Macroeconomic Interdependence and the International Role of the Dollar.

Linda Goldberg[a],[*] Cédric Tille[b][†]

[a] Federal Reserve Bank of New York and NBER;

[b] Geneva Graduate Institute of International and Development Studies and CEPR

Abstract

The U.S. dollar holds a dominant place in the invoicing of international trade. In addition to a direct role for most U.S. exports and imports, it plays a global role for trade flows outside the United States. Using a simple center-periphery model, we show that this global role magnifies the exposure of periphery countries to the U.S.'s monetary policy even when trade flows with the U.S. are limited. This generates gains from coordinated monetary policy, as U.S. policy leads to inefficient movements in intra-periphery relative prices. Despite this inefficiency, flexible exchange

1 rates remain valuable.

2 *Keywords:* exchange rate, pass-through, center-periphery, invoicing, monetary policy.

3 *JEL classification:* F41, F42

1.   Introduction

The prominent role of the U.S. dollar in the invoicing of international trade is a major feature of the global economy.[1] Goldberg and Tille (2008a) show that the international role of the dollar takes two forms. The first is a *direct* role where the dollar is used in the invoicing of U.S. exports and imports. The second is a *global* role where it also is used in the invoicing of trade flows that do not involve the United States.

This paper analyzes the impact of the direct and global international roles of the dollar on the international transmission of shocks and the setting of policy, focusing in particular on the global role which has received limited attention in the literature despite its sizable empirical relevance. The invoicing of international trade is a central aspect in international economics as it affects the extent to which exchange rate movements impact international relative prices – the so-called exchange rate pass-through – and lead to demand switches across goods produced in different countries. This, in turn, is a central element in the design of monetary policy in open economies (Corsetti and Pesenti 2005, Devereux and Engel 2003, Obstfeld and Rogoff 2002). While many studies have analyzed the impact of exchange rate pass-through on the design of monetary policy, most studies focus on a symmetric setting where the degree of exchange rate pass-through is the same for all directions of trade flows. Evidence of asymmetry in exchange rate pass-through, however, abounds between the United States and the Euro area countries with their respective trade partners (Campa and Goldberg 2005, Choudhri et al. 2005, and Gagnon and Ihrig 2004). While some theory contributions consider such asymmetries and show substantial implications for the design of policy (Corsetti and Pesenti 2005, Devereux, Shi, and Xu 2007), these contributions focus solely on the direct international role of a currency.

The analysis relies on a simple three-country model with a center country, which is referred to as the United States, and two Periphery "countries", which are called Asia and

---

[1] While the dollar also plays a major role in international reserve holdings and financial markets, our analysis focuses on the invoicing of trade.

Latin America. The region or country names are used solely in order to illustrate our results, and should not be interpreted as literally referring to the regions in question. Three broad results emerge that are outlined in Table 1, contrasting the consequences of the direct and global roles of the dollar.

First, the international role of the dollar magnifies the impact of U.S. monetary policy on worldwide real variables. The effect is most pronounced under the global role and does not hinge on direct trade flows between the U.S. and the Periphery.

Second, U.S. monetary policy under decentralized policy setting reacts to productivity shocks in both the United States and the Periphery. Policies in Asia and Latin America, by contrast, focus on their domestic shocks as their policy choices cannot influence the prices of U.S. goods sold in the Periphery and set in dollars. Under the direct role of the dollar, the policy response to the shocks leads to higher welfare in the Periphery than in the United States, as Periphery consumers benefit from more efficient movements in the prices of U.S. goods. By contrast, under the global role, fluctuations in the value of the dollar generate inefficient movements in the relative price of Asian and Latin American goods. Dollar movements reduce the Periphery welfare even when U.S.-Periphery trade flows are limited and intra-Periphery trade flows are strong.

Third, there are gains from cooperation in monetary policy. Under the direct role of the dollar in trade invoicing, cooperation leads U.S. policy to put more emphasis on U.S. shocks in order to deliver more efficient movements in the prices of U.S. goods in the Periphery. Under the global role of the dollar, the opposite is true as U.S. policy generates inefficient movements in intra-Periphery relative prices. In the context of the model, world-wide gains from policy cooperation can be large when the dollar has a global role. Moreover, the gains from cooperation under the global role of the dollar accrue primarily to whichever Periphery country has the least volatile domestic shocks.

Despite the limited efficiency of exchange rate movements under the global role of the dollar, limiting exchange rate movements through unilateral pegs or a currency union is a

costly strategy. Intuitively, the gains from limiting inefficiencies in the pricing of imports come at the cost of having larger inefficiencies in the pricing of domestic goods.

The emphasis on the international role of the dollar in intra-Periphery trade is consistent with the insights of Cook and Devereux (2006). They consider a partial equilibrium model of the East Asian crisis of 1997-1998, emphasizing the role of the dollar in the invoicing of trade between Asian countries. Their results point to this aspect as a central feature behind the magnitude and persistence of that crisis. This paper adds to their insights in several ways. It contrasts the direct and global roles of the dollar, distinguishing between international price movements on both the U.S.-Periphery and intra-Periphery dimensions. It also models the setting of policy in the United States, instead of taking it as exogenous. This modelling approach, which is very abstract in order to highlight specific theoretical mechanisms, shows the potential for gains from policy cooperation, and indicates how the extent of U.S.-Periphery trade linkages leads the U.S. monetary stance to focus more or less on domestic shocks.

The paper is organized as follows. Section 2 presents empirical evidence on the international invoicing role of the dollar. Section 3 presents a simple model. Section 4 analyzes the optimal monetary policy response to shocks. For brevity our exposition focuses on presenting the novel findings of our analysis and their intuitive interpretations. A fully detailed derivation of the results and the analytical solution is available online[2] and in the working paper version of this work (Goldberg and Tille 2008b). Section 5 concludes and suggests potential extensions of our simple setup.

2. Evidence on vehicle currency use in international trade

The empirical evidence clearly highlights the relevance of the global international role of the dollar. Table 2 presents evidence from Goldberg and Tille (2008a), which shows that the dollar's use in the invoicing of trade exceeds the role as direct trading partners of the

---

[2]The appendix is available at Science Direct.

U.S. and other "dollar bloc" countries which keep their currency stable vis-a-vis the dollar. For instance 85% of Korean exports are invoiced in dollars (col. 1), even though only 21% of Korean exports are shipped to the United States (col. 2). Even the addition of exports to dollar bloc countries still leaves the share (49%, col. 3) well short of accounting for the documented extensive invoicing role of the dollar. This type of strong pattern of dollar use in invoicing exports is not limited to Asian countries, as European Union countries and accession countries also actively use the dollar. A similar pattern is observed for imports (col. 4-6). The evidence thus shows that the dollar plays a large role in the invoicing of trade, even for trade flows that do not involve the United States or dollar bloc countries.

3.   A simple center-periphery model

This section reviews the main features of our model, which is a three-country variant of the workhorse "new open economy macroeconomics" models by Obstfeld and Rogoff (2002) and Corsetti and Pesenti (2005).

3.1.   *Geographical structure and timing*

The world is comprised of three countries denoted as the United States, Asia and Latin America (jointly the Periphery), their currencies being the dollar, won and peso, respectively. These names are used solely for illustrative purposes and do not purport to accurately capture any specific real world economies. We consider symmetric sizes between the U.S. and the Periphery, as well as within the Periphery: the U.S. accounts for half the world, while Asia and Latin America each represent a quarter of the world. This assumption is not central to our results, but greatly improves the analytical tractability of the model.

We consider a one-period stochastic model. Firms set their prices at the beginning of the period. Shocks then occur and monetary policy is adjusted leading to movements in exchange rates and, possibly, import prices. Consumption and production take place with firms meeting the realized demand at the preset prices. Firms' price setting is forward-looking

and takes account of the distribution of shocks and the monetary policy rules.[3]

3.2.   *Consumer optimization*

Each country is inhabited by a representative consumer who purchases all brands available in the world economy. Brands are distributed along a unit interval, with U.S., Asia and Latin American firms producing brands on the $[0, 0.5)$, $[0.5, 0.75)$ and $[0.75, 1]$ intervals, respectively. $C_{j \to i}(z)$ denotes the consumption in country i of the brand z produced in country j. Brands are aggregated into CES indexes with an elasticity of substitution between brands equal to $\lambda > 1$. $C_{j \to i}$ is the consumption in country i of the index of brands produced in country j. Indexes are aggregated further into overall consumption with unit elasticity, with C_i denoting the overall consumption index in country i. The overall baskets in the U.S. and Asia and Latin America are (Latin America being indexed by Lat):

$$C_{US} = (\alpha)^{-\alpha} ((1-\alpha)/2)^{-(1-\alpha)} (C_{US \to US})^{\alpha} (C_{Asia \to US} C_{Lat \to US})^{\frac{1-\alpha}{2}} \tag{1}$$

$$C_i = (1-\alpha)^{-(1-\alpha)} (\alpha/2)^{-\alpha} (C_{US \to i})^{1-\alpha} (C_{Asia \to i} C_{Lat \to i})^{\frac{\alpha}{2}} \quad ; \quad i = Asia, Lat \tag{2}$$

The coefficient $\alpha \in [0.5, 1]$ in (1)-(2) is a home bias parameter that reflects the degree of trade integration between the United States and the Periphery. One extreme ($\alpha = 0.5$) corresponds to a fully integrated world where consumers in all countries have similar consumption baskets. The other extreme ($\alpha = 1$) corresponds to a disconnected world with no trade at all between the U.S. and the Periphery. Under intermediate values of α, the U.S. consumer purchases mostly domestic goods, while consumptions in Asia and Latin America are tilted towards Periphery goods. The home bias is defined solely in terms of United States versus the Periphery, and there is no corresponding bias between Asia and Latin America.

