

Remittances, Inflation and Exchange Rate Regimes in Small Open Economies

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Abstract

Remittances are private monetary transfers. Yet the rapidly growing literature on the subject often ignores the role that exchange rate regimes play in determining the effect remittances have on a recipient economy. This paper uses a theoretical model and panel vector autoregression techniques to explore the role exchange rate regimes play in understanding the effect of remittances. The analysis considers yearly and quarterly data for seven Latin American countries. Our theoretical model predicts that remittances should temporarily increase inflation and generate an increase in the domestic money supply under a fixed regime but temporarily decrease inflation and generate no change in the money supply under a flexible regime. These differences are borne out in the data. This adds to our understanding of the true effect of remittances on economies and suggests that other results in the literature that do not control for regimes may be biased.

JEL Classification: F22 - International Migration; F33 - International Monetary Arrangements and Institutions; F41 - Open Economy Macroeconomics; C32 - Time-Series Models; C33 - Models with Panel Data

I. Introduction

Remittance flows are large, growing, and important for many economies. Beyond the increase in absolute terms, remittances have gained in importance relative to other flows. Indeed, Figures 1 and 2 show that remittances exceed foreign direct investment for many countries.

[INSERT FIGURES 1 AND 2]

Central banks in recipient countries struggle with how best to deal with these flows while researchers try to understand their effects in general. The critical questions involved turn on whether these flows are inflationary, pro- or counter-cyclical, and whether or not they generate relative price changes, causing a reallocation of domestic resources.

The recent debate about the effects of remittances mostly focuses on the real terms of international trade. Many papers such as Amuedo-Dorantes and Pozo (2004), Bourdet and Falck (2006) and Lopez, Molina, and Bussolo (2007) reach the same conclusion: that remittances have an inflationary effect and lead to a real exchange rate (RER) appreciation (a.k.a., “the Dutch disease”). Others, such as Rajan and Subramanian (2005) focus on foreign aid and growth and argue that regimes should only matter in the short run (i.e., for transition paths). Hence, they agree with the previous studies and report that, in the long run, real exchange rate appreciates for both regimes.

The literature offers a consensus regarding the impact of remittances on the exchange rate and inflation, yet all the studies previously cited assume in their analysis that the countries follow an unchanged exchange rate regime. By reporting the regime changes for the countries of interest, Table 1 shows that such an assumption is rather strong: each one has observed at least one change in regime for the periods considered. Caceres and Saca (2006) is the only study that explicitly controls for changes in the exchange rate regime when studying the impact of remittances. They focus on El Salvador’s economy while the country remains in a fixed regime and their findings confirm the inflationary effect of remittances. Although it is common for studies to assume a flexible regime in discussing theory and intuition, none of the empirical work has focused solely

on flexible regime. Ignoring the exchange rate regime and its potential changes may very well lead to spurious results.

[INSERT TABLE 1]

Other works, such as Acosta, Lartey, and Mandelman (2007), and Jansen, Naufal and Vacaflares (2007) use dynamic stochastic general equilibrium analysis to investigate the effect of a change in remittances on an economy. Again, they assume no change in the exchange rate regime. Hence, the calibration of their model may be cause for concern as it focuses on countries that, as shown in Table 2, display changes in regimes for the periods considered. Similarly, Chami, Cosimano, and Gapen (2006) investigate the optimal monetary and fiscal policy response to remittance inflows under a flexible regime. However, they calibrate to US data since the Korean War (i.e., 1955 – 2005) which includes both a fixed and floating regime. Hence, it is not clear if their predictions would be robust to a calibration solely based on the regime initially assumed when deriving the model.

[INSERT TABLE 2]

The present paper explicitly includes the exchange rate regime when analyzing the impact of remittances. It differs from Lartey, Mandelman, and Acosta (2008) in that it focuses on the monetary nature of remittance inflows.¹

The theoretical section derives, under different regimes, clear predictions regarding the effects of remittances on inflation and nominal money supply. It shows that under a fixed exchange rate regime, the remittances temporarily increase the rate of inflation and the nominal money supply. In contrast, under a flexible regime, the remittances temporarily decrease the rate of inflation but do not have any impact on the nominal money supply. Note that while the first

¹ Lartey, Mandelman, and Acosta (2008) focus solely on understanding the real exchange rate appreciation that often results from remittance inflows. In doing this, they consider the role of exchange rate regimes in affecting the path of the real exchange rate. They focus on the actual production of traded and non-traded goods in the economy and employ annual disaggregated (by sector) production data.

results are consistent with Caceres and Saca (2006), the latter results are at odds with most of the literature's findings.

The empirical section investigates whether there is any evidence of the theoretical predictions using yearly and quarterly data for seven Latin American countries. To the best of our knowledge, this is the first study using quarterly data in a panel for remittances. The impulse response functions (IRFs) derived from the panel vector autoregressive analysis support the predictions. They are robust to the estimation of different models as long as remittances are treated as one of the most exogenous variables. Additionally, there are no qualitative changes in the IRFs when the models allow remittances to respond to RER changes.

The paper is organized as follows. Section 2 describes the theoretical model and its predictions. Section 3 focuses on the empirical analysis. Finally, Section 4 concludes.

II. A Monetary Model for Remittances

The model imagines a representative individual that maximizes utility based on consumption of traded and non-traded goods as well as money services. The utility function is assumed separable in all of its components and over time.

$$U(c_t^T, c_t^N, m_t) = \int_0^\infty [\gamma \log(c_t^T) + (1-\gamma) \log(c_t^N) + \alpha \log(m_t)] e^{-\rho t} dt \quad (1)$$

where c_t^T , c_t^N , and $m_t \left(\equiv \frac{M_t}{E_t} \right)$ denote consumption of the traded good and the non-traded good, and real money balances in terms of the traded good, respectively.

Individuals can hold internationally traded assets yielding the constant world interest rate, r , earn income from the sale of traded and non-traded goods, receive/give transfers to the government and receive exogenous foreign-currency remittances from abroad². This is expressed in the following flow budget constraint

² We assume exogenous remittance flows for a number of reasons. First, the literature cannot agree on how they are endogenous with respect to the domestic economy. Thus, it is not clear how to model

$$\dot{a}_t = ra_t + y_t^T + \frac{y_t^N}{e_t} + \tau_t - c_t^T - \frac{c_t^N}{e_t} - i_t m_t + f_t \quad (2)$$

where y_t^T represents the traded good, y_t^N , the non-traded good, $e_t \left(\equiv E/P_H \right)$, the real exchange rate, a_t , net asset holdings, τ_t , government transfers and, f_t , the value of remittances. The law of one price holds for tradable goods and the foreign price for the traded good is equal to one.

