITION 1: *Given exogenous shocks $\{\psi_i\}$, an equilibrium is defined as follows:*

- (i) *households maximize utility over consumption, labor supply and asset holdings;*
- (ii) *each firm maximizes expected profits over labor, intermediate inputs, currency*

²While the exchange rate regime is taken as exogenous in the model, Egorov and Mukhin (2021) show that there is a feedback with the optimal tightness of the peg to the dollar increasing in the share of DCP in country's imports.

of invoicing and prices in each market, taking the decisions of all other firms as given and setting domestic prices in local currency; (iii) all markets clear.

B. Firm's Currency Choice

This section describes the invoicing problem of an individual exporter following closely the insights of Engel (2006); Gopinath, Itskhoki, and Rigobon (2010); and Cravino (2014). In contrast to the previous literature, which focuses mostly on a binary currency choice (e.g., between PCP and LCP), firms are allowed to set prices in any currency $k \in [0, 1]$ in the model. I approximate equilibrium conditions around the symmetric steady state and denote the log deviations of variables from the steady-state values with small letters (see online Appendix A.1 for details).

Let $\Pi_{ji}(p)$ denote the profit of the exporter from country j to country i as a function of price p expressed in the currency of destination.³ Define the optimal price $\tilde{p}_{ji}$ that maximizes profits for a given realization of shocks:

$$\tilde{p}_{ji} = \operatorname{argmax}_p \Pi_{ji}(p).$$

Ideally, firms would like to implement $\tilde{p}_{ji}$ in every state of the world. This is, however, not feasible because of price stickiness, and firms preset prices in currency k to maximize their expected profits:⁴

$$\bar{p}_{ji}^k = \operatorname{argmax}_p E \Pi_{ji}(p + e_{ik}).$$

The optimal preset price equals the *expected* value of $\tilde{p}_{ji}$ expressed in currency of invoicing k

$$(9) \quad \bar{p}_{ji}^k = E[\tilde{p}_{ji} + e_{ki}]$$

and allows firms to replicate the mean value of the optimal price. With the endogenous currency choice, firms can go one step further and target the second moment of $\tilde{p}_{ji}$:

LEMMA 1 (Currency Choice): *To the second-order approximation, the currency choice problem of the exporter is equivalent to choosing currency k , in which the optimal price $\tilde{p}_{ji} + e_{ki}$ is most stable:*

$$(10) \quad \begin{aligned} \max_{k \in [0,1]} E \Pi_{ji}(\bar{p}_{ji}^k + e_{ik}) &\Leftrightarrow \min_{k \in [0,1]} E [\bar{p}_{ji}^k + e_{ik} - \tilde{p}_{ji}]^2 \\ &\Leftrightarrow \min_{k \in [0,1]} \operatorname{var}[\tilde{p}_{ji} + e_{ki}]. \end{aligned}$$

³Because of constant returns to scale technology, marginal costs are independent of the quantity produced. Therefore, the profit function is separable across markets, and firms choose prices and currencies independently for each destination.

⁴I assume that profits are expressed in real discounted units; i.e., $\Pi_{ji}(\cdot)$ includes the stochastic discount factor (SDF). The variation in SDF does not affect the results under the approximation used below.

As the second expression makes clear, exporters choose currency k to mitigate the effect of sticky prices and to bring ex post price $\bar{p}_{ji}^k + e_{ik}$ closer to the optimal state-dependent value $\tilde{p}_{ji}$. Equivalently, it is optimal to use currency k , in which the optimal price $\tilde{p}_{ji} + e_{ki}$ is most stable.⁵

To give an example, if the optimal price is always \$100, then setting the price in dollars allows the firm to replicate $\tilde{p}_{ji}$ in every state of the world. The choice is more nuanced when the optimal price is not fully stable in one currency, e.g., when $\tilde{p}_{ji}$ can be expressed as \$50 + £50. As argued by Corsetti and Pesenti (2002), in this case, the firm would ideally like to set the price in terms of a basket of currencies.⁶ However, not only is there little empirical evidence for such pricing, but it also generates counterfactual predications at the aggregate level and makes the model inconsistent with the key stylized fact about the international price system:

LEMMA 2 (Basket of Currencies): *If firms could set prices in terms of baskets of currencies, then the share of DCP would not exceed the share of the United States in global trade.*

Intuitively, invoicing in baskets of currencies allows firms to reproduce their desired prices $\tilde{p}_{ji}$ and the equilibrium is the same as under flexible prices. As discussed below, the currency shares in the optimal basket are then determined by the amount of intermediates and competing products produced in each country and the share of the dollar is bounded by the size of the US economy. Therefore, I introduce the second key friction to the model on top of sticky prices, so that individual firms find it suboptimal to use baskets of currencies for invoicing and make discrete currency choices. In the spirit of Mankiw (1985), Lemma 1 ensures that small (second-order) fixed costs of adding currencies are sufficient to rationalize this assumption.

C. Equilibrium Prices

Lemma 1 shows that firms' currency choice is determined by the properties of the desired price $\tilde{p}_{ji}$. A constant returns to scale technology and a homothetic demand ensure that equilibrium prices depend only on the supply side of the economy and can be analyzed separately from the quantities, which greatly simplifies the analysis. In contrast to the constant elasticity of substitution (CES) case, the Kimball demand generates strategic complementarities in price setting across firms, so that the optimal price of an exporter from j to i depends not only on its marginal costs but also on the prices of competitors in the destination market:

$$(11) \quad \tilde{p}_{ji} = (1 - \alpha)(mc_j + e_{ij}) + \alpha p_i,$$

⁵ Although Lemma 1 summarizes optimal currency choice in a compact form, solving minimization problem (10) is equivalent to a pairwise comparison of all currencies: currency k is preferred to currency h if the pass-through of bilateral exchange rate shocks e_{kh} into the desired price $\tilde{p}_{ji} + e_{ki}$ is low (see Proposition 2 in Gopinath, Itskhoki, and Rigobon 2010).

⁶ Notice this is not the same as using mixed strategies (lotteries) across currencies. Moreover, the optimal currency basket is firm-specific and there is no one-size-fits-all solution like the special drawing rights.

where parameter α reflects the curvature of $\Phi(\cdot)$ and is different from demand elasticity.⁷ In the limit $\alpha \rightarrow 0$, the Kimball aggregator converges to the CES function and firms charge a constant markup, so that cost shocks are the only source of variation in the optimal price. The marginal costs of production in country i are a weighted sum of local wages w_i and prices of intermediates p_i :

$$(12) \quad mc_i = (1 - \phi)w_i + \phi p_i.$$

To the first-order approximation, the aggregate price index is the sum of the prices of locally produced goods p_{ii} and imported goods p_i^I with the weight of the former determined by the home bias $1 - \gamma$

$$(13) \quad p_i = (1 - \gamma)p_{ii} + \gamma p_i^I, \quad \text{where} \quad p_i^I = \int_0^1 p_{ji} dj,$$

while the bilateral price index combines the prices of adjusting and nonadjusting firms:⁸

$$(14) \quad p_{ji} = (1 - \lambda)\tilde{p}_{ji} + \lambda(\bar{p}_{ji}^k + e_{ik}).$$

A fraction $1 - \lambda$ of firms update prices after the realization of shocks and set them at the optimal level $\tilde{p}_{ji}$. The prices of other firms stay constant in the currency of invoicing k_{ji} , which means they move one-to-one with the exchange rate $e_{ik_{ji}}$ in the currency of the customers. It follows that the equilibrium price system is a fixed point with prices determined by firms' invoicing decisions and individual currency choices shaped by aggregate prices:

DEFINITION 2: *Given $\{w_i, e_{ij}\}$, the equilibrium international price system consists of price indices $\{p_{ji}\}$ and firms' currency choices $\{k_{ji}\}$ such that (i) given invoicing regime, $\{p_{ji}\}$ solve the system (11)–(14), and (ii) given prices, $\{k_{ji}\}$ solve problem (10).*

D. General Equilibrium

Definition 2 implies that the only general equilibrium objects that matter for exporters' currency choices are the second moments of exchange rates and nominal wages. In the general case, there is also a feedback effect: the dynamics of w_i and e_{ij} depend on international prices, which in turn are shaped by the invoicing decisions of firms. This section shows, however, that under the assumptions made in the baseline model, exchange rates and nominal wages do not depend on the currency

⁷ An alternative way of generating complementarities in price setting is to assume decreasing returns to scale in production (see Goldberg and Tille 2008, Bacchetta and van Wincoop 2005). In this case, the optimal price depends on shifts in demand and hence, on prices of competing firms. Despite this isomorphism, the important advantage of the Kimball demand is that it allows to solve for prices and invoicing independently from quantities keeping the analysis more tractable.

⁸ To simplify the notation, I assume that all exporters from j to i use the same currency of invoicing k . The results in Section II, however, apply even under mixed strategies if not noted otherwise.

of invoicing, and therefore, the model attains a convenient block-recursive structure: one can solve for equilibrium currency choice taking the *relevant* general equilibrium moments as given.⁹

LEMMA 3 (Exchange Rates): *The second moments of equilibrium nominal wages and exchange rates are independent of the invoicing decisions of firms.*

The result follows from the combination of log-linear utility, complete asset markets and the monetary rule that targets nominal spending. Indeed, the labor supply condition implies that wages are equal to nominal spending $w_i = p_i + c_i$ and hence, are stabilized by the monetary policy, while international risk sharing ensures that exchange rates depend only on financial shocks $e_{ij} = \psi_i - \psi_j$. The result from Lemma 3 holds more broadly and can be derived under the alternative set of assumptions. In particular, one can replace monetary policy that stabilizes nominal wages with the assumption that wages are sticky in domestic currency, while the assumption of complete asset markets can be relaxed to one internationally traded bond.

For future use, it is convenient to define a trade-weighted exchange rate of country i , which under symmetric trade flows is $e_i \equiv \frac{1}{1-n} \int_n^1 e_{ik} dk$. Any bilateral exchange rate can then be decomposed into country-specific components $e_{ij} = \frac{1}{1-n} \int_n^1 e_{ij} dk = \frac{1}{1-n} \int_n^1 e_{ik} dk - \frac{1}{1-n} \int_n^1 e_{jk} dk = e_i - e_j$. It follows from the structure of financial shocks that $e_i = \psi_i - \psi$ and hence, the trade-weighted exchange rates are uncorrelated across economies.

II. Equilibrium Currency Choice

This section solves for the equilibrium currency choice and shows that the model is consistent with the key stylized facts about the international price system. In particular, I argue that exporters find it optimal to coordinate on a single vehicle currency, the dollar is a preferred candidate for the role of the dominant currency, and there is a path dependence in currency choice explaining a delayed transition from the pound to the dollar.

A. Why Vehicle Currency?

While it is intuitive that firms might set prices in producer or customer currency, it is not immediately clear why they would ever use a third currency for invoicing. In this section, I show that a vehicle currency equilibrium (VCP) can arise naturally when price linkages across exporters are strong enough. The question of *which* currency is used as a vehicle currency is discussed in the next section.