The allocation of consumption is affected by relative prices, with the magnitude of this effect reflecting the elasticities of substitution across brands and consumption baskets. $P_{j \to i}(z)$

---

[3]While our static model can appear restrictive, the functional forms used imply that a dynamic version boils down to a succession of static models (Corsetti and Pesenti 2005).

denotes the price (in currency i) paid by the consumers in country i for each unit of brand z produced in country j. Prices are aggregated into price indexes corresponding to the various consumption baskets. The U.S., Asian and Latin American consumer price indexes, which represent the minimal expenditure required to purchase one unit of the corresponding aggregate consumption basket, are given by (for $i = Asia, Lat$):

$$P_{US} = (P_{US \to US})^{\alpha} (P_{Asia \to US} P_{Lat \to US})^{\frac{1-\alpha}{2}} \quad ; \quad P_i = (P_{US \to i})^{1-\alpha} (P_{Asia \to i} P_{Lat \to i})^{\frac{\alpha}{2}} \quad (3)$$

The representative consumer in country i maximizes a simple utility over consumption, real balances, M_i/P_i, and hours worked, H_i: $U_i = E[\ln(C_i) + \chi \ln(M_i/P_i) - \kappa H_i]$, for $i = US, Asia, Lat$, with E denoting expected values at the beginning of the period. The assumption of log utilities of consumption and real balances limits the technical complexity of the model. The consumer's resources are her wage income, the dividends of the firms in her country, and a lump-sum transfer from the government. The assumption that all firms are domestically held does not entail any loss of generality because of our assumptions of log utility of consumption and a unit elasticity of substitution between goods produced in different countries. The utility maximization of leads to standard labor supplies and money demands, which imply that nominal wages W_i are proportional to the money supply M_i.

3.3. Pricing and production

The invoicing of international trade is taken as exogenous in order to focus on how alternative patterns of invoicing change the transmission of monetary policy and its optimal design. While a growing literature has focused on the determinants of invoicing, the models and motives considered go beyond our simple setup.[4] Encompassing endogenous invoicing choice in our analysis would require a richer model and is left for future research.

Firms set the price for domestic sales, $\tilde{P}_{j \to j}(z)$, in the domestic currency, with the tilde

---

[4]See for instance Bacchetta and vanWincoop (2005), Devereux, Engel and Storegaard (2004), Goldberg and Tille (2008a).

notation denoting a preset price. Firms invoice exports in a basket currency that consists of all three currencies, a basket that can differ across destinations. Specifically $\gamma_{j\to i}^{k} \in [0,1]$ is the share of currency k in the invoicing of exports from country j to country i. These weights are the same for all firms in the exporting country. The price paid by the consumer in country i in her own currency, $P_{j\to i}(z)$, then consists of the preset price in the basket currency, $\tilde{P}_{j\to i}(z)$, as well as a combination of realized exchange rates that reflects the composition of currencies in the invoicing basket:

$$P_{j\to i}(z) = \tilde{P}_{j\to i}(z)(S_i)^{-1}(S_{Asia})^{\gamma_{j\to i}^{won}}(S_{Lat})^{\gamma_{j\to i}^{peso}} \tag{4}$$

1 where S_i is the exchange rate between the dollar and currency i, with an increase corre-
2 sponding to a bilateral depreciation of the dollar. (4) is a general specification, of which
3 existing contributions are special cases.

4   The specification of invoicing in a basket currency is a general approach that encom-
5 passes several particular cases. "Producer currency pricing" (PCP), with full pass-through
6 of exchange rate fluctuations to the consumer, corresponds to $\gamma_{j\to i}^{j} = 1$. "Local currency
7 pricing" (LCP), with no exchange rate pass-through, corresponds to $\gamma_{j\to i}^{i} = 1$.

8   Figure 1 presents five cases of invoicing. Arrows represent trade flows between the various
9 countries and are labelled with the invoicing currency (for instance a label *peso* on the arrow
10 from Latin America to the U.S. indicates that Latin American exports to the U.S. are
11 invoiced in pesos). The first two cases are the standard ones covered in prior analyses of the
12 role of invoicing and which that abstract from the broader international role of the dollar,
13 with either full exchange rate pass-through (PCP-all trade) or no exchange rate pass-through
14 (LCP-all trade) for all trade flows between countries.

15   The international role of the dollar is present in the remaining cases on which the analysis
16 focuses. The next two capture the direct international role with all trade flows that involve
17 the U.S. assumed to be invoiced in dollars. Intra-Periphery trade can be invoiced in the

producer's currency (Direct-PCP) or the consumer's (Direct-LCP). The final case captures the global role of the dollar, which encompasses two aspects. First is the direct role in U.S.-Periphery trade flows. Second is the indirect role with the dollar used in the invoicing of intra-Periphery trade flows. Exchange rate fluctuations between the dollar and Periphery currencies then affect the relative price of Asian and Latin American goods in these countries.

Firms use a simple technology with constant returns to scale, with one unit of labor producing K_i units of output in country i. Productivity K_i is stochastic and firms set their prices before shocks are realized.[5] Firms face downward sloping demand for their brand that is derived by aggregating the consumption demands across U.S., Asian and Latin American consumers, using (4) to express the prices in foreign markets.

Regardless of the structure of invoicing, the exchange rates simply reflect the relative monetary stances, a feature that is common to the various contributions in the literature:[6]

$S_{Asia} = M_{US}/M_{Asia}$ and $S_{Lat} = M_{US}/M_{Lat}$.

3.4. The flexible price allocation

A useful benchmark is given by the situation where firms can adjust their prices after the realization of shocks, i.e. the flexible price allocation. Firms set their price for sales to any country as a constant markup over marginal cost, which is the domestic monetary stance (equal to the wage) adjusted by productivity: $P_{j \to i} = mkup \cdot (M_j/K_j)$.

Productivity shocks are fully transmitted to output, with no impact on hours worked. Consumptions reflect weighted averages of productivity shocks, with the weights corresponding to the shares of the various goods in the consumption baskets (1)-(2).

---

[5]We adopt the standard assumption that productivity shocks are log-normal, with mean zero

[6]A shortcoming of this result is that the model implies a volatility of exchange rate well below the one observed in the data. This result does not alter the focus of the paper, and can be addressed by the inclusion of shocks to the money demand. Such shocks add complexity to our solutions but do not alter our resulting insights.

Also, we abstract from government spending and assume that the seigniorage income from monetary creation is repaid to the domestic households as lump sum income.

1   *3.5.   Optimal price setting with nominal rigidities*

When prices have to be set in advance of the realization of productivity, exchange rates and monetary stance, firms set them to maximize the expected value of profits discounted by the marginal utility of consumption. The price set by a firm in country j for sales to country i is then given by:

$$
\begin{aligned}
\tilde{P}_{j\to i} &= mkup \cdot E\left[(M_{US})^{\gamma_{j\to i}^{dollar}} (M_{Asia})^{\gamma_{j\to i}^{won}} (M_{Lat})^{\gamma_{j\to i}^{peso}} / K_j\right] \\
&= mkup \cdot \exp\left\{0.5 \cdot Var\left[\gamma_{j\to i}^{dollar} m_{US} + \gamma_{j\to i}^{won} m_{Asia} + \gamma_{j\to i}^{peso} m_{Lat} - k_j\right]\right\}
\end{aligned}
\tag{5}
$$

2   where lower case letters denote logs, Var denotes the variance, and we use the property
3   of the log normal distribution that the expected level of a variable is proportional to the
4   variance of its logarithm. Prices are set as a markup over the expected marginal cost, as
5   opposed to the actual cost under flexible prices. Intuitively, volatile unit margins lead firms
6   to set higher prices ex-ante. Existing analyses of monetary policy setting in a stochastic
7   open economy environment constitute particular cases of (5)
8   The right-hand side of (5) represents the drivers of cost and revenue faced by firms. It
9   reflects the various countries' monetary stances depending on their role in invoicing. Con-
10   sider for instance the case of an Asian exporter who fully invoices her sales to the U.S. in
11   dollars. The bracket term in (5) then simplifies to $E\left[M_{US}/K_{Asia}\right]$. Consider a drop in Asian
12   productivity (a lower K_{Asia}). In the absence of any monetary policy reaction this raises mar-
13   ginal costs and reduces the unit margin. If Asian authorities react and set $M_{Asia} = K_{Asia}$
14   they keep the wage in line with productivity. This however leads to an appreciation of the
15   won that lowers the won value of the unit revenue set in dollars, leading to a reduction in
16   unit margins. If U.S. authorities set $M_{US} = K_{Asia}$, the dollar appreciates against the won.
17   Even though the marginal cost increases because of constant wages and lower productivity,
18   the unit revenue in won increases to the same extent, thereby fully stabilizing unit margins.