Production in this economy uses a single input, labor³. Full employment is assumed throughout so that total employment is the sum of the levels in each sector. Total employment is set to unity and l_t represents employment in the traded good sector, leaving $1-l_t$ in the non-traded sector. The production functions in each sector are:

$$y_t^T = A_t l_t^\alpha \quad 0 < \alpha \leq 1 \quad (3.a)$$

and

$$y_t^N = B_t (1-l_t)^\beta \quad 0 < \beta \leq 1 \quad (3.b)$$

where A_t and B_t represent technology parameters and the production functions are concave.

Individuals maximize (1) subject to (2), (3.a), and (3.b). Doing so yields the following optimality conditions.

$$\frac{\gamma}{c_t^T} = \lambda \quad (4)$$

$$\frac{1-\gamma}{c_t^N} = \frac{\lambda}{e_t} \quad (5)$$

endogenous remittances. Modeling remittances as depending positively or negatively on either domestic output or the real exchange rate would reflect a bias that is not founded on any empirical or theoretical grounds. This is similar to modeling a stochastic variable as being uniformly distributed when one has no reliable information on its true distribution. Second, as shown in Section 5, the exogeneity assumption does not drive our empirical results. Finally, we are interested on the nominal effects of an increase in remittances and the degree to which exchange rate regimes matter in determining those effects. To that end, why remittances increase is much less important than the increase itself.

³ Including labor this way was inspired by Chapter 4 of Carlos A Végh's manuscript under preparation for his forthcoming book, current version (2007).

$$\frac{\alpha}{m_t} = \lambda i_t \quad (6)$$

$$\alpha A_t l_t^{\alpha-1} = \frac{\beta B_t (1-l_t)^{\beta-1}}{e_t} \quad (7)$$

Equations (4) and (5) are the typical consumption equations for optimization. Expression (6) is the optimality condition for real money balances showing that money must vary inversely with the nominal interest rate and the marginal utility of consumption. Equation (7) states that the marginal productivity of labor must be equal across the two sectors of the economy, a result that follows from assuming perfect labor mobility within the country.

Combining (4) and (5) yields an expression for the real exchange rate that must hold at all points in time.

$$e_t = \frac{c_t^N}{c_t^T} \left(\frac{\gamma}{1-\gamma} \right) \quad (8)$$

For later reference, combining (4) and (6) yields an expression for real money demand in terms of the traded good,

$$m_t = \frac{\alpha}{\gamma} \frac{c_t^T}{i_t} . \quad (9.a)$$

Likewise, (5) and (6) yield real money demand in terms of the non-traded good

$$n_t = \frac{\alpha}{1-\gamma} \frac{c_t^N}{i_t} \quad (9.b)$$

where $n \left(\equiv M/P_H \right)$.

i. Equilibrium Conditions

Interest parity requires

$$i_t = i_t^* + \varepsilon_t \quad (10)$$

where i represents the domestic nominal interest rate, i^* the foreign (world) interest rate and, ε , the depreciation rate of domestic currency.

Market clearing in the non-traded goods market implies

$$y_t^N = c_t^N \quad \text{for all } t. \quad (11)$$

In a perfect foresight equilibrium, traded and non-traded good consumption are both constant. That traded consumption is constant follows from (4). To show that home good consumption is constant requires the real exchange rate also be constant in equilibrium. We posit this here and include a proof in the Mathematical Appendix. Thus, in equilibrium, $e_t = \bar{e}$, $y_t^N = \bar{y}$, and $c_t^N = \bar{c}^N$.

Government revenue from money creation is given back to individuals via government transfer, τ , and this leads to the economy's overall resource constraint:

$$\dot{k}_t = rk_t + y_t^T + f_t - c_t^T \quad (12)$$

where k is the sum of asset holdings of individuals, a , plus official asset holdings (reserves) of the government (central bank), h , therefore $k \equiv a + h$.

Rearranging and integrating (12) forward yields an expression for the traded good consumption in equilibrium.

$$\bar{c}^T = rk_0 + \bar{y}^T + \bar{f}, \quad (13)$$

which says traded good consumption depends on the flow of returns from the initial asset holdings, the constant flow of remittances and traded good production. It is known to be constant (piecewise linear) by (4).

Combining (13) and (11) with (8) yields an expression for the equilibrium real exchange rate.

$$\bar{e} = \frac{y^N}{rk_0 + y^T + f} \cdot \frac{\gamma}{1 - \gamma} \quad (14)$$

where y^N and y^T are given by (3.a) and (3.b).

ii. Monetary Regimes and Economic Dynamics

To generate dynamics in this model, we assume that non-traded good prices adjust according to a Calvo-type pricing mechanism.

$$\dot{\pi}_t = -\theta(c_t^N - \bar{y}^N) \quad \theta > 0 \quad (18)$$

where \bar{y}^N is the steady state level of non-traded good production and θ is a constant parameter. Under this formulation the non-traded good price level is pre-determined at every point in time, but the rate of change of the non-traded good price level – i.e., “the inflation rate” – is not. In the short-run, output is assumed to be demand determined so that non-traded goods market equilibrium as described by (11) is maintained at all times.

Fixed Exchange Rate Regime (FIX)

Under a FIX the initial level of the nominal exchange rate, \bar{E}_0 , and its rate of change, $\bar{\varepsilon}$, are set by the central bank. The central bank maintains this regime by adjusting international reserve levels (and hence the nominal money supply) endogenously. By interest parity, constant currency depreciation implies that the nominal interest rate is constant in this regime, $\bar{i} = i^* + \bar{\varepsilon}$. By (9.a), in steady state, $\mu = \bar{\varepsilon}$ where μ is the rate of nominal money supply growth.

The economy's behavior is governed by the following two differential equations.

$$\dot{\pi}_t = \theta \left(\bar{y}^N(\bar{l}) - \frac{1-\gamma}{\gamma} \cdot e_t \bar{c}^T \right) \quad (19)$$

$$\dot{e} = e_t(\bar{\varepsilon} - \pi_t) \quad (20)$$

where $\bar{y}^N(\bar{l}) = B(1-\bar{l})^\beta$. Thus, changes in the steady state employment allocation change the steady state level of non-traded good production. (19) governs the control and (20) the state variable in this economy.