According to Lemma 1, the currency choice of an individual exporter from j to i depends on the properties of its desirable price $\tilde{p}_{ji}$, which in turn, is determined

⁹Notice this result does *not* mean that invoicing decisions of firms have no general equilibrium effects at all: consumption, output, exports, and imports do change with the currency of invoicing even though wages and exchange rates do not.

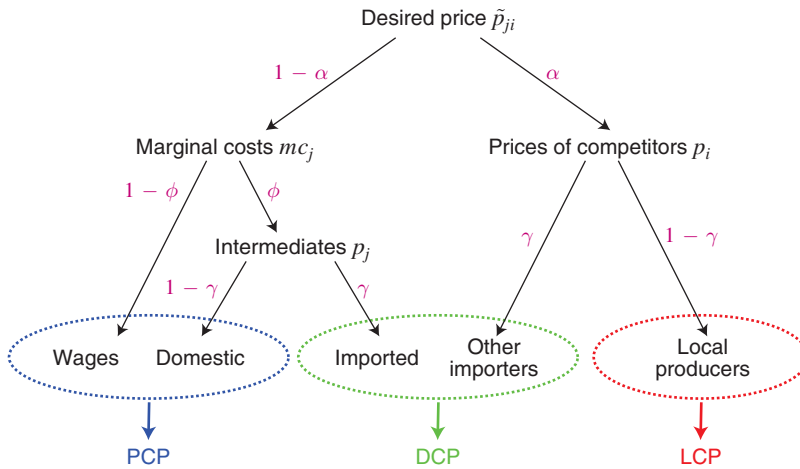


FIGURE 1. OPTIMAL PRICE AND THE CURRENCY CHOICE OF AN INDIVIDUAL FIRM

by the system of equilibrium conditions (11)–(14) summarized in Figure 1. Firms choose currency k , in which their optimal price is most stable:

$$(15) \quad \tilde{p}_{ji} + e_{ki} = e_k - (1 - \alpha)(e_j - \phi p_j) - \alpha(e_i - p_i).$$

To see the importance of price linkages between exporters for the VCP equilibrium, consider the currency choice in two limiting cases with no interactions between firms from different economies. First, assume the CES aggregator $\alpha = 0$ and no intermediates in production $\phi = 0$. With no price linkages across firms, the desired price $\tilde{p}_{ji} + e_{ki} = e_k - e_j$ is independent of prices and invoicing decisions of other exporters and is proportional to the nominal wage, which by assumption is stable in the domestic currency. It follows that the optimal price of the exporter is constant in the producer currency and PCP is always optimal; i.e., $k = j$. Second, consider the autarky limit $\gamma \rightarrow 0$, so that there are price linkages only between local firms. The aggregate prices in each country are then independent of exchange rate movements and are constant in local currency $p_i = 0$. With marginal costs stable in producer currency and the prices of competitors stable in local currency, the desired price is $\tilde{p}_{ji} + e_{ki} = e_k - (1 - \alpha)e_j - \alpha e_i$ and exporters choose PCP if $\alpha < 1/2$ and LCP if $\alpha > 1/2$, but never set prices in a vehicle currency.

These two special cases show that the price linkages between exporters from different countries are a *necessary* condition to sustain the vehicle currency pricing. The next proposition shows that the reverse is also true: the VCP equilibrium always exists as long as the share of foreign intermediates in production and/or the price complementarities across foreign firms are strong enough.¹⁰

¹⁰I use the following definition throughout the paper: the region of equilibrium Z in parameter space is said to be increasing in parameter x if for any $x_2 > x_1$ the set of (other) parameters for which Z exists under $x = x_2$ includes the set for which Z exists under $x = x_1$.

PROPOSITION 1 (Price Linkages): *The region of the VCP equilibrium in parameter space is nonempty and is increasing in the openness of economies γ and the share of intermediates in production ϕ , and can be nonmonotonic in price-setting complementarities α .*

Intuitively, when openness γ is high, so that a significant fraction of suppliers and competitors are coming from third countries, the optimal price $\tilde{p}_{ji}$ of an exporter is no longer stable in either producer or local currency, and using a vehicle currency might be optimal. The prices of inputs and competing products that a given exporter faces in this case depend on the invoicing decisions of suppliers and competitors: in particular, if other firms set their prices in dollars, the optimal price of the exporter becomes more stable in dollars as well, making DCP more attractive. An important implication of this result, which will be further discussed in Section IIIC, is that the globalization of the last few decades—including the rising participation of Asian countries in global value chains and the integration of post-Soviet states in the global economy—might have strengthened the incentives of exporters to coordinate on a common currency to avoid undesirable movements in relative prices.

Proposition 1 also shows an important difference between parameters α and ϕ : even though both strengthen complementarities in currency choice, the price-setting complementarities tie the invoicing decisions of firms *within* a given market, while the input-output linkages generate complementarities *between* markets. As a result, a higher share of intermediates in production ϕ always makes VCP more attractive, while stronger price complementarities α can potentially benefit LCP rather than VCP. In general, the effect of price complementarities is nonmonotonic: low α increases the share of producer currency in the optimal price, while high α increases the share of the local currency (see Figure 1). The chances of a vehicle currency are therefore, higher for intermediate values of α when neither producer nor local currency dominates in the desired price.

It is worth emphasizing that although Proposition 1 provides sufficient conditions for the existence of the VCP equilibrium, the uniqueness of an equilibrium is not guaranteed. Instead, the strong complementarities in currency choice that help to support VCP can also generate multiple equilibria despite unique optimal choice at the firm level. The next section shows, however, that DCP is not necessarily a sunspot equilibrium and there are *fundamental* factors that make firms choose dollar pricing.¹¹

B. Why the Dollar?

In order to disentangle the fundamental factors behind equilibrium invoicing from the complementarities in currency choice described above, I focus on the flexible-price limit $\lambda \rightarrow 0$, where all firms adjust prices ex post, and therefore the invoicing decision of a given exporter does not depend on the currency choice of other firms and the equilibrium is always unique (see Lemma A1). Indeed, given no

¹¹Online Appendix Section A.3.1 provides additional results about the coexistence of the PCP, LCP, and DCP equilibria.

nominal frictions, the aggregate prices are independent of the currency of invoicing and can be found directly from equations (11) to (14):

$$(16) \quad p_i = \frac{\gamma}{1 - (1 - \gamma)\phi}(e_i - ne_0).$$

Consistent with Proposition 1, the pass-through of exchange rate shocks into aggregate prices is increasing in the economy's openness and in the intensity of the input-output linkages. At the same time, the currency choice is still well-defined given an arbitrarily small price stickiness: the invoicing decision of an exporter depends only on the states of the world in which prices remain unadjusted and is determined even when the probability of these states converges to zero. Substituting price indices (16) into the optimal currency choice (15), we get the necessary condition for dollar invoicing:

LEMMA 4 (No-DCP Benchmark): *Assume $\lambda \rightarrow 0$. If countries are symmetric, $n = 0$, $\rho = 1$, exporters choose PCP when $\alpha \leq \frac{1}{2 - \gamma}$, LCP when $\alpha \geq \frac{1}{2 - \gamma}$, and no DCP equilibrium exists.*

Intuitively, when prices are (almost) flexible, the weights of different exchange rates in the optimal price $\tilde{p}_{ji}$ are determined solely by trade linkages. If countries are symmetric, $n = 0$, the market share of US products is infinitely small and therefore, the weight of the dollar in the optimal price of exporters from other countries is trivial. The same applies to all other currencies except for producer and destination ones, which have a positive weight due to home bias. Given that all exchange rates have the same volatility, $\rho = 1$, firms unambiguously choose either PCP or LCP.

Consider next the case when the volatility of exchange rates is the same for all countries, $\rho = 1$, but the United States accounts for a nontrivial share of global trade, $n > 0$.¹² This implies that a positive fraction of inputs and competing products in small economies are coming from the United States, and that the dollar has a positive weight in price index (16) and the optimal price $\tilde{p}_{ji}$ of foreign exporters. As a result, the dollar is preferable to any other vehicle currency and depending on parameter values, firms choose PCP, LCP, or DCP in equilibrium. Figure 2 panel A illustrates this result in the coordinates α and γ . Consistent with Proposition 1, exporters are more likely to set prices in producer (local) currency when complementarities in price setting are weak (strong), while a higher openness of the economies and a larger share of the United States in world trade increase the chances of the DCP equilibrium.

PROPOSITION 2 (Large Economy Advantage): *Assume $\lambda \rightarrow 0$. Then as long as the share of the US economy in international trade is positive, $n > 0$, the region in the parameter space with DCP as a unique equilibrium is nonempty and increases as n goes up.*

Figure 2 panel A also shows that equilibria with asymmetric invoicing can arise when $n > 0$. In particular, firms might choose PCP when trading between small

¹²Note that PCP, LCP, and DCP coincide for trade flows between regions within the United States.

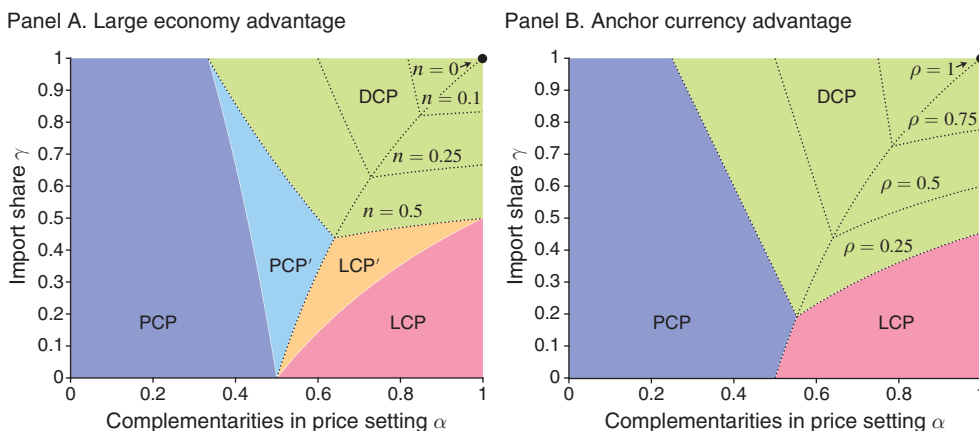


FIGURE 2. CURRENCY CHOICE: FLEXIBLE PRICE LIMIT

Notes: The figure shows equilibria for $\lambda \rightarrow 0$, $\phi = 0.5$ and (i) $\rho = 1$, different values of n ; (ii) $n = 0$, different values of ρ . PCP' (LCP') denotes the region where small countries set prices in producer (local) currency when trading with each other and use dollars when trading with the United States.

economies, but set prices in dollars when exporting to the United States. This is because the home bias is larger in the United States than in other countries when $n > 0$, and more competitors in the US market have prices stable in local currency. Similarly, exporters from the United States have a higher share of their marginal costs that are stable in their own currency and can choose DCP even when exporters from other economies prefer LCP.