4.   Monetary policy with the international roles of the dollar

This section derives the solution of the model. It first shows how the international role of the dollar affects the ex-post impact of U.S. policy on real variables, before deriving the optimal policy rules that affect the levels at which prices are preset in a stochastic environment. It presents both the policy rules and the resulting welfare levels in the various countries, contrasting the case where policy is set in a decentralized setting with a case of cooperation. The section concludes with an assessment of an exchange rate peg.

4.1.   The prominent impact of U.S. monetary policy

The first step is to derive the ex-post impact on consumption of monetary stances in the various countries. The log consumption in country i, c_i, is a weighted average of the log of the monetary stances in the U.S. (m_{US}), Asia (m_{Asia}), and Latin America (m_{Lat}), with the weights reflecting the invoicing structure of the country's imports. For instance, if a large share of imports is invoiced in dollars, a monetary expansion in the United States depreciates the dollar, reduces the consumer price of imports and boosts consumption. For brevity, focus on the worldwide consumption, defined as the weighted average of consumption of the United States, Asia, and Latin America: $c_W = 0.5c_{US} + 0.25c_{Asia} + 0.25c_{Lat}$. The worldwide monetary stance m_W is a similar average of the various countries' stances.

Proposition 1 *In the presence of an international role for the dollar, U.S. monetary policy has an impact on worldwide consumption that is proportionately greater than the share of the U.S. in world consumption. This magnification of U.S. policy is more marked in the presence of the global role of the dollar.*

Worldwide consumption under the direct and global roles of the dollar is given by:

$$c_W^{\text{Direct}} = \Theta_W + m_W + 0.5 \cdot (1 - \alpha) \left[m_{US} - 0.5 \left(m_{Asia} + m_{Lat} \right) \right] \tag{6}$$

$$c_W^{\text{Global}} = \Theta_W + m_W + \left[0.25 \cdot \alpha + 0.5 \cdot (1 - \alpha) \right] \left[m_{US} - 0.5 \left(m_{Asia} + m_{Lat} \right) \right] \tag{7}$$

1   where Θ_W is a constant term defined in the appendix and c_W^{Global} encompasses both the

2   direct and intra-Periphery country uses of the dollar. The impact a unit expansion of the

3   U.S. monetary stance ($m_{US} = 1$) on consumption is illustrated in Figure 2 as a function

4   of the degree of trade integration, α, between the United States and the Periphery. In the

5   absence of an international role of the dollar (dotted line) the impact of U.S. monetary policy

6   simply reflects the size of the U.S. economy ($c_W = \Theta_W + m_W$). The direct international role

7   of the dollar magnifies the impact of U.S. monetary policy (dashed line showing (6)). The

8   depreciation of the dollar reduces the price of U.S. goods expressed in Periphery currencies,

9   boosting Periphery consumption. This is not offset by any reduction of U.S. consumption

10 of Periphery goods, as U.S. import prices are set in dollars. The relatively large impact of

11 the U.S. monetary stance relies on trade flows between the United States and the Periphery,

12 and disappears when the two are disconnected ($\alpha = 1$).

13 Broadening the international role of the dollar to encompass intra-periphery transactions

14 further raises the impact of U.S. monetary policy on world consumption (solid line showing

15 (7)). A depreciation of the dollar now also lowers the peso price of Asian goods sold in

16 Latin America, as well as lowering the won price of Latin American goods sold in Asia. The

17 periphery consumption of imports from the other Periphery countries then increases. This

18 channel relies on intra-Periphery trade and operates even when the United States and the

19 Periphery are disconnected ($\alpha = 1$).

20 *4.2.   Monetary policy in a decentralized setting*

21 The next step considers the optimal design of monetary policy rules, which operate

22 through the levels at which prices are preset. Policy seeks to maximize some combination of

23 the welfare of the representative agents in the various countries.

₁ *4.2.1. Impact of the monetary stance*

The analysis follows the standard approach of ignoring the direct utility impact of real balances, and focuses on expected consumption and hours worked: $U_i = E \ln(C_i) - \kappa E H_i$. In equilibrium, expected hours are a simple function of the structural parameters regardless of the structure of invoicing, a well-known feature of such models (Corsetti and Pesenti 2005). The welfare assessment then focuses on the expected log of consumption. As consumption is proportional to real balances, the expected log of consumption is then the negative of the expected log of the consumer price index. The design of monetary policy then matters through its impact on the level at which the preset components of prices are set,[7] which is given by (5). For example, the U.S. welfare is:

$$
\begin{aligned}
\hat{U}_{US} = \ & -0.5 \cdot \alpha Var\left[\hat{m}_{US} - \hat{k}_{US}\right] \hspace{3cm} (8) \\
& -0.25 \cdot (1-\alpha)Var\left[\gamma^{dollar}_{Asia\to US}\hat{m}_{US} + \gamma^{won}_{Asia\to US}\hat{m}_{Asia} + \gamma^{peso}_{Asiat\to US}\hat{m}_{Lat} - \hat{k}_{Asia}\right] \\
& -0.25 \cdot (1-\alpha)Var\left[\gamma^{dollar}_{Lat\to US}\hat{m}_{US} + \gamma^{won}_{Lat\to US}\hat{m}_{Kor} + \gamma^{peso}_{Lat\to US}\hat{m}_{Lat} - \hat{k}_{Lat}\right]
\end{aligned}
$$

₂ where lower case hatted variables denote log deviations from a steady state equilibrium where
₃ productivity is constant. Logs of productivity shocks, k_i, are zero in expected value. $\hat{U}_{US}$ is
₄ the welfare expressed as a difference from its value under flexible prices. The derivation of
₅ (8) entails substantial technical steps and is presented in the online appendix. (8) shows that
₆ the best possible outcome is for policy to set all variances to zero and bring the economy to
₇ the allocation that prevails under flexible prices. Delivering this outcome requires an efficient
₈ *level* of demand, as the efficient response to higher productivity is to increase consumption,
₉ and requires an efficient *allocation* of demand, as the efficient response is to tilt consumption
₁₀ towards goods that are cheapest to produce.

₁₁   (8) shows that deviations from the flexible price allocation reflect volatile unit margins
₁₂ for U.S. firms (first row), as well as for Asian firms (second row) and Latin American firms

---

[7]While import prices can be affected by the exchange rate ex-post, the log exchange rates reflect the logs of monetary stances, and are equal to zero in expected value.

(third row) selling to the U.S. The intuition parallels the one discussed for (5). For brevity,

focus on the U.S.-Periphery dimension and consider a special case where productivity shocks

are identical in Asia and Latin America: $\hat{k}_{Asia,s} = \hat{k}_{Lat,s}$, where $\hat{k}_{Asia,s}$ is the log-deviation of

Asian productivity in state of nature s, relative to the steady state.

The optimal U.S. policy stance in a state of nature s is computed by setting to zero

the derivative of expected log U.S. consumption with respect to the U.S. stance in that

state. Similar first-order conditions are derived for the stances in Asia and Latin America.

These conditions are expressed as log-linear approximations around a steady state where

productivity is constant. The solution of that linear system gives the monetary stances,

$\hat{m}_{i,s}$, as linear functions of the shocks, $\hat{k}_{i,s}$. As expected shocks, $E\hat{k}_i$, are zero, so are the

expected monetary stances, $E\hat{m}_i$. The detailed steps for this optimization entail substantial

algebra and are presented in an online appendix to the paper.

4.2.2. Monetary rules

Under a decentralized setting each monetary authority focuses on the welfare of its own

residents. For instance the Asian authorities set $\hat{m}_{Asia,s}$ as a function of the shocks to

maximize $E \ln (C_{Asia})$. In the absence of an international role for the dollar, policy focuses

solely on domestic shocks ($\hat{m}_{i,s} = \hat{k}_{i,s}$) when there is full exchange rate pass-through (PCP-

all), an allocation that replicates the situation of flexible prices. In the absence of pass-

through (LCP-all) the policy stance in each country targets an average of shocks, weighted

by the share of goods from different origins in the country's consumption basket.

Proposition 2 *In the presence of an international role of the dollar (direct or global), the*

U.S. monetary policy targets a combination of worldwide shocks which reflect the composition

of the U.S. consumption basket. Monetary policies in Periphery countries focus solely on

domestic shocks.