Result 1: Under a fixed exchange rate regime, an increase in remittances generates an increase in inflation. For a proof see the Mathematical Appendix.

Result 2: Under a fixed exchange rate regime, an increase in remittances generates an increase in the nominal money supply. For a proof see the Mathematical Appendix.

[INSERT FIGURE 3]

Figure 3 is the phase diagrammatic representation of the model under a FIX, the dynamics of which are described by equations (19) and (20). In Figure 3, the economy's initial steady state is at point A. The initial impact of increased remittance flows is an increase in real money demand. The central bank responds by increasing the nominal money supply to offset the increase in money demand, leaving the nominal interest rate and exchange rate unchanged as required by the FIX regime, leading to Result 2. Upon impact of the shock, inflation jumps upward to point B, leaving the real exchange rate unchanged. This generates the home good price dynamics necessary to reach the new steady state. As the economy adjusts to the new level of inflows, the real exchange rate and inflation fall continuously which leads to Result 1 throughout transition. In the new steady state, point C, inflation returns to its initial level and the real exchange rate is at a lower level.

Flexible Exchange Rate Regime (FLEX)

Under a FLEX the initial level, \bar{M}_0 , and the rate of growth of the nominal money supply, $\bar{\mu}$, are set by the central bank. The central bank maintains the regime by allowing the nominal exchange rate to adjust endogenously. By $\dot{m} = m(\bar{\mu} - \varepsilon_t)$ and $\dot{m} = 0$ it follows that $\bar{\mu} = \varepsilon$ in steady state. Likewise, constant currency depreciation implies by interest parity that the nominal interest rate is constant, $\bar{i} = i^* + \bar{\varepsilon}$, in steady state.

The system's dynamics are captured in terms of real money balances in terms of the non-traded good, $n(\equiv M / P^N)$, and the non-traded good inflation rate, π . Under a FLEX, n is a

predetermined variable since M is exogenous and constant and P^N is predetermined. π remains a control variable. Differentiating the definition of real money balances with respect to time yields

$$\dot{n}_t = n_t (\bar{\mu} - \pi_t). \quad (21)$$

Using (8) and (9.a), substitute into (18) for c^N and rearrange to obtain

$$\dot{\pi}_t = \theta \left(\bar{y}^N(\bar{l}) - \frac{1-\gamma}{\alpha} i_t n_t \right) \quad (22)$$

where, again, $\bar{y}^N(\bar{l}) = B(1-\bar{l})^\beta$.

Result 3: Under a flexible exchange rate regime, an increase in remittances generates a decrease in inflation. For a proof see the Mathematical Appendix.

Result 4: Under a flexible exchange rate regime, an increase in remittances implies no change in the nominal money supply, by assumption⁴.

[INSERT FIGURE 4]

Figure 4 is the phase diagrammatic representation of the model under a FLEX, the dynamics of which are described by equations (21) and (22). In Figure 4, the economy's initial steady state is at point A. The initial impact of the increased remittance flow is an increase in real money demanded. The central bank does not respond under a FLEX, by assumption, which leads to Result 4. Upon impact, inflation jumps downward to point B, leaving real money balances, n , unchanged. This generates the home good price dynamics necessary to reach the new steady state and leads to Result 3. Since the rate of nominal money stock growth is constant, but the rate of non-traded price inflation has slowed, real money balances rise continuously throughout the transition. In the new steady state, point C, inflation returns to its initial level and real money balances are higher.

III. Empirical Analysis

⁴ No formal proof here is needed since Result 4 holds by our assumptions of the flexible exchange rate regime. That is, we have assumed that the central bank holds the stock of nominal money constant and allows the nominal exchange rate to adjust.

i. Testable Predictions

The model predicts that the exchange rate regime matters, most clearly for the inflation and money supply responses to an increase in remittances. Under a FIX, inflation rises, leading to the increase in money supply that offsets the increase in money demand. Under a FLEX, inflation falls while the money supply remains unchanged. Finally, the model suggests that, if the remittances are purely exogenous, the real exchange rate's transition path differs according to the regime. The real exchange rate should fall with an initial response more pronounced under a FLEX than a FIX. The difference is more subtle than for inflation and the money supply.

ii. Data Description

Our model suggests that the transition paths differ across regimes; hence the frequency of the data may matter. As a result, we consider annual and quarterly data for the CPI, nominal money supply (M2), real GDP, RER and remittances.

The annual data is collected from the World Development Indicators of the World Bank. Quarterly data on CPIs, nominal money supplies, and the RER are from the International Monetary Fund's International Financial Statistics. Real GDP and remittances are from the central banks of each country. The exchange rate classifications are based on Reinhart and Rogoff (2004) and Levy-Yeyati and Sturzenegger (2005) as well as IMF (2003.a, 2003.b, 2004.a, 2004.b, 2005.a, 2005.b, and 2006)⁵. The period considered is 1980:1 to 2006:4.

To our knowledge, this is the first study that also uses quarterly data in a panel for remittances. Selecting the countries with the most data and that are geographically close, the analysis focuses on seven Latin American countries: Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador and Mexico.

The original data is transformed into logarithms. The RER is constructed according to the theoretical definition as the nominal exchange rate (national currency per U.S. dollar) multiplied

⁵ Our final regime classification data is available upon request.

by international prices (proxy by U.S. prices) and divided by domestic prices. The nominal exchange rate is the market exchange rate at the end of the period.

A preliminary investigation of the variables demonstrates that they are non-stationary, and not co-integrated.⁶ Hence, our analysis focuses on the growth rates of inflation, real GDP, remittances, nominal money supply and on the changes in the RER. The quarterly percentage changes reported are annualized percentage changes.

iii. Methodology

To account for the variable endogeneity and benefit from the panel setting of the data, the empirical behavior of the variables is modeled using the Panel Vector Autoregressive approach.