Interestingly, the size of the US economy is not the only fundamental advantage of the dollar. Even if countries are symmetric in terms of their size, $n = 0$, and the dollar exchange rate does not appear in foreign price indices (16), the DCP equilibrium may still emerge because of the lower volatility of the US exchange rate, i.e., $\rho < 1$ (see Figure 2 panel B). To see the benefits of DCP in this case, consider a limiting case with no home bias $\gamma \approx 1$ and strong complementarities in price setting $\alpha \approx 1$, so that the optimal price of a given firm depends only on prices of foreign competitors (see Figure 1). It follows that all exchange rates enter symmetrically into the optimal price $\tilde{p}_j$ and the firm would ideally like to set prices in terms of a fully diversified basket of currencies. This is, however, not feasible because of the discrete nature of the invoicing problem, and firms look for a currency that can most closely replicate this diversified portfolio. Since the dollar has the lowest idiosyncratic volatility, $\rho < 1$, it strictly dominates other alternatives. Away from this limit, there is a trade-off between producer/local currency and the dollar, but the DCP region still increases as ρ goes down.

PROPOSITION 3 (Anchor Currency Advantage): Assume $\lambda \rightarrow 0$. Then as long as the dollar has lower volatility than other currencies, $\rho < 1$, the region in the parameter space with DCP as a unique equilibrium is nonempty and, if $n \leq 1/2$, increases as ρ goes down.

This result has several noteworthy implications. First, it shows that the relative volatilities of exchange rates are important even when they are not driven by nominal

shocks (*cf.* Devereux, Engel, and Storgaard 2004), and that volatile currencies are unlikely to be widely used in international trade. Second, the result establishes an important linkage between, on the one hand the wide use of the dollar as an anchor currency in the exchange rate policies of emerging economies and, on the other hand the dominance of the dollar in international trade: a tighter peg of exchange rates to the dollar makes it a better substitute for other currencies and raises its odds of becoming the vehicle currency. Finally, notice the connection between Propositions 2 and 3: while parameter n reflects the total size of economies with a *hard peg* to the dollar, parameter ρ captures the tightness of *crawling pegs* to the dollar.

C. Transition

The previous sections show that both the fundamentals and the complementarities in currency choice contribute to the dominant status of the dollar in today's world. But what happens when the two factors work in the opposite directions and firms coordinate on a currency that is losing its fundamental advantages? This section discusses the transition from the pound sterling to the dollar during the twentieth century, while Section IIIF below discusses the future of the dollar in the twenty first century.

To this end, I extend the model to have two large countries, the United Kingdom and the United States, and a continuum of small economies: constituting the rest of the world (RoW) (see Figure 3 and online Appendix A.2 for details). The global economy starts from the point where the United Kingdom has a fundamental advantage in terms of economy size and/or the anchor status of its currency, which it loses during the transition path as the US economy becomes larger and more countries switch to pegging their exchange rates to the dollar. I focus on the choice between the two potential dominant currencies and ignore the PCP and LCP alternatives. Importantly, I follow the previous literature (see e.g., Matsuyama, Kiyotaki, and Matsui 1993; Rey 2001) and make the assumption in the spirit of evolutionary game theory that as long as the old equilibrium exists, firms do not coordinate to jump into a new one.¹³

COROLLARY 1 (Transition): *Consider an increase in the relative size of the US economy or a decrease in the relative volatility of its exchange rate. The share of the pound remains above one-half even when the US fundamentals become the same as in the United Kingdom. The trade flows switch to the dollar in the following order: (i) between the United States and the RoW, (ii) between the RoW countries as well as between the United States and the United Kingdom, and (iii) between the United Kingdom and the RoW.*

¹³ Although a dynamic model with staggered pricing can be applied to select between “history” versus “expectations,” the equilibrium remains nonunique (see e.g., Matsuyama 1991, Krugman 1991). Alternatively, one can use a global game approach (Morris and Shin 2001), but its application in dynamic settings is complex and goes beyond the scope of this paper.

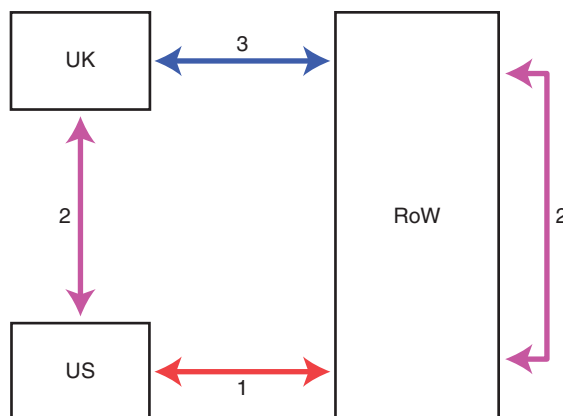


FIGURE 3. TRANSITION FROM ONE VEHICLE CURRENCY TO ANOTHER

Note: The figure shows the order in which trade flows between countries switch from the pound to the dollar.

This result follows from Propositions 1 to 3 and illustrates the interplay between the fundamental determinants of currency choice and the strategic complementarities across firms. The latter implies that no firm wants to be the first to adopt the dollar. As a result, the pound remains the dominant currency even when the US economy overtakes the UK economy in terms of size, and regarding the anchoring of exchange rates, which gives rise to path dependence in equilibrium invoicing. Although the fixed costs of changing the currency would further strengthen the hysteresis, they are not necessary given the complementarities in invoicing. The flip side of this result is that the United States can potentially speed up the transition by forcing its own firms adopt the dollar, which due to price linkages, would make exporters from other countries more willing to abandon the pound.

The model also has clear predictions about the order in which trade flows switch from one currency to another. As can be seen from Figure 3, trade between the United States and small economies is the first to switch from the pound because of the prevalence of US firms with costs stable in dollars. At the second stage, small economies start using the dollar as a vehicle currency when trading with one another, and trade flows between the two large economies also change the currency of invoicing. Finally, trade between the United Kingdom and small economies switches to the dollar as well. Interestingly, depending on the strength of complementarities in currency choice, there can be a full transition from the pound to the dollar or alternatively, the economy can end up in an equilibrium with multiple regional currencies: e.g., the dollar dominates in trade between the United States and small economies as well as across small economies, but the imports and exports of the United Kingdom remain invoiced in pounds.

These predictions are broadly consistent with historical evidence—the transition from the pound to the dollar was sluggish, followed with a lag after the United States overtook the United Kingdom as the largest economy, and was accelerated by the high volatility of the UK exchange rate after World War I (see Eichengreen 2011). While the invoicing data are scarce for most of the twentieth

century, the recent experience of the eurozone also fits the predictions of the model. In particular, the euro is more commonly used in trade between the eurozone and developing countries, but much less so in trade with the United States, and almost never as a vehicle currency (Kamps 2006).

III. Quantitative Analysis

This section shows that a straightforward extension of the analytical model described above can be taken to the data and be used for a rich quantitative analysis. To this end, I augment the baseline setup with staggered Calvo pricing, heterogeneous countries and sectors; calibrate the model using the global input-output table and exchange rate series; demonstrate a good fit of the model; and finally, do the counterfactual exercises about the future of the international price system.

A. Full Model

Although useful to build intuition, the baseline model is clearly too simplistic to be taken directly to the data. This section extends the setup in two directions—a general input-output matrix between countries and sectors, and richer dynamics of prices and exchange rates—briefly outlining the key new ingredients and relegating the details to online Appendix B.1. Consider an infinite horizon model with N economies, S sectors (industries), and K currencies. For convenience, in most of the analysis below, I use subscripts j and i to denote respectively the countries of origin and destination, and superscripts r and s for the sectors of origin and destination. Index k is reserved for currency of invoicing. Firms are free to set different prices across markets with the latter defined by the type of good r (industry of production) and country of destination i .

Heterogeneity.—of trade flows between countries and sectors is important in two ways. On the one hand, it allows analysis of the cross-sectional variation in currency choice. On the other hand, it incorporates the granularity of international trade with the resulting values of γ in trade-intensive sectors much higher than the aggregate import-to-GDP ratio.

To allow for heterogeneous trade flows between countries and sectors, assume that the individual varieties are aggregated via a generalized Kimball aggregator:

$$\sum_{j=1}^N \gamma_{ji}^r \Upsilon \left(\frac{X_{jit}^r}{\gamma_{ji}^r X_{it}^r} \right) = 1,$$

where X_{jit}^r is the quantities sold by firms from country j and sector r in country i , and γ_{ji}^r is demand shifters that determine the steady-state trade shares and sum up to one, $\sum_{j=1}^N \gamma_{ji}^r = 1$. Similarly, the heterogeneity across sectors arises due to different input shares for labor ϕ_i^{Ls} and intermediate goods ϕ_i^{rs} in the Cobb-Douglas production function. The marginal costs in sector s of country i are equal to

$$MC_{it}^s = \frac{1}{A_{it}^s} (W_{it})^{\phi_i^{Ls}} \prod_{r=1}^S (P_{it}^r)^{\phi_i^{rs}},$$

where P_{it}^r is the aggregate price index in the market of good r in country i , and the sum of input shares is equal to one to ensure a constant returns to scale, $\phi_i^{Ls} + \sum_{r=1}^S \phi_i^{rs} = 1$.

Dynamics.—of the model feature a random-walk process for exchange rates, the Calvo price adjustment, and fixed costs of changing invoicing currency. On the household side, the optimal risk sharing under complete markets remains unchanged, hence the properties of exchange rates from Lemma 3 still apply. I assume that financial shocks ψ_{it} are martingales potentially correlated across countries and that a deterministic wage inflation chosen by the monetary policy is $\Delta m_{it} = \mu_i$. Consistent with the empirical evidence from Meese and Rogoff (1983), it follows that the vector of equilibrium exchange rates e_t follows a random walk with drift μ and contemporaneous covariance matrix Σ across economies, $\Delta e_t \sim \text{i.i.d.}(\mu, \Sigma)$.

On the firm side, prices are assumed to adjust in a staggered way subject to the Calvo friction. This assumption allows me to calibrate the price stickiness in a conventional way and contrasts with the static setup, in which the value of λ depends on the period length and is not determinate. Leveraging the insights of Gopinath, Itskhoki, and Rigobon (2010); Cravino (2014); and Drenik and Perez (2021); online Appendix B.1 solves for the optimal currency choice in dynamic setting with nonzero inflation.¹⁴

PROPOSITION 4 (Calvo Pricing): *The optimal currency choice k maximizes the following statistic:*

$$(17) \quad 2(1 - \beta\lambda^r) \sum_{t=0}^{\infty} (\beta\lambda^r)^t \text{cov}(e_{it} - \tilde{p}_{jit}^r, \Delta e_{k0}) - \sigma_k^2 - \frac{1}{1 - \beta\lambda^r} \mu_k^2.$$

The formula generalizes the currency choice from Section IB, which can be nested as a special case when firms act myopically $\beta \rightarrow 0$ and inflation rates are zero $\mu_k = 0$. In contrast, as emphasized in the previous literature, what matters for invoicing in the dynamic setting is the medium-run pass-through, i.e., a discounted sum of intertemporal covariances between exchange rates and desired prices. The latter has complicated dynamics due to staggered price adjustment and can only be solved numerically. Consistent with the predictions of the one-period model, the second term of equation (17) indicates that firms are unlikely to use volatile currencies as a unit of account. Finally, the proposition adds inflation as a separate determinant of the currency choice that is only relevant in a dynamic model. Other things equal, a positive inflation in country i implies that the desired prices are growing in currency i and hence, it is optimal to set prices in other currencies in which the optimal price is more stable.