The policy rules under the direct role of the dollar are given by:

$$\hat{m}_{US,s} = \alpha \hat{k}_{US,s} + (1 - \alpha) \hat{k}_{Asia,s} \quad , \quad \hat{m}_{Asia,s} = \hat{m}_{Lat,s} = \hat{k}_{Asia,s} \qquad (9)$$

Intuitively the U.S. policy stance affects all producers selling to the U.S. market as all prices are set in dollars. The optimal policy is then to react to the shocks faced by U.S. firms, $\hat{k}_{US,s}$, which account for a share α of the consumption baskets, and the shocks faced by Periphery firms, $\hat{k}_{Asia,s}$, which jointly account for the remaining share.[8]

The Asian central bank has no influence of the prices of imports from the U.S. which are invoiced in dollars. It reacts only to domestic shocks, $\hat{k}_{Asia,s}$. Under the direct role of the dollar, the Asian policy also affects the pricing of Latin American firms selling to Asia if they invoice in won. However, our assumption of perfect correlation between Asian and Latin American productivity (in this particular example) ensures that this does not lead to any trade-off with an impact on the pricing of Asian firms. Under the global role of the dollar, the Asian authorities do not impact the pricing of imports from Latin America as these prices are set in dollars.

The analysis stresses an asymmetric form of monetary policy rules between the center and the periphery countries in the presence of an international role for the center's currency, an aspect indicated by Corsetti and Pesenti (2005) and Devereux, Shi, and Xu (2007) who exclusively focus on the direct international role of a currency.

4.2.3. Welfare

While the policy rules are the same under the direct and global international roles of the dollar, the cases differ in two important ways. First, policy rules are affected by the global role under a cooperative policy setting, as shown below. Second, the rules have different implications for welfare under the direct and global roles.

---

[8]Absent the simplifying assumption of identical productivity shocks across periphery countries, the monetary policy rule of the US would have a weighted average of those shocks.

1 **Proposition 3** *In the presence of an international role of the dollar (direct or global), U.S.*

2 *welfare is identical to its level in the symmetric case without pass-through. Under the direct*

3 *role of the dollar, welfare is higher in the Periphery than in the U.S. as the Periphery benefits*

4 *from movements in U.S.-Periphery relative prices that are partially efficient. Under the global*

5 *role of the dollar, Periphery welfare is lower than under the direct role because of inefficient*

6 *movements in intra-Periphery relative prices.*

Any international role of the dollar prevents U.S. authorities from achieving an efficient allocation of consumption as the relative consumer price in the United States between goods from different origins is insulated from exchange rate movements:

$$\hat{U}_{US} = -0.5 \cdot \alpha \left(1 - \alpha\right) Var \left[\hat{\hat{k}}_{US} - \hat{\hat{k}}_{Asia}\right] < 0 \tag{10}$$

7 Figure 3 illustrates the U.S. welfare (dotted line) as a function of the degree of U.S.-Periphery

8 integration α.[9] The numbers correspond to the equivalent change in consumption across all

9 states: a value of -0.1% indicates that welfare is lower than in the flexible price allocation

10 by an extent equivalent to a reduction of consumption by 0.1% in all states. The U.S. welfare

11 is lower than under flexible prices, with the magnitude of the gap being inversely related

12 to the extent of U.S.-Periphery trade. If the two regions are disconnected ($\alpha = 1$), relative

13 prices do not matter for U.S. consumers who are then as well off as under flexible prices.

Under the direct role of the dollar, the Asian (and Latin American) consumer is better off than her U.S. counterpart:

$$\left(\hat{U}_{Asia}\right)_{\text{Direct}} = -0.5 \cdot (1 - \alpha)^3 Var \left[\hat{\hat{k}}_{US} - \hat{\hat{k}}_{Asia}\right] \in \left[\hat{U}_{US}, 0\right] \tag{11}$$

14 This welfare is shown as the dashed line in Figure 3. As the price for U.S. goods in Asia

15 is affected by the exchange rate, monetary policy leads to movements in the relative prices

---

[9]For this illustration we set the standard deviation of productivity shocks at 5% for all countries, leading to a standard deviation for the U.S.-Periphery productivity differential of 7%.

faced by the Asian consumer that are partially efficient. A productivity boom in the United States, for example, leads to an expansion of U.S. monetary policy and a depreciation of the dollar. U.S. goods are then cheaper in Asia, inducing the Asian consumer to switch her consumption towards U.S. goods, which is an efficient allocation as these goods are cheaper to produce. But, since U.S. policy does not react one-for-one to U.S. shocks, the exchange rate movement is inefficiently small from the point of view of Asian consumers. This result hinges on direct trade between the U.S. and the Periphery, and Asian welfare is closer to its level under flexible prices when the U.S.-Periphery connection is loose (i.e. α is high).

The global role of the dollar lowers Asian welfare below the level under the direct role:

$$\left(\hat{U}_{Asia}\right)_{\text{global}} = - \left[0.5 \cdot (1-\alpha)^3 + 0.25 \cdot \alpha^3\right] Var\left[\hat{k}_{US} - \hat{k}_{Asia}\right] < \left(\hat{U}_{Asia}\right)_{\text{Direct}} \qquad (12)$$

This welfare is shown by the solid line in Figure 3. Movements in the dollar-won and dollar-peso exchange rates affect the relative price between Asian and Latin American goods faced by consumers in the Periphery, which is inefficient in our example as productivity is identical in the two Periphery countries. For instance, a loosening of U.S. policy in response to higher U.S. productivity lowers the price of Latin American goods in Asia and of Asian goods in Latin American, even though this relative price should not move on efficiency grounds. These inefficient movements in intra-Periphery relative prices remain even when the U.S. and the Periphery are fully disconnected ($\alpha = 1$). When the U.S.-Periphery trade connection is limited ($\alpha > 0.71$) the cost to Periphery consumers from inefficient intra-Periphery relative prices exceeds the benefit they get from partially efficient movements in U.S.-Periphery relative prices, and they are worse off than their U.S. counterparts.

4.3. *Monetary policy in a cooperative setting*

The next step is to assess the design of policy in a cooperative setting where the monetary authorities in all countries set their policy stances to maximize the weighted average of the

welfare levels: $0.5 \cdot E \ln (C_{US}) + 0.25 \cdot E \ln (C_{Asia}) + 0.25 \cdot E \ln (C_{Lat})$.

4.3.1.   Monetary rules

Cooperation offers no gains in the absence of any international role of the dollar, either because the impact of a country's policy on its neighbors is identical to the domestic impact and there is no trade-off (the PCP-all case, Obstfeld and Rogoff 2002), or because a country's stance has no impact on its neighbors (the LCP-all case, Corsetti and Pesenti 2005).[10] Two conditions are required for cooperation to be warranted. First, a country's policy must impact the welfare of its neighbors. Second, it must do so in a way that differs from its domestic impact that is the central bank's focus in a decentralized setting.[11]

Proposition 4 *Cooperation has no impact on the policy rule of Periphery economies. Under the direct role of the dollar, cooperation calls for U.S. policy to focus more intently on domestic shocks. The enhanced focus on U.S. shocks occurs under the global role only if the U.S. and Periphery are closely linked through trade.*

With the international role of the dollar, the Asian monetary stance does not affect U.S. consumer prices that are set in dollars. While it can affect Latin American consumers under the direct role of the dollar (in the Direct-PCP case), this impact reflects $Var \left[\hat{m}_{Asia} - \hat{k}_{Asia} \right]$ and is identical to the impact of Asian policy on domestic prices, which is taken into account by Asian authorities. Under the global role of the dollar, the Asian monetary stance has no impact outside Asia as all trade flows are invoiced in dollars. Thus, cooperation does not require a change in the policy rules of Periphery countries as their impact on other countries is either nonexistent or identical to their domestic impact.

The international role of the dollar generates an international impact of U.S. policy that is not taken into account by U.S. authorities. The U.S. policy rule under cooperation then

---

[10]Cooperation improves welfare in intermediate cases where the extent of pass-through is the same for all countries and lies between 0 and 1.

[11]In our model externalities are linked to U.S. policy. Cooperation is thus beneficial only if it involves the U.S. No gain can be achieved by policy cooperation between Asia and Latin America alone.

differs from the one under the decentralized setting. Under the direct international role of the dollar, the U.S. authorities ignore their impact on the price of U.S. goods in the Periphery. Specifically, the expansionary U.S. policy in response to higher U.S. productivity depreciates the dollar and leads to an efficient reduction of the price of U.S. goods in the Periphery. Taking this aspect into account calls for a larger depreciation of the dollar, and the U.S. policy rule under cooperation is:

$$\hat{m}_{US,s} = (2-\alpha)^{-1}\,\hat{k}_{US,s} + \left[1 - (2-\alpha)^{-1}\right]\hat{k}_{Asia,s} \tag{13}$$

1 As $(2-\alpha)^{-1} > \alpha$ the expansion in response to an increase in $\hat{k}_{US}$ is larger than under (9).
2 The gap between the two rules (9) and (13) reflects the extent of U.S.-Periphery trade, with
3 the two rules being identical when the U.S. and the Periphery are disconnected ($\alpha = 1$).