The initial econometric model takes the following reduced form:

$$Y_{i,t} = \Gamma(L)Y_{i,t} + u_{i,t} \quad (23)$$

where $Y_{i,t}$ is the 5 x 1 dependent and endogenous vector of variables with $Y_{it} = [\Delta \ln(CPI_{i,t}), \Delta \ln(GDP_{i,t}), \Delta \ln(RER_{i,t}), \Delta \ln(Money_{i,t}), \Delta \ln(remittances_{i,t})]'$. $\Gamma(L)$ is a matrix polynomial in the lag operator (with $\Gamma(L) = \Gamma_1 L + \Gamma_2 L^2 + \dots + \Gamma_s L^s$). $u_{i,t}$ is the model error.

Since the main argument of this paper is the impact of the different regimes – FIX and FLEX – on each variable, we include dummy variables to account for the exchange rate regime (D_{flex} for flexible and D_{fix} for fixed).^{7,8} The exchange rate regimes are assumed to be exogenous. The econometric model becomes:

$$Y_{i,t} = \Gamma_{flex}(L)Y_{i,t} \cdot D_{flex_{i,t}} + \Gamma_{fix}(L)Y_{i,t} \cdot D_{fix_{i,t}} + u_{i,t} \quad (24)$$

We then derive the impulse response functions (IRFs) from Equations (23) and (24), relying on the Cholesky decomposition to orthogonalize the residuals. To do so, the variables must be ordered such that variables placed higher in the ordering have a contemporaneous impact

⁶ The results are available upon request.

⁷ The fixed regime dummy accounts for fixed, pegged and dirty pegged regimes while the flexible regime dummy corresponds to the purely floating regime.

⁸ In order to avoid any bias due to changes in regime, a regime change is accounted for only if it lasts a least 3 periods.

on all variables lower in the ordering. Hence, the first variable should be the most exogenous. A careful ordering of the variables allows identifying the response of inflation and money supply to a positive shock on remittances.

The theoretical model considers remittances as the most independent of the internal conditions of a country while they should have a large effect on the other variables. Although this assumption can be questioned based on the Granger Causality Test results presented in Table 3, where it can be seen that the nominal money supply, among others, granger causes remittances. Other studies, such as The World Bank (2006), have shown that remittances do respond to external factors that are independent of the country's internal conditions and, therefore, not considered in our model. These factors include, for example, a reduction in transaction costs in the country where migrants live, tightened security in the sending country which encourages migrants, especially those that are undocumented, to remit more, and economic conditions in the country where the migrant works. Given that the empirical exercise here is to test for differences between the effects that remittances have on the economy under a FIX versus a FLEX, we include remittances as the first variable in our ordering, while the ordering of the remaining variables differs depending on the exchange rate regime considered. Following our initial analysis, and based on the arguments and results in Amuedo-Dorantes and Pozo (2004), we consider an alternative ordering where remittances respond to changes in the RER as a check on our initial results.

[INSERT TABLE 3]

Under a FIX, the central bank must intervene to keep the nominal exchange rate stable. Hence, a change in remittances leads to a change real money demand, proxied here by GDP, and in the nominal money supply, then, in inflation and, finally, in the RER. The resulting orderings are thus:

$$\text{Model1: } \Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$$

$$\text{Model2: } \Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$$

Under a FLEX, the central bank does not intervene. Hence, a change in remittances leads to a change in real money demand (i.e., GDP) and in RER then in inflation and, finally, in the nominal money supply. The resulting orderings are:

Model 3: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{RER}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{Money}_{i,t})$

Model 4: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{RER}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{Money}_{i,t})$

iv. Estimation and Empirical Results

Since the time dimension ($t = 26$ and 104) of the panel is larger than the cross-sectional dimensions ($N = 7$), we estimate the system of equations using seemingly unrelated regression (SUR). Yet, the consistency of the estimator relies on the absence of fixed effects and serial correlation in the error terms. The lag length of each panel is selected so there is no serial correlation remaining in the residuals. The SUR estimation and the generalized least square dummy variable (LSDV) estimation generate similar results allowing us to conclude that there are no fixed effects in the data.⁹

Both equations (23) and (24) are estimated for each data set, at quarterly and annual frequencies. The resulting IRFs show the impact of a change in remittances on the variables whether the regimes are combined or dissociated, respectively. Table 4.a investigates whether the IRF are statistically different from one regime to the other. The IRFs derived from the orderings listed for Model 1 through Model 4, are summarized in Table 4.b for inflation and the nominal money growth rate. Figures 3 to 8 illustrate the responses of inflation, money supply, GDP and RER as well as their 95% confidence intervals.

[INSERT TABLE 4.a. AND 4.b]

Annual Results, Figure 5, 6 and 7

Table 4.a shows that the responses of both inflation and money supply differ depending on the exchange rate regime, hence analysis of the annual data focuses on these two variables.

⁹ Bun (2001) discusses in detail the case when T is larger than N .

Figure 5 shows that, under a FIX, an increase in remittance inflows has a positive impact on both inflation and the money supply. More specifically, the impact persists for several periods after the shock with an impact remaining positive for the money supply while oscillating between (statistically) positive to (statistically) negative for the inflation.

Figure 6 shows that, under a FLEX, the impact of an increase in remittance inflows is negative on inflation and positive on the money supply.

A comparison between both figures highlights key differences in the behavior of the variables across regimes: the change in the money supply is much smaller under a FLEX than a FIX since the 95% confidence interval is consistently lower. The change in inflation is of opposite sign with a stronger and more persistent impact under a FIX than a FLEX. Finally, compared to Figure 7, where the results correspond to the case where no controls for the regimes are included, demonstrates that if the different regimes are not modeled, the dynamics are similar to a FIX but with noticeably lesser effects. This result suggests support for the argument we make regarding the likely biased results of previous studies due to the lack of controls for exchange rate regimes.

[INSERT FIGURES 5, 6, AND 7]

Quarterly Results, Figure 8, 9 and 10

Table 4.a shows that the responses of GDP, inflation, money supply and RER differ depending on the exchange rate regime. Our model does not focus on GDP. Hence the analysis of the quarterly data focuses on inflation, money supply and RER.

Figure 8 shows that, under a FIX, an increase in remittance inflows has a contemporaneous and positive impact on inflation that lasts one period. The response of the money supply is also positive but lagged and remains significant for 2 periods. The real exchange rate responds positively on impact.

Figure 9 shows that, under a FLEX, the impact of an increase in remittance inflows is negative on inflation, contemporaneous and positive for GDP and RER but positive and lagged

for the money supply. Finally, comparing both figures with Figure 10, where controls for the regimes are ignored, shows that ignoring the exchange rate regimes may lead to spurious results, further suggesting the possibility of biased results in previous studies.