Finally, I allow for fixed costs τ of changing the currency of invoicing; i.e., an individual firm switches from one currency to another only if that increases statistic (17) by more than τ .¹⁵ Although similar to the menu costs, the motivation

¹⁴The expression is isomorphic to the formula in Drenik and Perez (2021), but is derived for an arbitrary process $\tilde{p}_{jit}$ rather than the one with a constant growth rate, which is important given the endogenous nature of $\tilde{p}_{jit}$ in this setting.

¹⁵For simplicity, I assume that the fixed costs are paid in local currency and are a pure transfer to households.

for this additional ingredient is quite different. As the analysis above shows, there are strategic complementarities and path dependence in currency choice, even in the absence of any fixed costs. Instead, the main challenge is that invoicing decisions of firms are indeterminate in the limit of fixed exchange rates and are unstable in its neighborhood. As a result, equilibrium currency choice can change abruptly in response to minor shocks when the volatility of exchange rates is low, e.g., under a “crawling peg.” The fixed costs ensure that firms change invoicing only in response to sufficiently large shifts in exchange rate regimes and can be interpreted as both costs of renegotiating contracts and rational inattention (Sims 2003, Mankiw and Reis 2002).

Simulation.—of the model is done in three steps. Although my main focus is on the current structure of the international price system, I capture the history dependence of the currency choice by estimating the model sequentially for years 1995, 2005, and 2015 using equilibrium invoicing from the previous period as a starting point when solving for the new equilibrium. The choice of dates is constrained by the availability of the global input-output tables. Moreover, in the absence of historical data on currency choice, I have to make a crude assumption that all international prices are set in dollars before 1995. The aim is that it provides a reasonable approximation to the late Bretton-Woods period and plays a diminishing role for later periods. To simplify the analysis, it is assumed that domestic firms set prices in local currency, while exporters are allowed to choose between PCP, LCP, and five potential vehicle currencies—the dollar, euro, pound, yen, and renminbi. Section IIID below relaxes all these restrictions and shows the robustness of the main results.

B. Data and Calibration

This section briefly summarizes the main sources of data and the calibration strategy, while further details can be found in online Appendix B.2. The parameters of the model are calibrated in three different ways. The values of the standard parameters are borrowed from the previous literature. The two main inputs of the quantitative model—the country-sector trade flows (γ, ϕ) and the exchange rate moments (μ, Σ) —are estimated directly from the data. Finally, the only targeted invoicing moment is the aggregate share of DCP in 1995 that is used to calibrate the fixed costs of currency adjustment.

Following most of the literature, the monthly discount factor is $\beta = 0.96^{\frac{1}{12}}$. I use the estimates of price adjustment frequencies from Nakamura and Steinsson (2008) to calibrate λ^r at the sectoral level (see online Appendix Table A1). The elasticity of strategic complementarities in price setting α^r is calibrated following the estimates for large firms that account for most of international trade from Amiti, Itskhoki, and Konings (2019). Given scarce evidence on the cross-industry variation in α^r , I use the same value of 0.5 for all sectors in manufacturing and services, but a much higher value of 0.99 for commodities in order to capture the price-taking behavior of firms in these sectors.

The main source of trade shares is the OECD inter-country input-output (ICIO) table widely used in international trade literature. After making the tables consistent across years, the sample includes $N = 63$ countries (including all OECD econo-

mies, the European Union, most East Asian countries, plus the RoW) and $S = 32$ two-digit International Standard Industrial Classification of All Economic Activities (ISIC) industries (including 2 commodity sectors, 16 manufacturing industries, and 14 sectors in services). The database has a good coverage with only 2 percent of international trade accounted for by the within RoW flows that are not observed separately from the domestic flows of these economies.

The ISIC table is adjusted in several ways to bridge the gap between the model and the data. Following the model that defines markets at the country-good level, I eliminate the variation in γ_{ji}^{rs} across importing sectors s . The adjusted input-output matrix matches the original cross-country trade flows and sectoral input shares, but is different in terms of sector-to-sector flows. To capture the fact that prices of most commodities are determined at a global level with relatively little variation across countries, I assume one international market for each commodity, in which the worldwide price of the corresponding good is determined. Finally, because ICIO tables do not report labor costs, one needs to adjust total value added by firms' profits. To this end, I use the estimates of markups for Compustat firms from Baqaee and Farhi (2020), which I aggregate to the sectoral level, average across years, and extrapolate to all economies and periods.

The covariance matrix of exchange rates is computed using monthly series of bilateral exchange rates from the IMF International Financial Statistics database. Given almost no variation in their exchange rates, Saudi Arabia and Hong Kong are assumed to have a hard peg to the dollar and all members of the euro-zone have a hard peg to the euro. Motivated by the fact that out of 124 countries not included in ICIO tables, less than 1 percent have a free floating exchange rate (Ilzetzi, Reinhart, and Rogoff 2019), I construct the exchange rate for the RoW as a weighted-average of dollar and euro exchange rates. Finally, given the limited availability of wage-based inflation rates, parameter μ_i is estimated as an average of the consumer price index inflation and exchange rate depreciation in each economy (see online Appendix Table A2). I use a 15-year window before 1995, 2005, and 2015 to estimating the corresponding exchange rate and inflation moments assuming they provide an accurate approximation to agents' expectations about the near future.

As mentioned above, the fixed costs of currency adjustment are introduced to avoid large swings in invoicing when countries switch between floating and pegged exchange rates. As a result, the switching between currencies—both in sample and in the counterfactual analysis—depends crucially on the value of this parameter. Given little empirical guidance on the size of these adjustment costs, I adopt two calibration strategies. First, starting with microevidence, I assume that the fixed costs of changing the currency are equal to the standard menu costs of price adjustment. Using the estimates from Nakamura and Steinsson (2010), Golosov and Lucas (2007), and Levy et al. (1997) that firms spend about 0.5 percent of their revenues on menu costs, I get $\tau = 0.5 - 1 \cdot 10^{-4}$. Second, I directly target invoicing moments and calibrate fixed costs to match the share of DCP in 1995 for a subsample of countries with available data. Given the initial guess that all international trade is invoiced in dollars, the share of DCP is monotonically decreasing in

τ and provides a good identification. This approach leads to a similar estimate and I adopt $\tau = 0.8 \cdot 10^{-4}$ as the baseline value of fixed costs.¹⁶

I use the IMF dataset compiled by Georgiadis et al. (2020), which provides annual shares of exports and imports invoiced in dollars, euros, and home currencies for more than 100 economies over the period from 1990 to 2020. I focus on three-year averages as a benchmark, but given the large number of missing values, I increase the window to five years for some economies. This allows me to get invoicing shares for about 63 percent of global trade in 2015 with the main limitation being the absence of data for China. Because most numbers come from customs authorities and cover only merchandise trade, I compare empirical values with model-implied invoicing for manufacturing and commodities, excluding service sectors.¹⁷ I complement this country-level data with the bilateral and sectoral invoicing for Switzerland in 2015 (Bonadio, Fischer, and Sauré 2020).

C. Descriptive Evidence

Before proceeding to the structural results, I present a first look at the raw data and summarize the main empirical facts about trade flows (γ, ϕ) and exchange rates (μ, Σ) . The objective is to visualize the main inputs of the quantitative model and to evaluate the role of four determinants of the DCP equilibrium from Propositions 1 to 4: high inflation and tight trade linkages in shaping demand for a vehicle currency, and the large-economy and the anchor-currency advantages of the United States in making the dollar the top candidate for this role. A reader more interested in the predictions of the structural model can proceed directly to Section IIID.

Starting with the implications of Proposition 4, the much-studied hyperinflation in Latin American countries in the 1980s and in Eastern Europe in the 1990s, as well as a relatively high inflation in most East Asian economies in the same time period, imply that the currencies of the vast majority of economies in 1995 were hardly suitable for invoicing and that exporters from these countries were looking for a vehicle currency to be used in international trade (see online Appendix Figure A4 and Table A2). Comparing these patterns with the later period, one can see that despite a substantial decrease in inflation rates across-the-board in the 2000s, most emerging economies—with the notable exception of China—still exhibit significantly higher inflation rates than developed countries. This presumably lowered the global demand for a vehicle currency and increased the number of potential candidates for this role relative to earlier decades, even though for many economies, inflation still generates strong incentives to use foreign currency in international trade.

FACT 1 (Inflation): *The median inflation rate across emerging economies was 16.8 percent in the 1980–1990s and went down to 2.7 percent in the 2000s against 0.7 percent in developed economies.*

¹⁶The main results do not change much as long as τ stays within the range $0.5 - 1.2 \cdot 10^{-4}$.

¹⁷That said, the currency shares for some countries are inferred from settlement data collected by central banks, which include trade in services and can potentially be one source of discrepancy between the model and the data.

This negative trend in inflation was, however, largely offset by the rising openness of economies that, according to Proposition 1, helped to sustain the dominant currency equilibrium. To show this, I use the flexible-price version of the model to compute the pass-through of exchange rates into aggregate prices.¹⁸ The only input in this exercise is the global input-output table, which allows to estimate the shares of labor from different countries in the aggregate basket of good r sold in country i . These estimates allow to express prices in terms of labor costs across countries and are equivalent to the pass-through of country-specific exchange rates e_{it} . In particular, the pass-through of a home currency shows how much domestic prices change in terms of foreign units when the local exchange rate depreciates against all other currencies and is a convenient way to measure the openness of the economy: it is equal to one for closed economies and zero in the limit with no home bias. I focus on manufacturing goods and use imports as weights to aggregate the pass-through coefficients across markets.¹⁹

Figure 4 shows the results. As can be seen from the first panel, there is a large heterogeneity in openness across countries with the average content of home currency ranging in 2015 from less than 20 percent for small East Asian and East European economies, to more than 50 percent for large economies of the United States, Japan, China, and the eurozone (see also online Appendix Table A3). On average, the share of local currency among nonlarge economies is about 30 percent, leaving enough room for a foreign dominant currency. Moreover, the openness of the economies has substantially increased over the last decades. The left panel of Figure 5 shows that while the average share of domestic currency went up between 1995 and 2015 for countries that joined the eurozone, it went down for almost all other economies. The differences are quantitatively large, including the change from 78 percent to 56 percent in Japan. Thus, the increase in the openness of economies has largely counteracted the fall in inflation in emerging economies discussed above, and has helped to sustain demand for a vehicle currency in international trade.