Under the global international role, U.S. policy has an additional externality. An expansionary policy in response to higher U.S. productivity depreciates the dollar and lowers the price of Asian goods in Latin America (and conversely). Taking this externality into account calls for a smaller monetary expansion, and the U.S. policy rule under cooperation is:

$$\hat{m}_{US,s} = 2\,(4-\alpha)^{-1}\,\hat{k}_{US,s} + \left[1 - 2\,(4-\alpha)^{-1}\right]\hat{k}_{Asia,s} \tag{14}$$

4 As $(2-\alpha)^{-1} > 2\,(4-\alpha)^{-1}$, the monetary expansion in response to an increase in U.S.
5 productivity, $\hat{k}_{US}$, is smaller under the global role than under the direct one.
6   The global international role of the dollar entails two opposite externalities of U.S. mone-
7 tary policy. The externality along the U.S.-Periphery dimension calls for a stronger response
8 to U.S. shocks, while the one along the intra-Periphery dimension calls for a weaker response.
9 The second aspect dominates if the United States and the Periphery are not closely linked
10 ($\alpha > 0.59 \Rightarrow 2\,(4-\alpha)^{-1} < \alpha$) in which case the reaction of U.S. policy to U.S. shocks is
11 dampened under cooperation.

1   *4.3.2.   Welfare*

2   The U.S. policy stance is the only one that differs between the decentralized and cooper-

3   ative cases. As the United States could choose (13)-(14) in the decentralized allocation but

4   instead opts for (9), cooperation entails a welfare loss for the U.S. This loss is more than

5   offset by a gain for Asia, as the cooperative solution maximizes world welfare.

6   **Proposition 5** *Under the direct role of the dollar, the welfare gain (in the Periphery) and*

7   *loss (in the U.S.) from cooperation are positively related to the extent of U.S.-Periphery*

8   *integration.   Under the global role of the dollar, the gains and losses are non-monotonic*

9   *functions of the extent of trade integration.   The magnitude of the gains and losses under*

10 *limited integration is large.*

      The welfare impact of cooperation is illustrated in Figure 4 which shows the U.S. loss

(panel A) and the Periphery gain (panel B). The results are presented in terms of the differ-

ence between a country's welfare under cooperation and its welfare under the decentralized

allocation. Under the direct international role of the dollar, the externality of the U.S. pol-

icy operates through the price of U.S. goods in the Periphery. The impact of cooperation is

proportional to the extent to which the U.S. and the Periphery trade with each other:

$$\left(\hat{U}_{US}\right)^{\text{Gain}}_{\text{Direct}} = -0.5 \cdot (1-\alpha)^4 (2-\alpha)^{-2} Var\left[\hat{k}_{US} - \hat{k}_{Asia}\right] < 0 \qquad (15)$$

$$\left(\hat{U}_{Asia}\right)^{\text{Gain}}_{\text{Direct}} = 0.5 \cdot (1-\alpha)^3 \left[1 - (2-\alpha)^{-2}\right] Var\left[\hat{k}_{US} - \hat{k}_{Asia}\right] > 0 \qquad (16)$$

11 (15)-(16) are presented in Figure 4 (dotted line), both being zero under complete disconnect

12 ($\alpha = 1$). The magnitude of Asia's gain exceeds that of the U.S. loss, and both decline quickly

13 as the connection between the Periphery and the United States is reduced (α is high).

      Under the global role of the dollar, two competing aspects are present when the United

States and the Periphery are closely integrated (α is low). The externality from the direct role

along the U.S.-Periphery dimension calls for a smaller reaction of U.S. policy to U.S. shocks,

while the additional externality along the intra-Periphery dimension calls for the opposite

response. If the trade flows between the United States and the Periphery are important ($\alpha < 0.59$), the first externality dominates. Conversely, the second externality dominates when the links are limited ($\alpha > 0.59$). In both cases cooperation increases worldwide welfare. When $\alpha = 0.59$ the two externalities cancel out and cooperation is not warranted:

$$\left(\hat{U}_{US}\right)^{\text{Gain}}_{\text{Global}} = -\Phi_1 Var\left[\hat{k}_{US} - \hat{k}_{Asia}\right] \quad ; \quad \left(\hat{U}_{Asia}\right)^{\text{Gain}}_{\text{Global}} = \Phi_2 Var\left[\hat{k}_{US} - \hat{k}_{Asia}\right] \tag{17}$$

where $\Phi_1 = 0.5\{\alpha\left[\left[1 - 2/\left(4 - \alpha\right)\right]^2 - \left(1 - \alpha\right)^2\right] + \left(1 - \alpha\right)\left[\left[2/\left(4 - \alpha\right)\right]^2 - \alpha^2\right]\}$ and $\Phi_2 = 0.5\cdot\left(1 - \alpha\right)\left[\left(1 - \alpha\right)^2 - \left[1 - 2/\left(4 - \alpha\right)\right]^2\right] + 0.25\cdot\alpha\left[\alpha^2 - \left[2/\left(4 - \alpha\right)\right]^2\right]$. Both Φ_1 and Φ_2 are positive for $\alpha \in [0.5, 1]$, except for $\alpha = 0.59$ where they are both zero, this value being the one where policy rules are the same under a decentralized and a cooperative setting in the context of the global role of the dollar.

(17) are shown in Figure 4 (solid line). While the magnitude of the welfare gain and loss is limited when the United States and the Periphery are closely integrated, it increases substantially when they are disconnected. The United States then becomes a closed economy where monetary policy reacts substantially to domestic shocks. This generates large exchange rate movements that feed directly into inefficient movements of intra-Periphery relative prices. The gain from cooperation can then be substantial, as the gain for Asia and Latin America (0.07% when $\alpha = 1$) offsets nearly half of the welfare gap from the flexible price allocation (-0.13% in Figure 3).

4.4. Exchange rate peg

The efficiency, or lack thereof, of exchange rate movements is at the core of the gains from cooperation. Given that a full-blown cooperative setting can be hard to implement across countries, a natural question is whether the simpler strategy of a peg of Periphery currencies to the dollar could be beneficial. This turns out not to be the case.

Proposition 6 *Despite the limited efficiency of exchange rate movements, in the context of*

1 *our model pegging Periphery countries to the dollar is a suboptimal policy.*

2   The simple form of a peg would be for Periphery countries to unilaterally stabilize the
3 value of their currencies against of the dollar. In the context of our model and the inefficien-
4 cies identified, this policy is clearly suboptimal. Intuitively, the externalities of decentralized
5 policies under the international role of the dollar arise when the optimization by U.S. au-
6 thorities does not internalize the policy impact on Periphery countries. Any improvement in
7 Periphery's welfare then requires the involvement of the U.S. authorities.

8   A currency union presents a policy setting where the U.S. authorities internalize their
9 impact on Periphery countries, which is perhaps simpler to implement than full-blown co-
10 operation among policy makers. Specifically, Periphery countries peg their currencies to the
11 dollar and the U.S. authorities set their monetary stance to maximize the worldwide welfare
12 average taking the pegs into account. The U.S. policy does not try to alter international
13 relative prices and reacts to the worldwide productivity shock, setting the efficient level of
14 demand without aiming at its composition. The monetary stances in the Periphery track the
15 U.S. stance and $\hat{m}_{i,s} = \hat{k}_{W,s}$ for all countries. Welfare is equalized across all three countries
16 regardless of the structure of invoicing: $\hat{U}_i = -(1/8) \cdot Var\left[\hat{k}_{US} - \hat{k}_{Asia}\right]$.

17   The welfare under these various policies are presented in Figure 5. For brevity, the
18 discussion focuses on scenario of the global role of the dollar, under which the impacts of
19 cooperation on welfare are largest (Figure 4), and consider the worldwide average welfare:
20 $\hat{U}_W = 0.5 \cdot \hat{U}_{US} + 0.25 \cdot (\hat{U}_{Asia} + \hat{U}_{Lat})$. Welfare is clearly lowest under the currency union
21 (solid line) than under the decentralized setting (dotted line, combining (10) and (12)) and
22 the cooperative setting (dashed line, combining (10) and (12) with (17)).

23   The poor performance of a currency union can be surprising given the inefficient move-
24 ments in intra-Periphery relative prices under flexible exchange rates. This result reflects
25 the fact that the external effects of monetary policy are secondary relative to the domestic
26 effects. While monetary authorities aim at stabilizing the margins of foreign producers, they
27 also aim at stabilizing the margins of the domestic producers which account for a large share

1 of the consumption basket. Reducing inefficient movements in international prices limits the

2 ability of monetary policy to stabilize domestic margins. Under the global role of the dollar,

3 Periphery policies are always fully inward-oriented (9). A currency union requires them to

4 respond to worldwide shocks, half of which originate in the United States. The gain from

5 a peg, in the form of limiting inefficient movements in international relative prices, is then

6 dominated by the loss from inefficient stabilization of the domestic economy.