[INSERT FIGURES 8, 9, AND 10]

The inflation and money supply responses to increased remittances agree in direction but not in amplitude across the annual and quarterly results. The increase in frequency strengthens the responses from non-statistically significant to a statistically significant positive response of the real exchange rate that varies in amplitude across the regimes.

Note that the different responses of GDP to remittance flows are relevant for understanding whether remittances are sent for reasons of benevolence or as investment. If they are benevolent one expects them to be counter-cyclical. Pro-cyclicality is then interpreted as implying investment motives. Under a FIX, changes in GDP are slightly negative or not statistically different from zero, depending on the data frequency. Under a FLEX, they are positive or not statistically different from zero, depending on the data frequency. So no clear conclusion can be derived from our data.

v. Theory versus Empirical Evidence and Further Discussion

Both the annual and quarterly outcomes are consistent with our model's prediction for inflation and the money supply:

- Under a FIX, we observe a positive change in inflation followed by convergence to the steady state. Similarly, the money supply displays a positive change before converging.
- Under a FLEX, we observe a negative change in inflation followed by convergence to the steady state. The money supply displays very small to no change.

The results with respect to the real exchange rate are quite different from the theoretical prediction in direction, yet they agree in magnitude, reporting a stronger response under a FLEX. The lack of exogeneity of remittances in the data sets is a potential explanation. Studies such as Amuedo-Dorantes and Pozo (2004) suggest that remittances may in part react to RER

movements. This reverse causality may also explain part of our findings. To investigate this possibility, we generate a new set of IRFs using the following ordering: RER as the most exogenous variable followed by remittances with all other variables in the same order as before.

Under a FIX:

Model 1.a : $\Delta \ln(RER_{i,t}), \Delta \ln(remittances_{i,t}), \Delta \ln(GDP_{i,t}), \Delta \ln(Money_{i,t}), \Delta \ln(Inflation_{i,t})$

Model 2.a : $\Delta \ln(RER_{i,t}), \Delta \ln(remittances_{i,t}), \Delta \ln(Money_{i,t}), \Delta \ln(GDP_{i,t}), \Delta \ln(Inflation_{i,t})$

Under a FLEX:

Model 3.a : $\Delta \ln(RER_{i,t}), \Delta \ln(remittances_{i,t}), \Delta \ln(GDP_{i,t}), \Delta \ln(Inflation_{i,t}), \Delta \ln(Money_{i,t})$

Table 5.a confirms that, even when considering the new orderings, the IRFs statistically differ depending on the exchange rate regime. The dynamic responses of inflation, money supply and RER are summarized in Table 5.b.¹⁰

[INSERT TABLES 5.a. AND 5.b]

The empirical results previously reported on inflation and money supply are robust to the new ordering for both annual and quarterly data, but weaker in some cases. However, the RER response changes noticeably and becomes either negative and lagged for the annual data under FLEX, or insignificant for all the other cases. While this suggests that reverse causality may exist between remittances and the RER, it also implies that assuming exogenous remittances is not driving our results for inflation and the money supply¹¹.

Our work argues theoretically and empirically that exchange regimes are an important component of understanding the effect of remittance inflows on small open economies. It is clear that the responses of both inflation and the nominal money supply differ across regimes in accordance with theory.

¹⁰ The corresponding IRFs and their 95% confidence interval are available upon request from the authors.

¹¹ Although not the focus of this paper, as a robustness check, we also included GDP first in the ordering since it is likely in practice that remittances respond to changes in domestic output. This ordering had no substantive changes on our results and is not included. It is available upon request from the authors.

Most studies use annual data and do not control for exchange rate regimes. Figure 7 suggests that, at this level of aggregation and frequency, the inflationary effects from fixed regimes tend to dominate in the data. This helps explain why works such as Caceres and Saca (2006), focusing on countries with a FIX, often emphasize the inflationary aspect of remittances, and studies such as Lopez, Molina and Bussolo (2007) focus attention on monetary policies to combat the inflationary effects of remittances. Our results thus hint at the likely direction of the bias in the estimates in the literature.

IV. Conclusions

Remittance flows to emerging markets have been increasing in recent years. For many countries, they exceed official flows, including foreign direct investment. It is thus no surprise that they are attracting attention from researchers and policy makers alike. The literature on remittances has focused on real effects and trade-theoretic models while deemphasizing the monetary nature of the transfers. Once the monetary nature is reemphasized and focus is placed on strictly monetary variables like inflation and the nominal money supply, it is clear that monetary regimes should matter. Failure to account for regimes should thus lead to biased estimates.

Our work shows theoretically how exchange rate regimes matter and makes simple predictions. Under a fix regime, inflation rises leading to an increase in the money supply to offset the increase in money demand. Under a flexible regime, inflation falls while the money supply remains unchanged. Finally, the model suggests that, if the remittances are purely exogenous, the real exchange rate's transition path differs according to the exchange rate regime as well.

Empirically, we employ a panel vector autoregressive approach that controls for regime differences. We explore impulse response functions specific to each regime and at two different levels of frequency in the data: annual and quarterly. While most studies use annual data, to our knowledge, this is the first study to also use quarterly data for a panel with remittances. We find

the predictions for inflation and the money supply borne out in the data, but much less support for the real exchange rate predictions. We then investigate the potential for reverse causality between the real exchange rate and remittances. While we find some evidence of this, the main outcome is the robustness of our findings to the variable ordering regarding inflation and the nominal money supply.