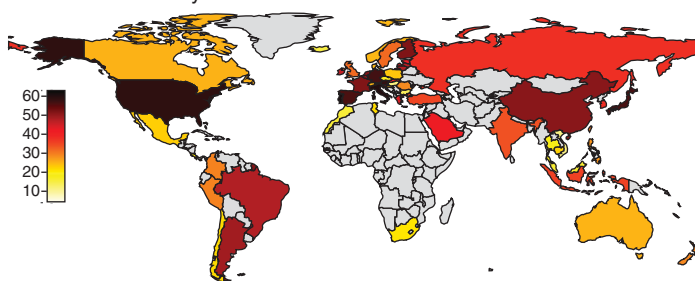
FACT 2 (Price Linkages): *The average pass-through of home currency in prices is about 30 percent for small economies and 55 percent for the United States, the eurozone, Japan, and China.*

Turing next to the two fundamental advantages of the United States, Figure 4 panels B and C show the import-weighted pass-through of the euro and the dollar exchange rates into the prices of manufacturing goods across economies. While the euro share is above 30 percent for European countries trading actively with the eurozone, the numbers are close to zero for other economies, suggesting that the euro is more likely to be a regional currency rather than a global one. In contrast, the dollar share is high not only for Canada and Mexico—the two countries with the most intense trade linkages with the United States—but also for Latin American and Asian countries. Aggregating across all economies other than the issuer of the

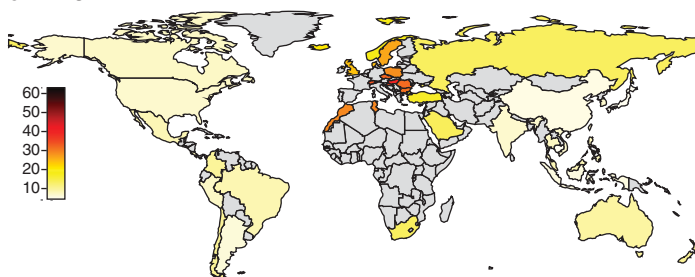
¹⁸Relative to this flexible-price benchmark, the equilibrium pass-through in a full structural model can be either higher due to import prices being sticky in foreign currency or lower due to local and import prices being sticky in home currency.

¹⁹The results are similar for the currency content of exports as shown in Table A4, Figures A5, and A6 in the online Appendix.

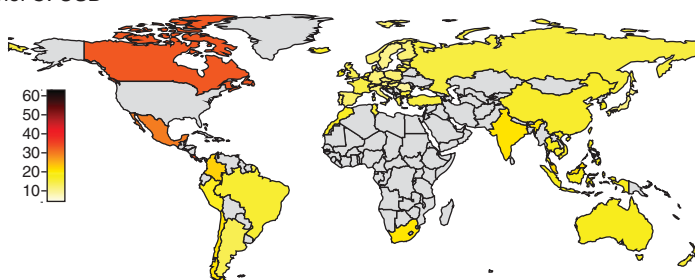
Panel A. Home currency



Panel B. EUR



Panel C. USD



Panel D. USD + RMB

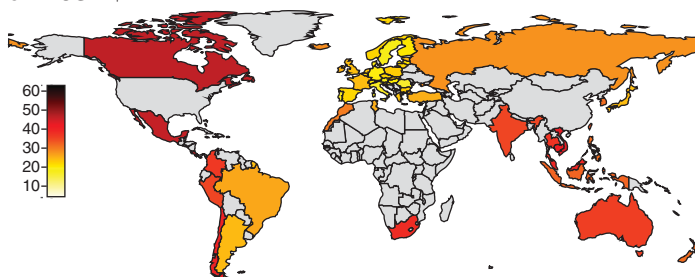


FIGURE 4. PASS-THROUGH INTO DOMESTIC PRICES

Notes: The figure shows the pass-through of home currency, euro, dollar, and a combination of dollar and renminbi exchange rates into domestic prices in 2015 (percent). All values are computed taking into account the global input-output linkages, are aggregated across markets using imports as weights, and include only markets of manufacturing goods.

respective currency, the import-weighted average pass-through is 11 percent for the euro and 21 percent for the dollar. Given a tight peg of the renminbi to the dollar

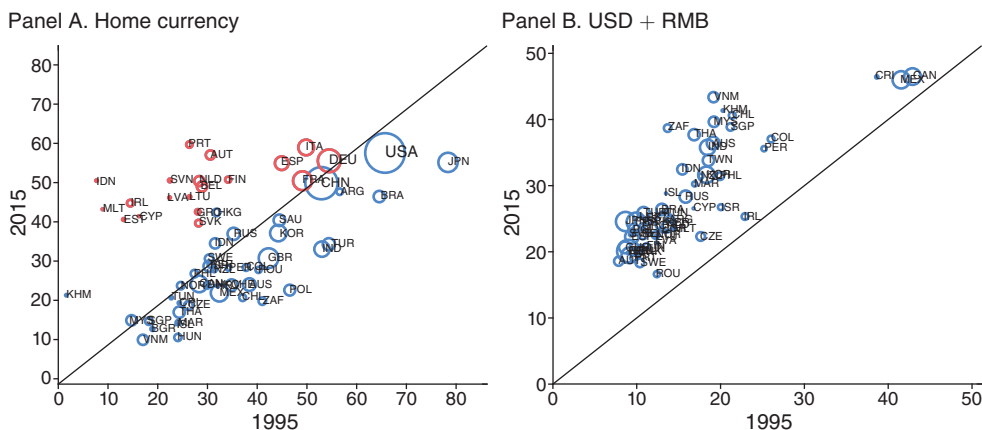


FIGURE 5. PASS-THROUGH INTO DOMESTIC PPIs: 1995 VERSUS 2015

Notes: The figure compares the pass-through of exchange rates from Figure 4 with counterparts estimated for 1995. The size of each circle represents a country's share in world imports. The members of the eurozone are shown in red in panel A.

over most of the period, a more relevant statistic for currency choice might be a combined pass-through of the two currencies, which reaches 33 percent at the global level (see Figure 4 panel D). This ensures that in most markets, the dollar ranks as the top foreign currency and often surpasses the home currency. The second panel of Figure 5 shows that this dominance has only strengthened over the last decades as the combined share of the dollar and the renminbi went up for every singly country in the sample, including the eurozone economies. The total share has almost doubled with the renminbi contributing two-thirds of this growth. At the same time, the share of the dollar remains twice as large as the share of the renminbi because of the contribution of the RoW, which is mostly pegged to the dollar.

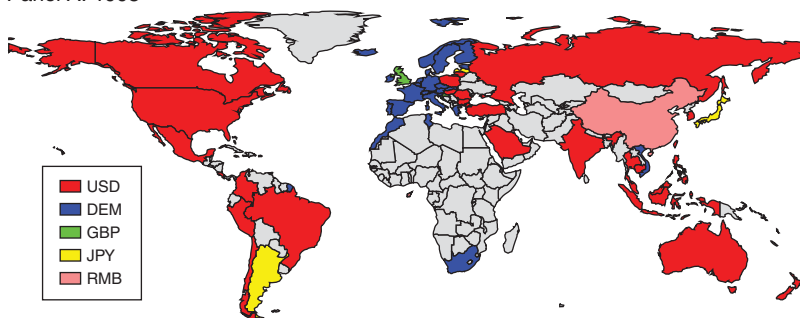
FACT 3 (Large Economy Advantage): *Between 1995 and 2015, the average pass-through of the dollar in prices went up from 16 percent to 21 percent and the pass-through of the renminbi increased from 2 percent to 12 percent.*

Finally, to evaluate the role of the anchor currency advantage, I turn to the sufficient statistic from Proposition 4 and focus on the limit of static economy $\beta \rightarrow 0$ with no inflation $\mu_i = 0$. I define the pass-through coefficients into desired prices of exporters, such that $\tilde{p}_{ji}^r - e_i = -\sum_m \chi_{ji}^r(m) e_m$ and note that $\sum_m \chi_{ji}^r(m) = 1$. It follows that the currency choice statistic (17) can be rewritten as

$$\begin{aligned} 2\text{cov}(e_i - \tilde{p}_{ji}^r, e_k) - \sigma_k^2 &= 2\sum_m \chi_{ji}^r(m) \text{cov}(e_m, e_k) - \sigma_k^2 \\ &= \sum_m \chi_{ji}^r(m) (2\text{cov}(e_m, e_k) - \sigma_k^2). \end{aligned}$$

Without taking a stand on the values of $\chi_{ji}^r(m)$, which depend on the trade flows and currency choices of other firms, one can ask the following hypothetical question: what vehicle currency will a firm choose if it does not want to use currency m

Panel A. 1995



Panel B. 2015

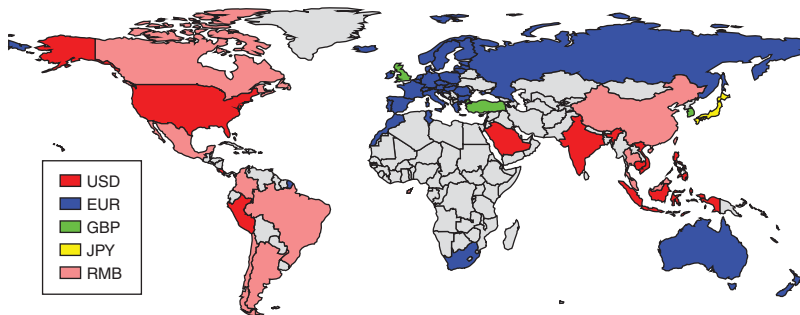


FIGURE 6. BEST SUBSTITUTION CURRENCY

Notes: For currency m of each country, the figure shows the best substitute k among five potential vehicle currencies with the highest value of $2\text{cov}(e_m, e_k) - \sigma_k^2$. The panels report results for two periods from 1981 to 1995 and from 2001 to 2015.

for invoicing—because of either high inflation μ_m or a low share of currency m in desired price $\chi_{ji}^r(m)$ —and is looking for the closest substitute k that maximizes $2\text{cov}(e_m, e_k) - \sigma_k^2$? Clearly, if a single currency k turns out to be a good substitute for a large number of currencies, it has a better chance of becoming the dominant currency in international trade. For simplicity, I do this exercise allowing firms to choose only among five potential vehicle currencies and show the results in Figure 6, where each country on a map corresponds to currency m and the colors show the best choice k .