7 *4.5.   Impact of different volatility of shocks*

8   For brevity the analysis so far focuses on the U.S.-Periphery dimension by setting produc-

9 tivity shocks in Asia and Latin America to be equal. A more general solution with different

10 shocks brings two additional insights in the context of the global role of the dollar. They

11 can be illustrated by considering a case where only Asia experiences productivity shocks.

12   First welfare is higher in Asia than in Latin America under a decentralized policy setting.

13 This puzzling result reflects the fact that the Asian monetary authorities can offset the Asian

14 shocks, while the Latin American authorities cannot. Asian shocks affect the price set by

15 Asian producers for domestic sales, which is proportional to $Var\left[\hat{m}_{Asia} - \hat{k}_{Asia}\right]$. The Asian

16 monetary authorities can fully address this problem by setting $\hat{m}_{Asia} = \hat{k}_{Asia}$. The shocks

17 also affect the price set by Asian firms for sales in Latin America. As this price is set in

18 dollars, it is proportional to $Var\left[\hat{m}_{US} - \hat{k}_{Asia}\right]$. The Latin American monetary authorities

19 cannot influence the import price, leading to lower welfare.

20   Second, Latin America gains more from cooperation than Asia does, as long as the

21 Periphery and the United States are not tightly connected. In that case, the U.S. monetary

22 policy reacts more strongly to shocks in either Periphery country under cooperation (14) than

23 under a decentralized setting (9). This affects countries Asia and Latin America through

24 the prices of their imports from each other. In Asia, the preset component of the price for

25 Latin American imports is proportional to $Var\left[\hat{m}_{US} - \hat{k}_{Lat}\right]$, which is the variance of the

26 U.S. monetary stance as there are no shocks in Latin America. Cooperation increases this

variance as U.S. policy shifts its emphasis to Asian shocks, increasing the price of Latin American goods for the Asian consumer. By contrast the preset component of the price of Asian goods in Latin America is proportional to $Var\left[\hat{m}_{US} - \hat{k}_{Asia}\right]$. As U.S. policy reacts more to Asian shocks under cooperation, this variance is reduced and Asian goods become cheaper for the Latin American consumer.

5.   Conclusion

The international role of the dollar matters for macroeconomic interdependence, especially when considering both its direct role in the invoicing of trade flows involving the United States and its global role in invoicing trade flows between other countries. Despite its empirical relevance, this global role has received little attention in the literature on international transmission and optimal policy. The global role of the dollar magnifies the impact of U.S. monetary policy, and opens the potential for substantial world gains from cooperation between monetary authorities (conditional on the modelling approach). These gains require a full-blown cooperative policy setting and cannot be achieved by a monetary union. The gains are also larger for those Asian countries where the shocks are the least volatile.

The international role of a currency is thus a central feature of international interdependence. While our analysis deliberately maintains a simple theoretical setup for expositional clarity, it can be extended along many directions. First, the assumption of an exogenous structure of invoicing can be relaxed to assess the joint determination of monetary policy and invoicing strategy. This is a promising avenue of research, as shown by Devereux, Shi, and Xu (2007), who assess the conditions under which the direct role of the dollar is an equilibrium. Second, the assumption that all trade takes place in final goods can be relaxed. While the impact of exchange rate on international relative prices that are at the center of our analysis would still operate at the level of inputs, the empirical evidence that much of world trade is in intermediate inputs warrants additional work in this direction. In particular, the international role of the dollar could be smaller once trade flows in intermediate

inputs are netted out to focus on the local value added. Third, our approach assumes that price rigidities apply to all goods, while in reality the degree of price stickiness is higher for some goods, such as manufacturing products, than other, such as commodities. If the international role of a currency is concentrated among goods with relatively flexible prices, such as in commodities and raw materials, the magnitudes of the effects are likely to be reduced. Finally, the analysis focuses on the ability of the exchange rate to generate efficient movements in international relative prices. The finding that a peg is not optimal abstracts from the extensive range of other motives for having fixed exchange rates that appear in other theoretical contributions.

References

Bacchetta, P., Van Wincoop, E., 2005. A theory of the currency denomination of international trade. Journal of International Economics 67, 295-319.

Campa, J.-M., Goldberg, L., 2005. Exchange rate pass-through into import prices. Review of Economics and Statistics 87, 679-690.

Choudhri, E., Faruqee, H., Hakura, D., 2005. Explaining the exchange rate pass-through in different prices. Journal of International Economics 65, 349-374.

Corsetti, G., Pesenti, P., 2005. International dimensions of optimal monetary policy. Journal of Monetary Economics 52, 281-305.

Cook, D., Devereux, M., 2006. External currency pricing and the east asian crisis. Journal of International Economics 69, 37-63.

Devereux, M., Engel, C., 2003. Monetary policy in the open economy revisited: exchange rate flexibility and price setting-behavior. Review of Economic Studies 70, 765-783.

Devereux, M., Shi, K., Xu, J., 2007. Global monetary policy under a dollar standard. Journal of International Economics 71, 113-132.

Devereux, M., Engel, C., Storgaard, P., 2004. Endogenous exchange rate pass-through when nominal prices are set in advance. Journal of International Economics 63, 263-291.

Gagnon, J., Ihrigh, J., 2004. Monetary policy and exchange rate pass-through, International Journal of Finance and Economics 9, 315-338.

Goldberg, L., Tille, C., 2008a. Vehicle currency use in international trade. Journal of International Economics 76, 177-192.

Goldberg, L., Tille, C., 2008b. Macroeconomic interdependence and the international role of the dollar. Center for Economic Policy Research Discussion Papers 6704.

Obstfeld, M., Rogoff, K., 2002. Global implications of self-oriented national monetary rules. Quarterly Journal of Economics 117, 503-356.

Table 1: Main results

	Direct international role of the dollar	Global international role of the dollar
Sensitivity of world consumption to U.S. monetary stance.	- Higher than in the absence of an international role. - Requires direct trade between the U.S. and the Periphery.	- Higher than under the direct international role. - Does not requires direct trade between the U.S. and the Periphery
Decentralized policy — Policy rules	- U.S. follows a combination of U.S. and Periphery shocks. - Periphery focuses on domestic shocks.	- Identical to the case of a direct international role.
Decentralized policy — Welfare	- Higher in the Periphery than in the U.S. as it benefits from some efficient movements in Periphery-U.S. relative price. - Periphery-U.S. gap requires direct trade between the U.S. and the Periphery.	- Lower in the Periphery than in the U.S. as it suffers from inefficient movements in intra-Periphery relative price. - Periphery-U.S. gap does not require direct trade between the U.S. and Periphery.
Cooperative policy — Policy rules	- Periphery is unchanged. - U.S. focuses more on U.S. shocks.	- Periphery is unchanged. - U.S. focuses less on U.S. shocks, as long as the U.S. and the Periphery are not closely connected.
Cooperative policy — Welfare	- Periphery benefits moderately from cooperation. - Gain requires direct trade between the U.S. and the Periphery.	- Periphery benefits substantially from cooperation. - Gain does not require direct trade between the U.S. and the Periphery.

The direct international role of the dollar is its use as the invoicing currency for U.S. exports and imports. The global international role also includes, in addition to the direct role, the use of the dollar as the invoicing currency for trade flows between Asia and Latin America.

Table 2: International Role of the Dollar

	Year of Invoicing Observation and Trade Shares	Share of Country Exports			Share of Country Imports		
		Invoiced in Dollars	Sold to the US	Sold to the US + "Dollar Bloc" [b]	Invoiced in Dollars	Bought from the US	Bought from the US + "Dollar Bloc" [b]
		(1)	(2)	(3)	(4)	(5)	(6)
Asia							
Japan	2001	52.8	30.4	51.5	70.0	18.3	51.8
Korea	2001	84.9	20.8	49.0	82.2	15.9	45.5
Malaysia	1996	66.0	18.2	31.6	66.0	15.5	22.2
Thailand	1996	83.9	17.8	35.3	83.9	12.3	26.8
Australia	2002	67.9	9.6	29.6	50.1	18.3	36.8
European Union							
Belgium[a]	2002	31.9	20.1	33.5	33.5	16.4	29.9
France[a]	2002	34.2	15.4	27.2	43.3	15.6	29.7
Germany[a]	2002	31.6	17.9	28.7	34.5	13.1	25.5
Greece[a]	2002	71.1	7.5	18.7	62.0	8.7	28.1
Italy	2002	20.5	9.8	17.3	30.8	4.9	12.3
Luxembourg[a]	2002	35.7	10.4	17.8	38.0	15.3	19.6
Portugal[a]	2002	33.4	17.4	22.6	34.5	7.2	19.3
Spain[a]	2002	32.8	11.0	19.7	39.5	8.5	24.5
United Kingdom	2002	26.0	15.5	22.2	37.0	11.9	21.3
EU-Accession							
Bulgaria	2002	44.3	4.8	8.1	37.1	2.2	9.0
Cyprus	2002	44.7	2.3	21.8	34.9	4.9	17.2
Czech	2002	14.7	2.9	6.0	19.5	3.3	11.6
Estonia	2003	8.5	2.3	7.7	22.0	2.9	13.3
Hungary	2002	12.2	3.5	6.2	18.5	3.7	13.2
Latvia	2002	32.1	4.3	7.4	32.1	1.6	4.6
Poland	2002	29.9	2.7	7.6	28.6	3.3	10.0
Slovakia	2002	11.6	1.4	3.5	21.2	2.1	6.5
Slovenia	2002	9.6	2.8	5.2	13.3	2.9	6.2

The first three columns show the shares of countries' exports that are invoiced in dollar (1), that are sold to the U.S. (2), and that are sold to the U.S. and "dollar bloc" countries (3). Columns (4)-(6) are the corresponding shares to countries' imports.