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Table 1. Selected Empirical Studies and Exchange Rate Regimes

Amuedo-Dorantes and Pozo (2004)				Lopez, Molina, and Bussolo (2007)			
1979 - 1998	Number of Regimes	FIX (y/n)	FLEX (y/n)	1990-2003	Number of Regimes	FIX (y/n)	FLEX (y/n)
Argentina	3	yes	yes	Argentina	3	yes	yes
Belize	1	yes	no	Belize	1	yes	no
Bolivia	3	yes	yes	Bolivia	2	yes	no
Colombia	2	no	yes	Brazil	3	yes	yes
Dominican Republic	3	yes	yes	Chile	2	no	yes
Jamaica	3	yes	yes	Colombia	2	no	yes
Mexico	3	yes	yes	Costa Rica	3	yes	yes
Nicaragua	2	yes	no	Dominican Republic	2	no	yes
Peru	2	no	yes	Ecuador	3	yes	yes
Trinidad & Tobago	3	yes	yes	El Salvador	3	yes	yes
Bourdet and Falck (2006)				Guatemala	2	no	yes
1975 - 2005	Number of Regimes	FIX (y/n)	FLEX (y/n)	Haiti	2	yes	yes
Cape Verde	3	yes	yes	Honduras	3	yes	yes
Caceres and Saca (2006)				Jamaica	3	yes	yes
1995 - 2004	Number of Regimes	FIX (y/n)	FLEX (y/n)	Mexico	3	yes	yes
El Salvador	1	yes	no	Nicaragua	2	yes	no
Rajan and Subramanian (2005)				Panama	1	yes	no
1980s	Number of Regimes	FIX (y/n)	FLEX (y/n)	Paraguay	2	no	yes
Bangladesh	n.a.	n.a.	n.a.	Peru	2	no	yes
Bolivia	3	yes	yes	Venezuela	3	yes	yes
Botswana	1	yes	no	1990s			
Burundi	3	yes	yes	Bolivia	2	yes	no
Congo	1	yes	no	Cameroon	2	yes	no
Honduras	1	yes	no	Costa Rica	2	no	yes
Jamaica	3	yes	yes	Egypt	2	yes	no
Kenya	3	yes	yes	Ethiopia	3	yes	yes
Madagascar	2	yes	no	Indonesia	2	yes	no
Malawi	2	yes	yes	Jordan	3	yes	yes
Papua New Guinea	1	yes	no	Kenya	3	yes	yes
Senegal	1	yes	no	Mauritius	3	yes	yes
Sri Lanka	3	yes	yes	Morocco	n.a.	n.a.	n.a.
Swaziland	1	yes	no	Panama	1	yes	no
Tanzania	2	no	yes	Philippines	3	yes	yes
Zambia	3	yes	yes	Senegal	2	yes	no
				Sri Lanka	2	no	yes
				Tanzania	2	no	yes
				Tunisia	2	no	yes

Notes: Based on Levy-Yeyati and Sturzenegger (2005) three way classification (Fix, Flex, Intermediate). The only cases where the entire sample wasn't covered, the countries in question had three regimes during the subsample and therefore had three in the overall. For example, Levy-Yeyati and Sturzenegger (2005) only have data on Cape Verde for 1998 – 2002. Since Cape Verde had three regimes between 1998 and 2002, they must have had three regimes between 1975 and 2003 as well.

Table 2. Selected Theoretical Studies and Exchange Rate Regimes

Acosta , Lartey, and Mandelman (2007)			
1991Q1 - 2006 Q2	Number of Regimes	FIX (y/n)	FLEX (y/n)
El Salvador	3	yes	yes
Chami, Cosimano, and Gapen (2006)			
post-Korean War (1955 - 2005)	Number of Regimes	FIX (y/n)	FLEX (y/n)
USA	2	yes	yes
Jansen, Naufal, and Vacaflores (2007)			
1990 - 2004	Number of Regimes	FIX (y/n)	FLEX (y/n)
Bolivia	2	yes	no
Brazil	3	yes	yes
Colombia	2	no	yes
Ecuador	3	yes	yes
El Salvador	3	yes	yes
Guatemala	2	no	yes
Honduras	3	yes	yes
Mexico	3	yes	yes
Panama	1	yes	no
Peru	2	no	yes

Notes: Based on Levy-Yeyati and Sturzenegger (2005) three way classification (Fix, Flex, Intermediate).

Table 3. P-values for Granger causality tests

	Inflation does not Granger cause Remittances	Money does not Granger cause Remittances	GDP does not Granger cause Remittances
Annual data			
All	0.51	0.02	0.00
FIX	0.35	0.08	0.00
FLEX	0.39	0.05	0.11
Quarterly data			
All	0.00	0.03	0.17
FIX	0.72	0.07	0.32
FLEX	0.00	0.33	0.12

**Table 4.a. Impulse Response Functions:
Statistical difference between the two regimes (FIX-FLEX)**

Annual data						
T	GDP		Inflation		Money	
1	-1.038		9.692	***	4.730	***
2	-0.522		-1.833	**	2.760	***
3	-0.892		3.480	***	2.601	***
4	0.203		-2.865	***	3.757	***
5	0.292		1.068		2.683	***
6	0.640		0.486		2.962	***
7	0.588		-0.408		0.727	
8	-0.003		-2.047	**	-0.229	
9	-0.298		-0.077		0.092	
10	-0.282		0.338		0.100	

Quarterly data						
T	GDP		Inflation		Money	
1	2.635	***	4.455	***	0.443	1.703 **
2	1.839	**	-2.274	**	-1.427 *	0.810
3	2.067	**	-1.307	*	-1.058	0.416
4	1.370	*	-0.977		-0.518	0.550
5	1.340	*	-1.521	*	-0.148	1.003
6	0.680		-1.200		-0.331	0.556
7	0.507		-0.309		-0.156	0.959
8	0.347		-0.494		-0.095	0.575
9	0.245		-0.260		-0.137	0.199
10	0.163		-0.058		-0.092	0.159

***, **, and * stand for statistical evidence that the coefficients of the IRF from the different regimes are different at the 1%, 5% and 10% level.

Table 4.b. Impulse Response Functions summary

Theory	Inflation		Money	
	t=0	t>0	t=0	t>0
FIX	↑	Convergence toward the steady state	↑	Convergence toward the steady state
FLEX	↓		↔	
Annual data				
All	↑	Osc. decay ¹²	↔	↑, decay
FIX	↑	Osc. decay	↑	↑, decay
FLEX	↓	Decay	↑	decay
Quarterly data				
All	↔	↑, decay	↔	↑, decay
FIX	↑	decay	↔	↑, decay
FLEX	↓	Osc. decay	↔	↑, decay

↑ (↓) stands for an increase (a decrease) significant at a 5% level, and ↔ for no statistically significant changes

¹² Osc. stands for oscillating

**Table 5.a. Impulse Response Functions:
Statistical difference between the two regimes (FIX-FLEX)
Reverse Causality**

Annual data						
t	GDP		Inflation		Money	
1	-1.074		9.834	***	4.803	***
2	-0.716		-1.859	**	2.833	***
3	-1.041		3.631	***	2.644	***
4	0.200		-2.978	***	3.778	***
5	0.252		1.102		2.722	***
6	0.626		0.467		2.994	***
7	0.627		-0.410		0.717	
8	0.009		-2.126	**	-0.238	
9	-0.310		-0.085		0.072	
10	-0.281		0.324		0.092	