The first thing to notice from this picture, is that the dollar is the best substitute for the vast majority of currencies in 1995, with the only exception being Western European currencies that have the German mark as the closest substitute.²⁰ Almost no currency is paired with the pound, yen or the renminbi in this period.²¹ The position of the dollar is more ambiguous in 2015 as can be seen from the second

²⁰This result echoes the findings of Ilzetzi, Reinhart, and Rogoff (2019) that most countries peg their exchange rates to the dollar, although the sufficient statistic for currency choice is different from the one used in their classification and does not depend on whether the comovement of the exchange rates is driven by a monetary policy or nonmonetary shocks.

²¹The fact that the Argentinian peso is substituted for yen is driven by a few large depreciations of the former and is not robust to the exclusion of these outliers.

panel of Figure 6. On the one hand, it loses its dominance among Eastern European currencies to the euro and its position among several Latin American and East Asian currencies to the renminbi. On the other hand, if one excludes the renminbi from the set of potential vehicle currencies, given its tight peg to the dollar over this period, the position of the dollar is even stronger in 2015 than in 1995. The expansion of China also explains a falling trade-weighted share of the euro despite an increase in the number of countries pegging to the currency.

FACT 4 (Anchor Currency Advantage): *Between 1995 and 2015, the trade-weighted share of countries with the corresponding currency as a best substitute went down from 44 percent to 26 percent for the dollar, up from 2 percent to 29 percent for the renminbi, and down from 41 percent to 32 percent for the euro.*

D. Model's Fit

While the previous section provides suggestive evidence about fundamentals that can support the DCP equilibrium, the strategic interactions between firms imply that it is not possible to accurately predict currency choice without a full structural model. Next, I combine together all ingredients in a calibrated version of the model and show that it can quantitatively replicate the key empirical facts about global use of currencies, the cross-sectional variation, and the evolution of invoicing in time.

Starting with the aggregate predictions of the model, column 2 of Table 1 reports the share of international trade invoiced in the dollar, euro, renminbi, British pound, yen, and in the remaining currencies of advanced and emerging economies. The dollar clearly emerges as the dominant currency with almost two-thirds of global trade invoiced in the US currency. It is followed by the euro, which accounts for another 22 percent of international flows, while the share of any other currency in world trade does not exceed 2.5 percent. To dissect the *optimal* currency choice from purely mechanical effects, it is worth comparing these numbers with the shares of the corresponding countries in world trade reported in column 1 of the table: the share of DCP is three times larger than the total trade share of countries with a hard peg to the dollar (including most of the RoW). In this sense, the relative size of economies can only explain about one-third of DCP in world trade with the remaining use of the dollar arising endogenously. In contrast, the percentage of international prices set in euros is very close to the contribution of the eurozone to global trade and the use of other currencies is disproportionately smaller than the trade share of their issuers. Note that although the difference is especially large for emerging economies, it is also significant for currencies of advanced economies, including the pound, which served as the main vehicle currency before the dollar.

To confront the model predictions with the data, I next look at a subsample of countries, for which invoicing data are available. Figure 7 replicates the plot from Georgiadis et al. (2020) showing in the first two bars the share of dollarized and euroized economies and their currencies in total exports of countries in the subsample.²² As emphasized by Gopinath (2016), the invoicing share of the dollar

²²The results for imports are similar and are shown in Figure A7 in the online Appendix.

TABLE 1—CURRENCIES IN WORLD TRADE

	Trade share (1)	Baseline model (2)	Robustness					
			Include services (3)	Any VCP (4)	Domestic invoicing (5)	Zero inflation (6)	Initial invoicing (7)	Flexible prices (8)
USD	22.6	64.7	60.3	63.6	64.7	61.1	58.8	65.2
EUR	20.9	21.7	24.9	21.2	21.7	18.2	26.0	23.8
RMB	14.2	0.7	0.6	0.8	0.7	1.6	0.9	1.1
GBP	3.1	1.3	1.7	1.2	1.3	1.8	1.3	1.1
JPY	4.3	2.4	2.4	2.4	2.4	4.1	5.0	4.1
Other AE	14.0	5.2	6.5	7.0	5.2	6.1	4.3	2.9
Other EM	20.9	4.0	3.5	3.8	4.0	7.1	3.7	1.7

Notes: Column 1 shows the percent of world trade accounted for by countries with the corresponding currency; column 2 shows the fraction of world trade invoiced in a given currency; column 3 reports invoicing shares for all sectors including services; in column 4 exporters choose between 13 vehicle currencies; in column 5 domestic firms optimally choose the currency; column 6 assumes $\mu_k = 0$ in all countries; column 7 uses initial invoicing based on Ilzetzi, Reinhart, and Rogoff (2019) classification; and column 8 assumes $\lambda^r \rightarrow 0$ for all sectors. In each case, the model is re-estimated for all periods. Advanced economies (AE) are defined according to the IMF classification and emerging economies (EM) include the RoW.

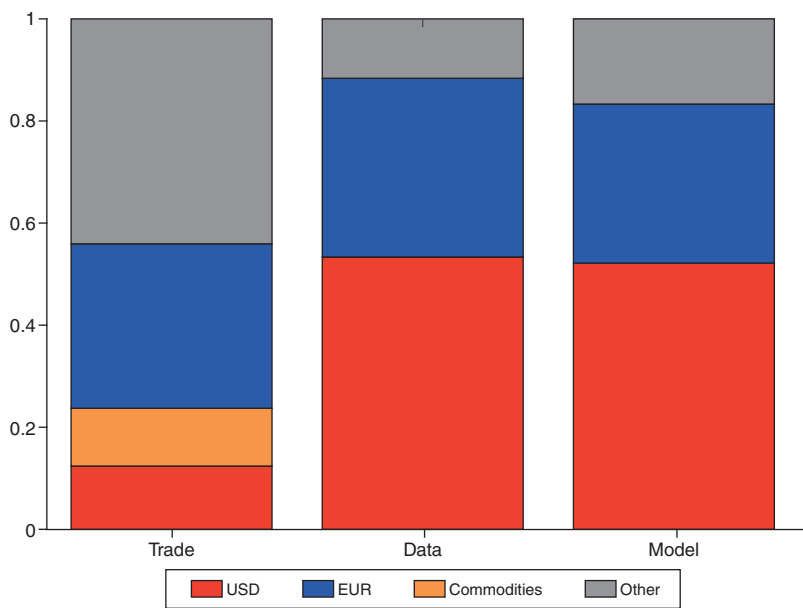


FIGURE 7. GLOBAL EXPORTS AND INVOICING

Notes: “Trade” bars show the share of commodity trade and the share of noncommodity trade with dollarized and euroized economies in world exports. “Data” and “Model” bars show respectively the empirical and model-implied fraction of exports invoiced in dollars and euros. All numbers are computed for a subsample of countries with available invoicing data.

(53 percent) is disproportionately large relative to its trade share (12 percent). Importantly, this pattern cannot be attributed solely to the dollar invoicing of commodities: the share of the dollar is about 2.3 times larger than the combined share of dollarized economies and commodity trade between other countries. The third

bar of the plot shows that the model replicates closely these empirical facts with the global share of DCP equal to 52 percent against 53 percent in the data and the share of ECP equal to 31 percent against 35 percent in the data.

Given a good fit at the global level, one can go one step further and ask whether the model is also consistent with the cross-country variation in invoicing. Focusing again on economies with available data, Figure 8 panel A presents a scatterplot of empirical and simulated shares of DCP in imports across countries (see also Figure A8 and Table A5 in the online Appendix). The figure shows that there is substantial variation in the use of the dollar across economies in the data: e.g., the dollar share is around 20 percent in Germany, 40 percent in the United Kingdom, 70 percent in Japan, 90 percent in India, and 100 percent in the United States. This heterogeneity is well captured by the model as indicated by the fact that most observations lie close to the 45-degree line. In particular, the model reproduces a low share of DCP in the eurozone countries and a high share in the United States and most developing economies. Perhaps most surprisingly, it also rationalizes the widespread use of the dollar in such advanced economies as Japan, Korea, New Zealand, and the United Kingdom. A good cross-country fit of the model is not limited to DCP and, as can be seen from panels C and D, also extends to the use of the euro and local currencies in international trade.

To measure the goodness of fit more formally, I use the fraction of (trade-weighted) cross-country dispersion explained by the model, i.e., $R^2 \equiv 1 - \frac{\sum_i \omega_i (\pi_i - \hat{\pi}_i)^2}{\sum_i \omega_i (\pi_i - \bar{\pi})^2}$, where ω_i is the share of country i in world imports, π_i and $\hat{\pi}_i$ are respectively empirical and simulated shares of a given currency in imports of country i , and $\bar{\pi}$ is a weighted-average share in the data. Note that the statistic is equal to one when the model perfectly matches the data $\hat{\pi}_i = \pi_i$ and converges to zero when the model can only explain the global use of currencies, but not the cross-country variation $\hat{\pi}_i = \bar{\pi}$. As can be seen in Figure 8, the statistic is $R^2 = 0.80$ for the dollar, $R^2 = 0.96$ for the euro, and $R^2 = 0.91$ for local currencies—a surprisingly good fit, especially given the amount of noise in the data. To put these numbers in perspective, consider a “naïve invoicing” when all commodity prices are set in dollars and the prices in noncommodity sectors are split in half between the currency of the seller and the currency of the buyer.²³ Figure 8 panel B shows that in contrast to the structural model, the naïve invoicing substantially underestimates both the global use of the dollar and its variation across countries with the DCP share staying between 10 and 40 percent for all non-dollarized economies and the resulting R^2 being negative.

Going a step further, I complement these cross-country results with the invoicing patterns between different sectors. Since such data are not available at the global level, I focus instead on one individual economy—Switzerland—with a substantial use of home currency, DCP, and ECP and a large variation in invoicing across sectors. Figure 9 compares the empirical and model-implied shares of DCP and ECP in imports and exports across manufacturing sectors with the remaining trade in each industry mostly invoiced in Swiss francs. Even at this granular level when one controls for the country of origin or destination, the fit of the model is quite

²³ Notice this is a conservative benchmark as it takes for granted the dollar invoicing of commodities. Instead, this is an endogenous outcome in the model.