[a] Invoicing data and trade data refer only to "extra euro-area" trade.

[b] Dollar bloc countries are: Afghanistan, Antigua & Barbuda, Azerbaijan, the Bahamas, Bahrain, Bangladesh, Barbados, Belize, Bermuda, China, Djibouti, Dominica, Ecuador, El Salvador, Ethiopia, Grenada, Guinea, Guyana, Hong Kong, India, Iraq, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Malaysia, Maldives, Mongolia, Mozambique, Netherlands Antilles, Oman, Pakistan, Panama, Qatar, St Vincent & the Grenadines, Sao Tome & Principe, Saudi Arabia, St Kitts & Nevis, St Lucia, Sudan, Suriname, Syrian Arab Republic, Trinidad & Tobago, Ukraine, United Arab Emirates, Vietnam, Yemen, and Zimbabwe. In the case that trade data to one of these countries is not available, reported trade shares do not include trade with that country in the numerator.

Figure 1: Five cases of invoicing

The labels next to the arrows denote the currency used
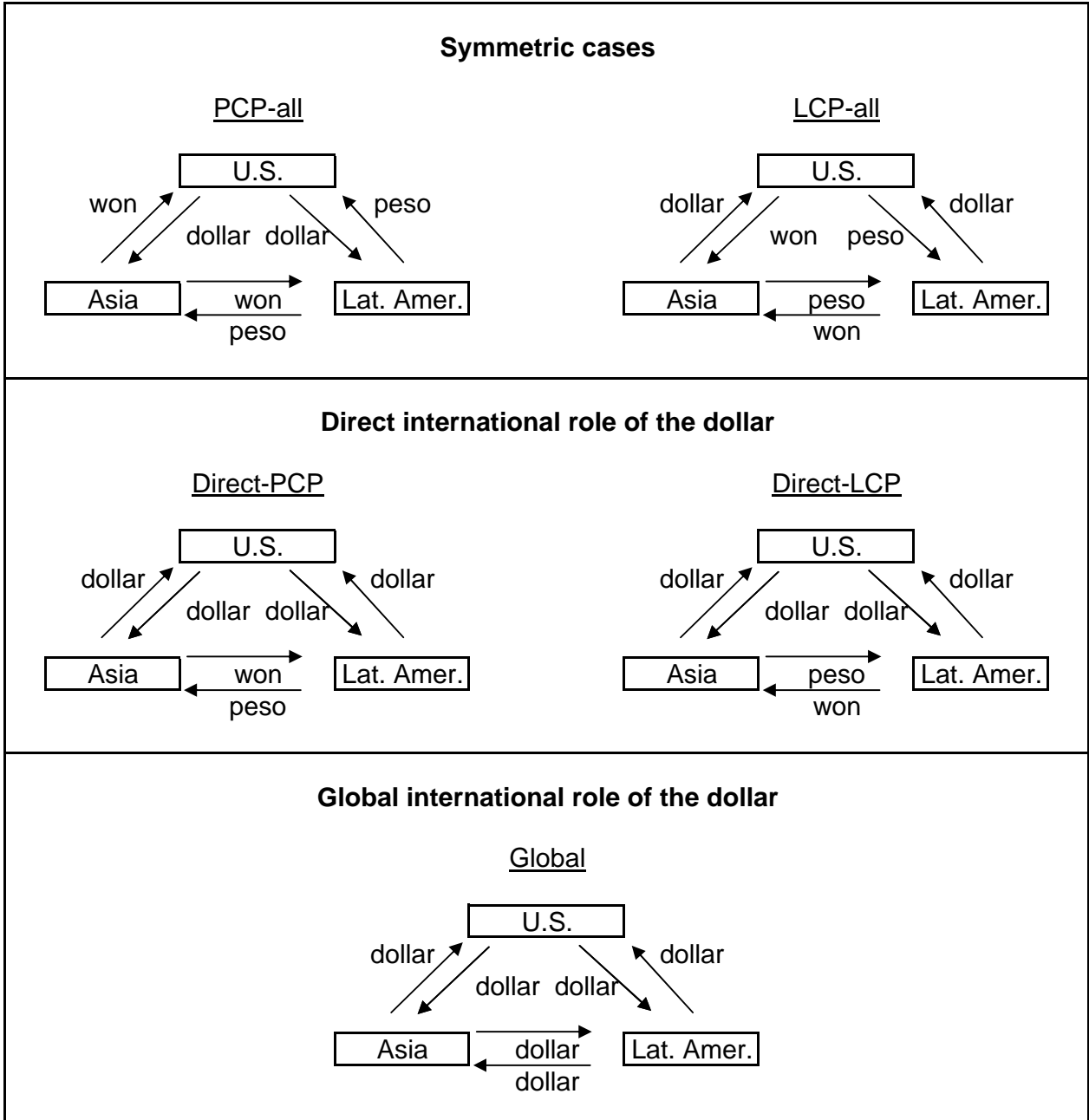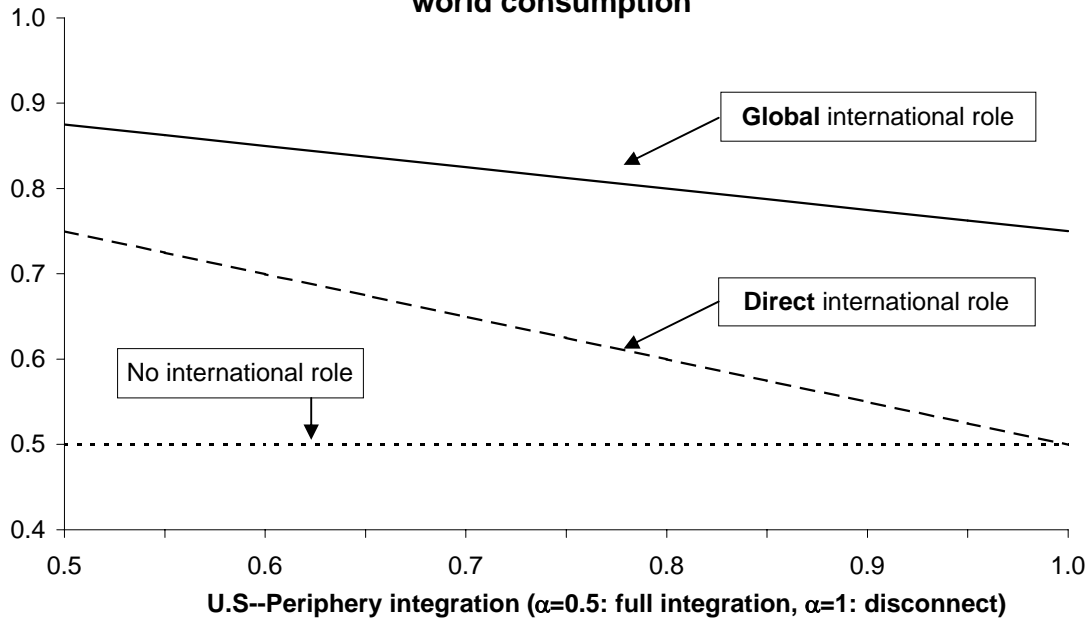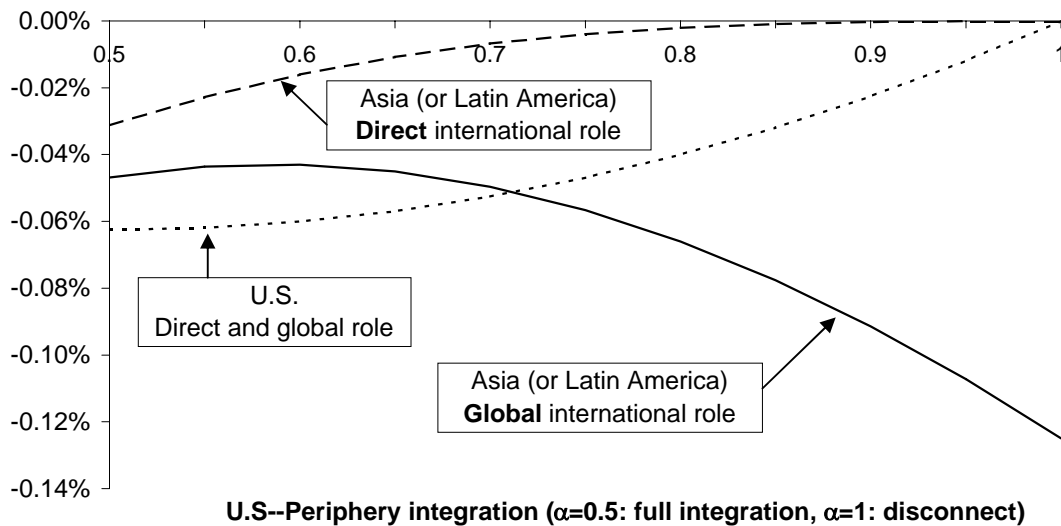for the invoicing of the corresponding trade flows