Quarterly data						
t	GDP		Inflation		Money	
1	3.263	***	2.881	***	1.167	NA
2	2.720	***	-1.139		-0.564	0.684
3	3.372	**	-0.862		-0.336	0.719
4	1.949	**	-2.570	***	-1.165	1.301
5	1.601	*	-1.695	**	-0.818	2.078
6	0.814		-1.973	**	-0.627	1.235
7	0.558		-0.984		-0.381	1.068
8	0.320		-0.546		-0.237	0.670
9	0.239		-0.359		-0.130	0.389
10	0.155		-0.203		-0.093	0.211

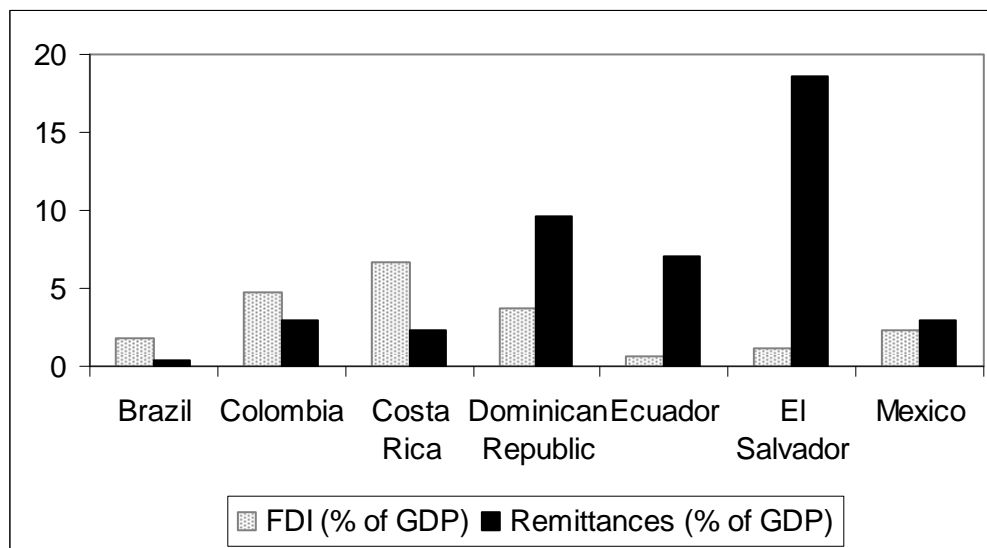
***, **, and * stand for statistical evidence that the coefficients of the IRF from the different regimes are different at the 1%, 5% and 10% level.

Table 5.b. Impulse Response Functions summary
Reverse Causality

	Inflation		Money		RER	
Theory	t=0	t>0	t=0	t>0	t=0	t>0
FIX	↑	Convergence toward the steady state	↑	Convergence toward the steady state	↓	Convergence toward the steady state
FLEX	↓		↔		↓	
Annual data						
All	↑	Osc. decay	↔	↑, decay	↔	↔
FIX	↑	Osc. decay	↑	↑, decay	↔	↔
FLEX	↓	Decay	↑	decay	↔	↓, decay
Quarterly data						
All	↔	↓, decay	↔	↑, decay	↔	↔
FIX	↑	Osc. decay	↔	↑, decay	↔	↔
FLEX	↔	↑, decay	↔	↔	↔	↔

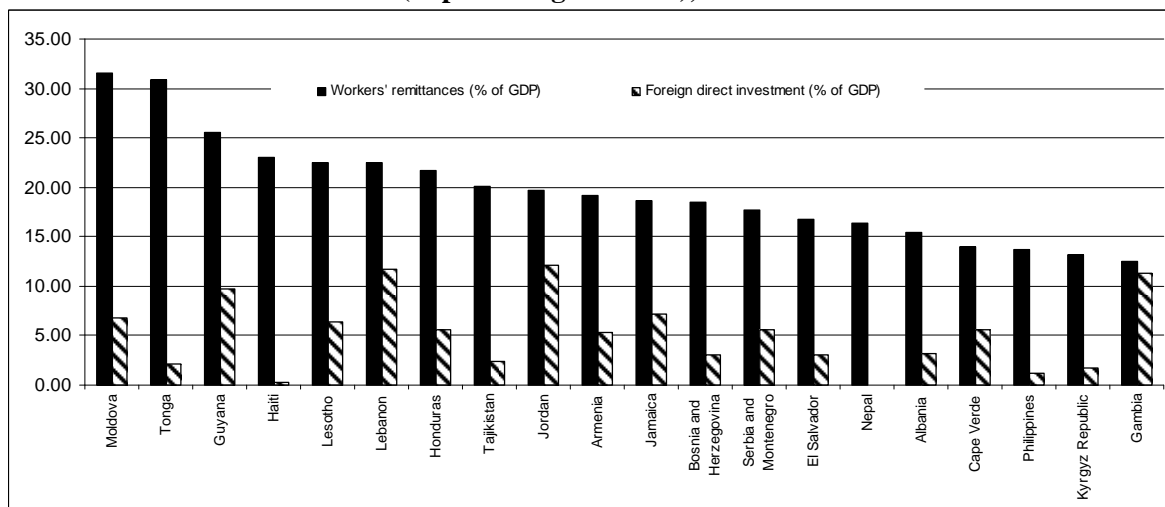
↑ (↓) stands for an increase (a decrease) significant at a 5% level, and ↔ for no statistically significant changes

**Figure 1. Remittances versus Foreign Direct Investment
(as percentage of GDP), 2007**



Source: World Development Indicators (2008).

**Figure 2. Top 20 Remittance Recipient Countries
(in percentage of GDP), 2005**



Source: World Bank (2007).