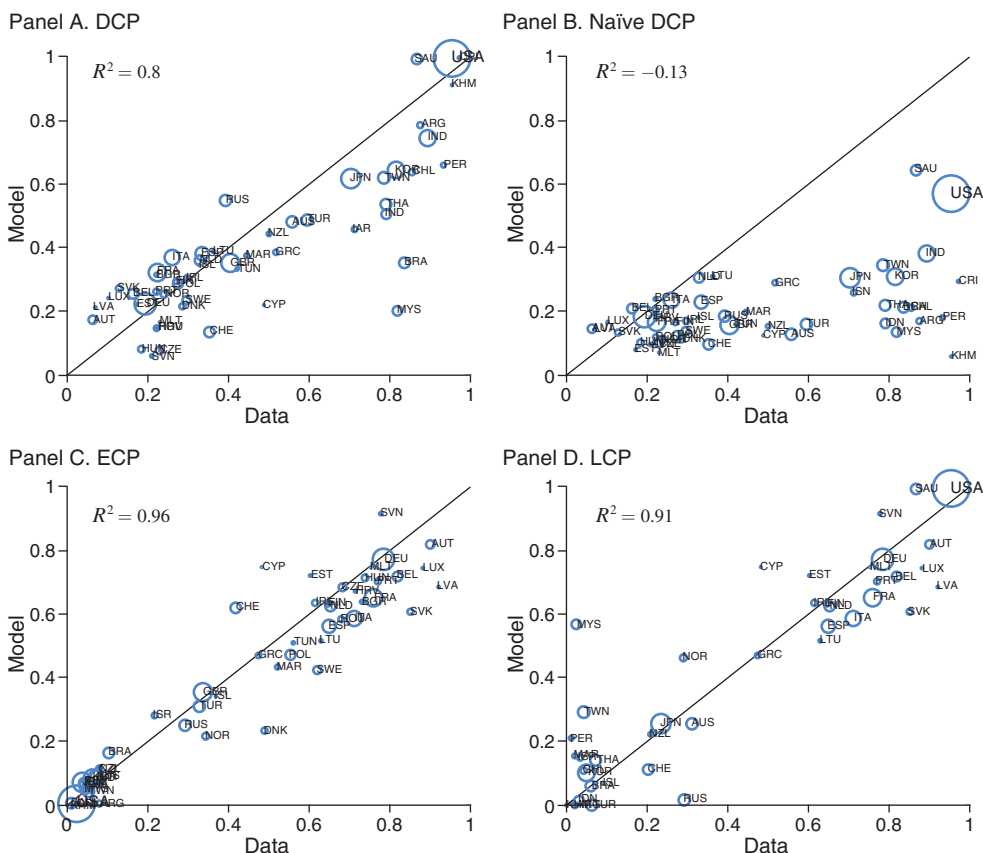


FIGURE 8. CROSS-COUNTRY IMPORT CURRENCY SHARES: MODEL VERSUS DATA

Notes: Panels A, C, and D show empirical and model-implied shares of DCP, ECP, and LCP in imports. Panel B shows a counterfactual share of DCP in imports if commodities were invoiced in dollars and invoicing of other goods were split equally between currencies of the buyer and the seller. The size of circles is proportional to country's share in world imports.

good. Although overestimating the average share of the euro in exports, the model reproduces well the ranking of sectors in their use of dollars and euros, including a higher share of DCP in exports of food, chemicals, and petroleum and a higher share of ECP in exports of vehicles, paper, and plastics. Of course, the model's performance deteriorates as one looks at a more granular level, since by construction, the currency choice is the same for all firms within a sector-exporter-importer triplet.²⁴ More disaggregated data on trade flows is required to make progress in this direction.

Finally, moving to the time dimension, one of the key properties of the international prices system is the stability of invoicing patterns (Gopinath 2016). The fixed costs of changing a currency and the complementarities in currency choice allow

²⁴Decomposing the variance of simulated invoicing in international trade, one gets that the countries of origin and destination account each for about 47 percent of the total variation, while sectors explain the remaining 5 percent. Figure A9 in the online Appendix illustrates this result by showing the use of currencies across countries in their trade with Switzerland.

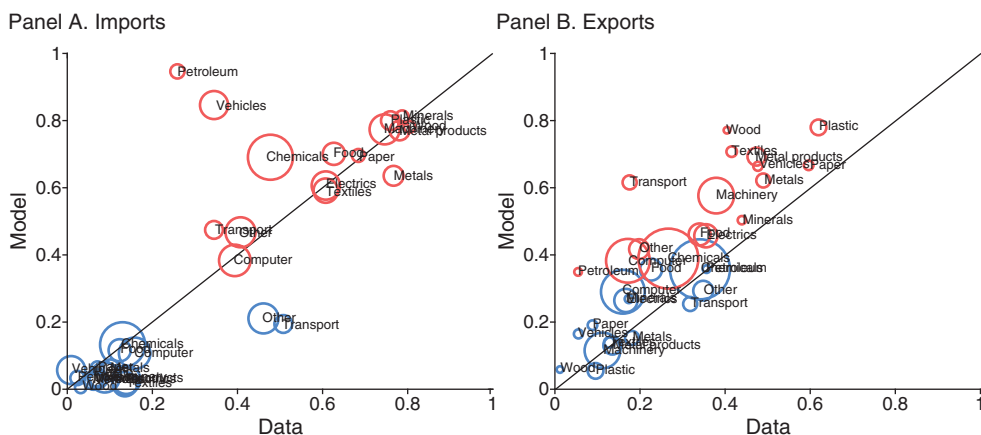


FIGURE 9. CURRENCY SHARES IN SWITZERLAND BY SECTOR: MODEL VERSUS DATA

Notes: The figure shows the share of DCP (blue) and ECP (red) in imports and exports of Switzerland by sector. The size of circles is proportional to sector's share in country's trade.

the model to reproduce this fact. The simulated share of DCP is stable not only at the global level (see Figure A10 in the online Appendix), but also at the country level. Focusing on the evolution of export invoicing between 2005 and 2015, the cross-country median absolute change in the DCP (ECP) share is 3.6 percent (3.2 percent) in the model against 3.5 percent (2.9 percent) in the data.²⁵ The model also matches well the fraction of countries with a rising share of ECP in exports (47 percent against 50 percent in the data), but underpredicts the number of countries with a growing share of DCP (36 percent against 52 percent in the data). At the same time, as emphasized by Georgiadis et al. (2020), there are a few countries with substantial changes in invoicing between 1995 and 2015. The upper panel of Figure 10 illustrates this point by showing the evolution of the dollar share in exports of selected economies with a good data coverage. Both in the data and in the model, there is a negative trend among European countries that either joined the euro area or had strong trade linkages with euro economies.²⁶ On the other hand, the figure shows the model also matches a stable DCP share in Japan and Turkey, and a moderate positive trend in Australia driven by country's trade with China.

E. Discussion

Having established a good empirical fit of the model, it is worth discussing in greater detail the mechanisms that sustain the DCP equilibrium. This section studies

²⁵I focus on the period from 2005 to 2015 because of a better data coverage and a lower sensitivity to the pre-1995 invoicing. The trade-weighted means are close to the medians. See Figure A11 in the online Appendix for the cross-country evidence.

²⁶The results are similar for Bulgaria, Estonia, Hungary, and Latvia. Although the model somewhat overestimates the share of DCP in the first period due to a crude guess for the pre-1995 invoicing, it reproduces well the negative trend from the data. A counterfactual with infinite adjustment costs shows that the results from the baseline model are driven not only by a mechanical effect of changing export shares, but is also due to the endogenous change in the currency of invoicing.

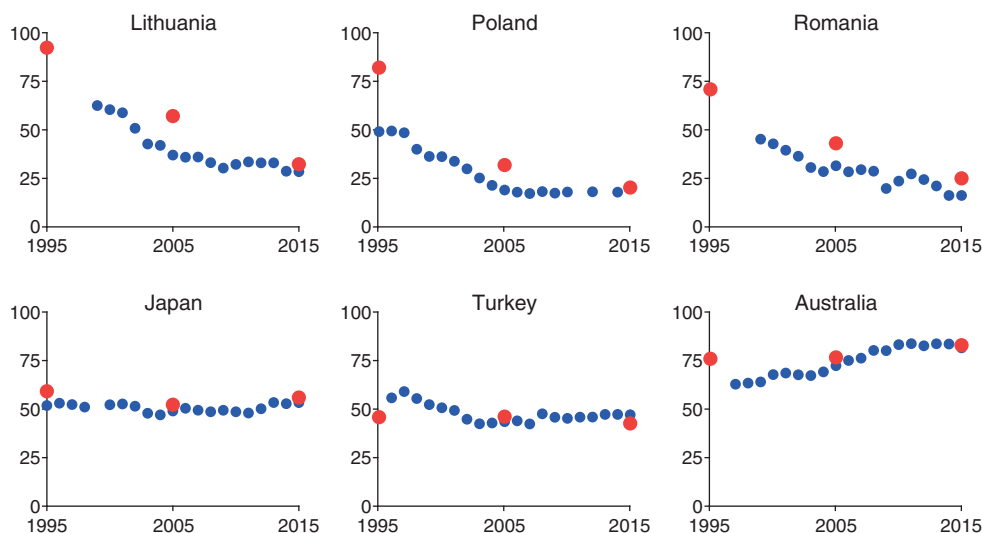


FIGURE 10. EVOLUTION OF DCP IN EXPORTS OF SELECTED ECONOMIES

Note: The figure shows the evolution of empirical (blue) and simulated (red) DCP shares (in percent) in countries' exports.

the currency choice under alternative values of parameters and shows the robustness of the main findings.

Addressing the fact that empirical invoicing shares of some countries include not only merchandise trade, but also the trade in services, column 3 of Table 1 reports the global use of currencies across all sectors. Because of a larger share of the euro-zone and the United Kingdom in services, the use of their currencies is slightly higher in this case. The share of the dollar, on the other hand, goes down. This is expected given the larger role of PCP and LCP in service sectors: according to the model, a stronger home bias and a lower share of foreign intermediates in these sectors implies that the third currencies account for about 76 percent of world trade in commodities, 32 percent in manufacturing, and only 20 percent in services (see online Appendix Table A6 for details). Yet, the dollar remains the dominant currency with a global share above 60 percent.

The next column of the table relaxes the assumption that exporters can choose from five vehicle currencies and in addition, allows them to set prices in the currencies of Switzerland, South Korea, Norway, Sweden, New Zealand, Australia, Canada, and South Africa.²⁷ Although, expectedly, this increases the share of currencies of advanced economies, the changes are quantitatively small. In particular, the DCP share falls from 64.7 percent to 63.7 percent indicating that given the starting conditions and the fundamentals, there is little scope for other vehicle currencies in international trade.²⁸

²⁷I focus on these currencies because of their floating regime and a high liquidity—together they account for more than 90 percent of foreign exchange turnover. At the same time, the results remain almost unchanged when exporters are allowed to use arbitrary currencies for invoicing.

²⁸Here and below, I solve for the whole new path of currency choice starting from 1995.

I then consider the case when both exporters and domestic firms can optimally choose the currency of invoicing. Consistent with a dramatic fall in inflation rates documented in Section IIIC, the model implies that the share of domestic manufacturing goods in emerging economies invoiced in local currency went up from 38 percent in 1995 to 94 percent in 2015. These changes, however, had only minor effects on exporters' decisions given the low share of currencies of emerging economies in international trade and the dominance of local currencies in the domestic flows of developed economies. Thus, the baseline assumption of exogenous PCP in local sales provides a good approximation to the equilibrium invoicing in 2015 and, as can be seen from column 5 of Table 1, is almost inconsequential for the currency shares in international trade.