Figure 2: Ex-post impact of U.S. policy on world consumption

Global international role

Direct international role

No international role

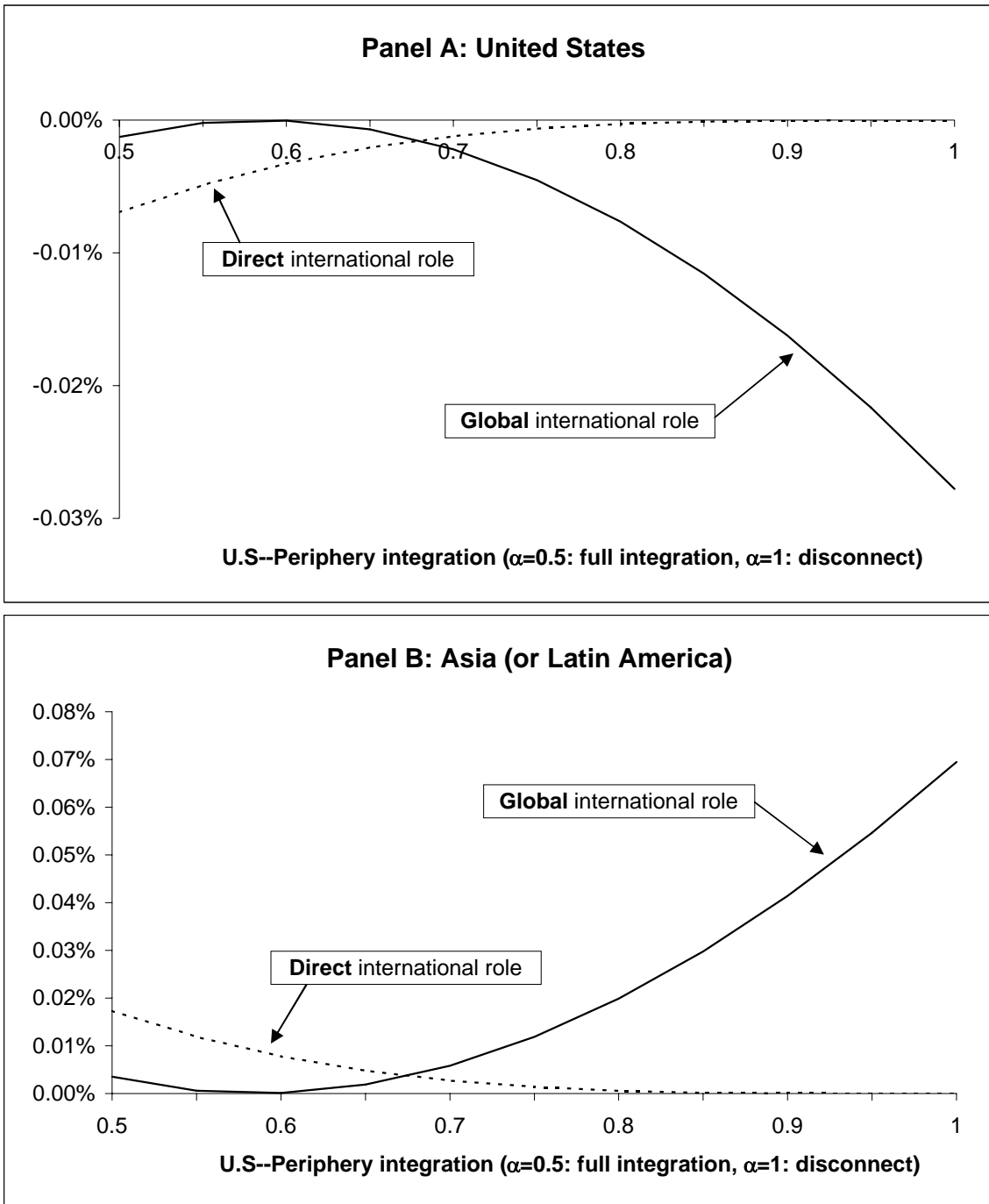U.S--Periphery integration (α=0.5: full integration, α=1: disconnect)

The figure shows the percentage change in the weighted average of consumption across the U.S., Asia and Latin America following a 1 percent expansion in the U.S. monetary stance. It contrasts the cases where the international role of the dollar is non-existent, limited to direct trade with the U.S., and applying globally to all trade flows.

Figure 3: Welfare under decentralized policy

Asia (or Latin America) **Direct** international role

U.S. Direct and global role

Asia (or Latin America) **Global** international role

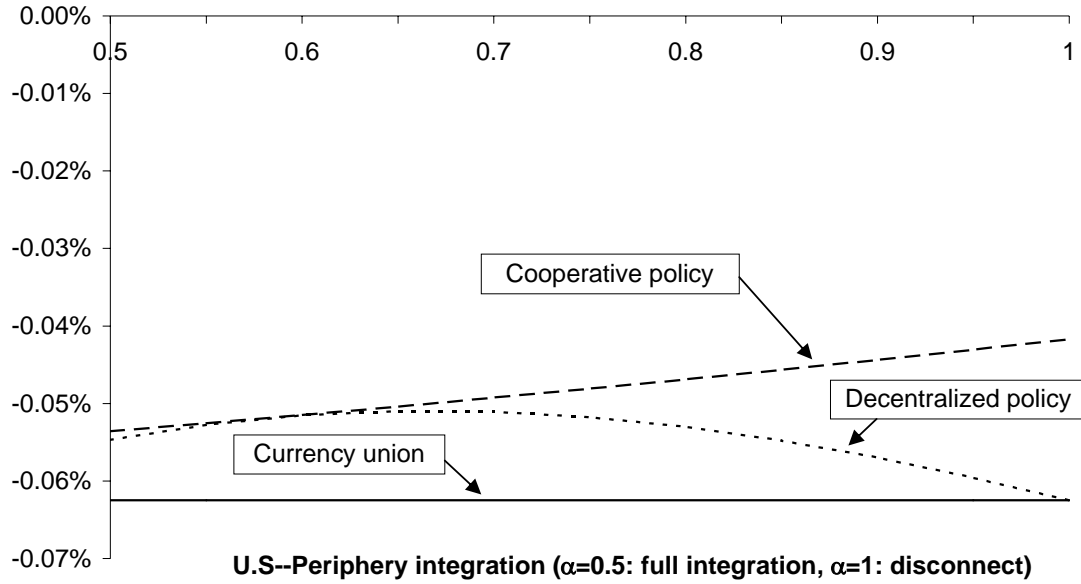U.S--Periphery integration (α=0.5: full integration, α=1: disconnect)

The figure shows deviations from welfare under flexible prices, with the values corresponding to the equivalent reduction in average consumption (in percent). The figure focuses on the case with an international role of the dollar, contrasting the situations where the international role is limited to direct trade with the U.S., or applying globally to all trade flows.

Figure 4: Gain from cooperation

Panel A: United States

Direct international role

Global international role

U.S--Periphery integration (α=0.5: full integration, α=1: disconnect)

Panel B: Asia (or Latin America)

Global international role

Direct international role

U.S--Periphery integration (α=0.5: full integration, α=1: disconnect)

The figure shows the difference between welfare under cooperation and welfare under a decentralized setting.
The values correspond to the equivalent reduction in average consumption (in percent). The figure focuses on the
cases with an international role of the dollar, contrasting the situations where the international role is limited to direct
trade with the U.S., or applying globally to all trade flows.

Figure 5: Worldwide welfare under global role of the dollar

The figure shows the weighted average of welfare across the U.S., Asia and Latin America. Welfare is expressed as a deviation from its level under flexible prices, with the values corresponding to the equivalent reduction in average consumption (in percent). The figure focuses on the case of a global international role of the dollar, and contrast the case where policy is set in a decentralized setting, in a cooperative setting, or as a currency union where the U.S. authorities maximize average welfare taking account of Periphery pegs to the dollar.