Similarly, column 6 shows that the currency shares remain largely unchanged if one assumes zero inflation across economies. This result should be interpreted with caution as it only holds because of the initial guess that all exporters set their prices in dollars and there are both fixed costs and complementarities that make switching to currencies of emerging economies suboptimal even in a low-inflation case. In other words, the high inflation of the 1990s confirms the status quo. If instead one assumes PCP or LCP in the pre-1995 period, the inflation substantially changes the currency choice of exporters and makes them switch to vehicle currencies. To further evaluate the role of the initial currency choice, I consider the case when exporters set prices in anchor currencies of their economies as defined by Ilzetzi, Reinhart, and Rogoff (2019) for year 1995. Expectedly, this increases the share of currencies of developed economies and lowers the share of the dollar (see column 7). Yet, even in this case, the dominance of the US currency remains undisputed. Interestingly, if one assumes instead that all export prices except for commodities are set in euros (German mark) before 1995, then in 2015 the share of DCP is 53.2 percent and the share of the ECP is 28.5 percent. This shows that although the history dependence enhances the role of the dollar and especially so in the commodity sectors, it is the fundamental anchor-currency advantage of the United States that ensures that its currency dominates the euro in world trade, even if the initial conditions work against the dollar.

Finally, to disentangle the role of fundamental factors and the complementarities in currency choice, I consider the flexible-price limit $\lambda^r \rightarrow 0$. Perhaps surprisingly, column 8 shows that the dollar and the euro further crowd out other currencies relative to the baseline case. Intuitively, there are two effects of greater price flexibility: on the one hand, it lowers the invoicing complementarities across exporters, which dampens the role of vehicle currencies. On the other hand, it also lowers the complementarities between domestic firms and exporters, which helps to support the DCP equilibrium. The latter effect dominates in the calibrated model, although quantitatively the net effect is close to zero, meaning that equilibrium invoicing is robust to a wide range of price stickiness.²⁹

²⁹This result is not driven by the fixed costs of currency adjustment. First, the costs are normalized by λ^r and go to zero in the limit of flexible prices (see online Appendix B.2.3). Second, a simulation with zero fixed costs confirms that the DCP share is higher under flexible prices.

F. *Future of the Dollar*

After making sure that the equilibrium invoicing matches closely the current use of currencies in world trade, I next take full advantage of the general equilibrium structure of the model to do counterfactual analysis about the future evolution of the international price system. This section evaluates the effect of economic growth, exchange rate regimes, and monetary policy on the prospects of the renminbi to replace the dollar as a global currency.

The first counterfactual focuses on the growing role of China in world economy and asks how much the use of currencies will change 20 years from now, by year 2035, if countries continue to grow at their current rates. To answer this question, I compute future bilateral trade flows $\{\gamma_{ji}^r\}$ using a standard structural gravity model from the international trade literature (Eaton and Kortum 2002; see online Appendix B.3 for details). The growth rates are estimated at the country level using the actual values for 2016–2019 and the IMF forecasts for 2020–2025 and are extrapolated for the whole horizon of twenty years. Importantly, this scenario assumes no changes in other parameters—including inflation rates and exchange rate covariances—keeping them at the 2001–2015 level.

The second bar in Figure 11 shows the results. Interestingly, the model predicts that if anything, the increasing role of China and other emerging economies in the world economy strengthens the dominance of the dollar, shrinking the share of the euro, and leaving the share of the renminbi and other currencies close to zero. This is because there are almost no changes in currency choice and all dynamics are driven by the composition effect—the contribution of emerging economies to world trade goes up and the share of the Eurozone in world economy falls. Thus, the fixed costs and complementarities in currency choice are strong enough to prevent exporters from switching to the renminbi even when the share of China in world manufacturing exports rises from 19 percent to 23 percent and its home bias goes up from 91 percent to 93 percent. Notice there is no contradiction between this result and Corollary 1: the peg to the dollar in several emerging economies including China implies that the effective share of the dollarized countries in world economy is increasing, promoting the status of DCP.

To better understand the role of the exchange rate policy, consider the second counterfactual, which assumes that China abandons foreign exchange interventions and switches to a floating regime. While it is hard to predict the properties of the renminbi exchange rate without government interventions, I assume that once expressed against a bundle of floating currencies, it has a zero correlation with other exchange rates and the same volatility as the US dollar.³⁰ The trade flows and other parameters take the same values as in 2015. The third bar in Figure 11 shows that the equilibrium share of the renminbi is significantly larger in this case: a higher volatility of the Chinese exchange rate against the dollar breaks the isomorphism between the two currencies and makes firms reconsider their currency choice. As a result, some trade flows to and from China switch to the renminbi invoicing. At the same time, the share of Chinese currency remains lower than the

³⁰ Indeed, once expressed in this way, the average correlation of each floating currency with the others is close to zero.

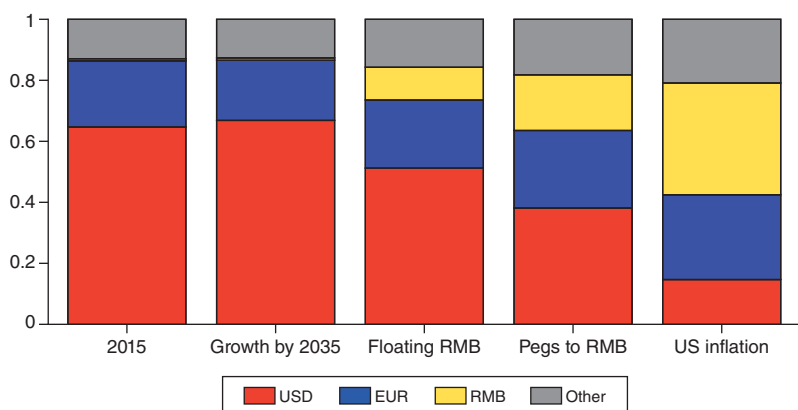


FIGURE 11. COUNTERFACTUAL CURRENCY SHARES IN WORLD TRADE

Notes: The bars show the model-implied shares of the main vehicle currencies in world trade (i) in 2015, (ii) under the predicted trade flows in 2035, (iii) if China adopts a floating exchange rate regime, (iv) if the renminbi replaces the dollar as an anchor currency for other economies, and (v) if the US inflation goes up to 10 percent per year.

country's contribution to world trade (11 percent against 14 percent) and the renminbi is almost never used as a vehicle currency between third countries.

The previous counterfactual makes a conservative assumption that keeps most currencies pegged to the dollar and to the euro after China switches to a floating regime. One can argue instead that developing countries are likely to adopt the renminbi as an anchor currency in their exchange rate policy in response to its rising role in international goods and financial markets (see, e.g., Egorov and Mukhin 2021). The next counterfactual considers such a possibility and switches the positions of the renminbi and the dollar in the exchange rate covariance matrix.³¹ In this case, the share of Chinese currency reaches 18 percent exceeding the country's contribution to world trade, while the share of DCP falls to 38 percent and the share of ECP rises slightly to 25 percent (see the fourth bar in Figure 11). Although the renminbi also gains the status of a vehicle currency in trade between some countries, the dollar retains its status of the main vehicle currency. Thus, the history dependence is strong enough to prevent the renminbi from becoming the new dominant currency, but is not sufficient for the dollar to remain the only global currency. The world in this case features several regional currencies in line with the predictions of Eichengreen (2011).

Finally, I consider the case when the evolution of the international price system is driven by changes in the US economy rather than in the rest of the world. In particular, assume that US inflation goes up to 10 percent with no other changes in the world economy relative to the year 2015. Such a shock can be a consequence of the rising government debt burden and the inability of the fiscal authorities to raise enough taxes to finance it. Alternatively, one can consider a shock to the safe-asset status of US bonds and the resulting depreciation of the exchange rate (Farhi and Maggiori 2018), which has similar implications for the equilibrium invoicing (see

³¹In particular, I assume that the covariances between the renminbi and other currencies become the same as they are for the dollar in 2015, while the covariance of the dollar with other exchange rates is zero.

Corollary 1). The last bar in Figure 11 shows that the share of DCP falls dramatically to 15 percent, the share of ECP goes up to 28 percent, and the Chinese currency emerges as the dominant currency accounting for 37 percent of international trade. In fact, only commodities with flexible prices remain invoiced in dollars in this case. Intuitively, an increase in US inflation makes exporters look for an alternative unit of account and although the use of most currencies goes up, the gains are especially high for the renminbi, which is the closest substitute to the dollar.

To summarize, there are three main takeaways about the future of the dollar. First, the rise of China and other emerging economies does not put at risk and can even strengthen the dominance of the dollar as long as these countries stay pegged to the US currency. Second, the dollar is more likely to lose its global status if US inflation goes out of control, suggesting that the internal problems of the US economy are more damaging for the dominance of the dollar than external factors. Moreover, in this scenario, the anchor status works against the dollar as it simplifies the transition to the renminbi. Finally, the model suggests that the dominance of one currency in today's world is due to a particular combination of the previous history, when there were no good alternatives to the dollar, and the current fundamentals, with many emerging economies pegging their exchange rates to the dollar. If the peg is abandoned, the world is likely to move to a new equilibrium with multiple regional currencies rather than to switch to a new global currency. However, the PCP/LCP equilibrium with symmetric use of currencies in world trade is still unlikely because of the complementarities in currency choice and the high volatility of emerging economies.

IV. Conclusion

This paper provides a general equilibrium framework of the international price system that can be used to study analytically and quantitatively the use of currencies in world trade. The model is broadly consistent with the key empirical facts, including the dominant status of the dollar in global trade, a large heterogeneity of invoicing across economies, and delayed transition from one dominant currency to another. A calibrated version of the model shows that high inflation and volatility in emerging economies create global demand for a vehicle currency, which is further amplified by strategic complementarities in currency choice. The large size of the US economy and a widespread peg to the dollar among other countries naturally make the US currency the leading candidate for the role of the global currency. While the increasing role of China in the world economy and its drift toward a floating regime can undermine the dominance of the dollar in the future, it is unlikely to fully replace it on the global stage.

The tractability of the baseline model allows for several extensions and applications, which are left for future research. First, although the use of the world input-output table and exchange rate covariance matrix allows me to match the global and cross-country invoicing patterns from the data, more granular data on inter-firm linkages can greatly improve the model's predictions at a more disaggregated level (Amiti, Itskhoki, and Konings 2020). More empirical evidence is also required regarding the size of the fixed costs of currency adjustment (Crowley, Han, and Son 2020). Second, augmenting the model with a more realistic financial sector

and gross capital flows would allow analyzing the interactions between the dominant status of the dollar as a vehicle currency in international trade and as a reserve currency in global asset markets (Bahaj and Reis 2020). Third, the framework lends itself to a variety of counterfactuals and policy experiments. This paper makes the first step in this direction, leaving for future analysis many interesting experiments, such as the invoicing implications of joining the eurozone. Finally, the counterfactual analysis shows that the future of the international price system depends heavily on the status of the dollar as the main anchor currency. More work is required to understand how countries choose the exchange rate regime, how it interacts with the other roles of the dollar, and how it is going to change in the future (Gourinchas 2021).

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