Figure 3. Shock Under FIX

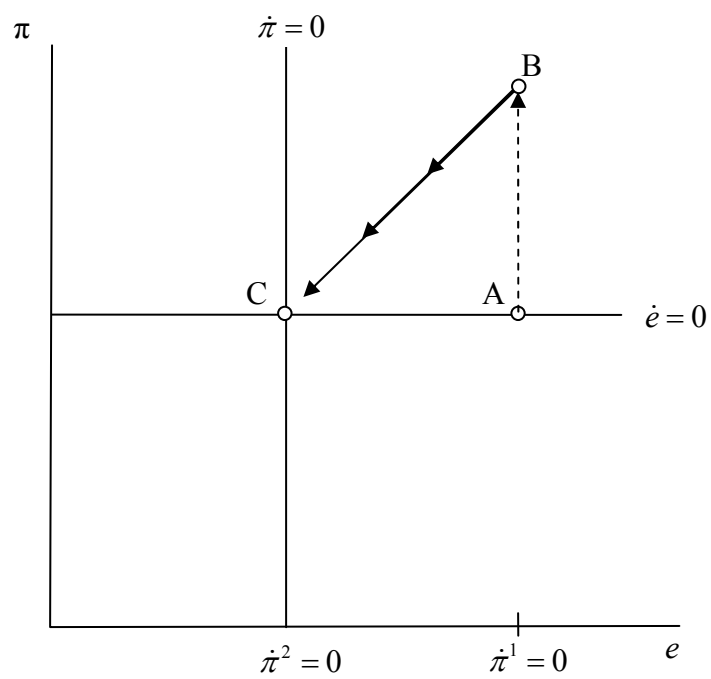


Figure 4. Shock Under FLEX

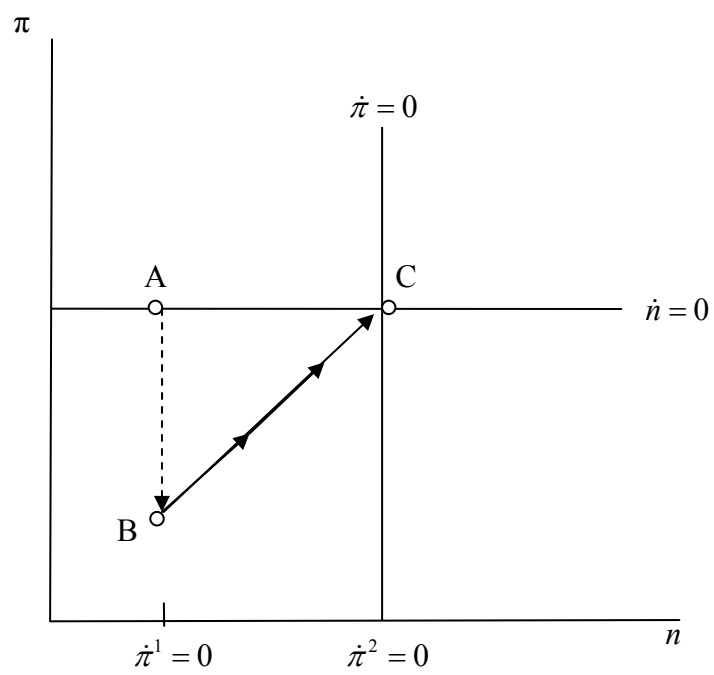


Figure 5. Annual FIX Impulse Responses

Model1: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$

Model2: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$

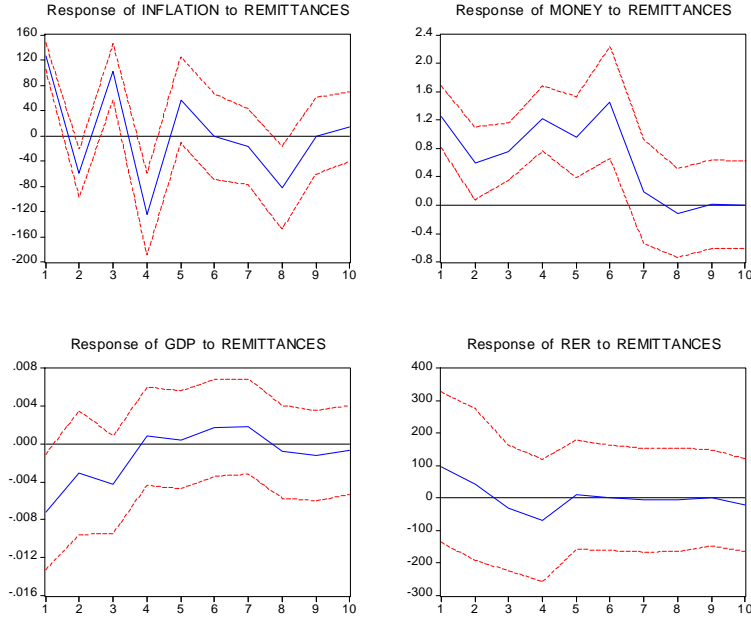


Figure 6. Annual FLEX Impulse Responses

Model1: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$

Model2: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$

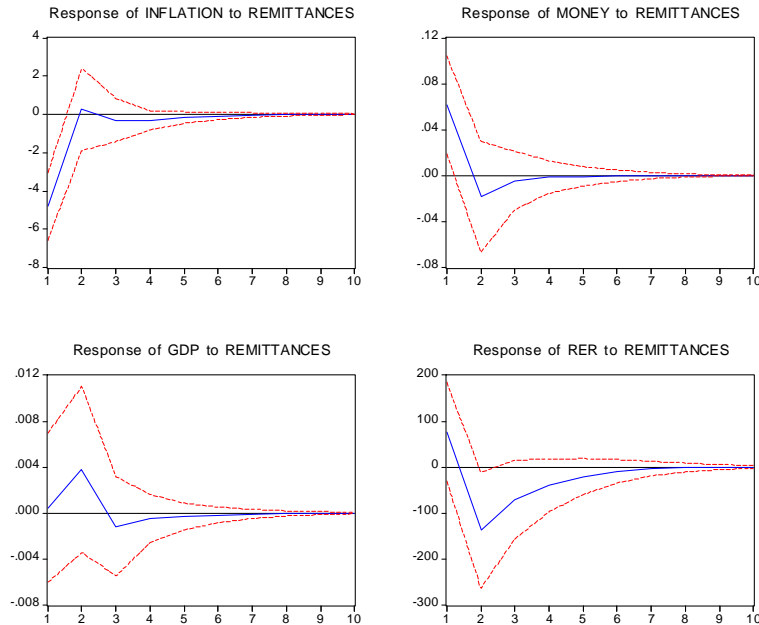


Figure 7. Annual Both Regimes Impulse Responses

Any model

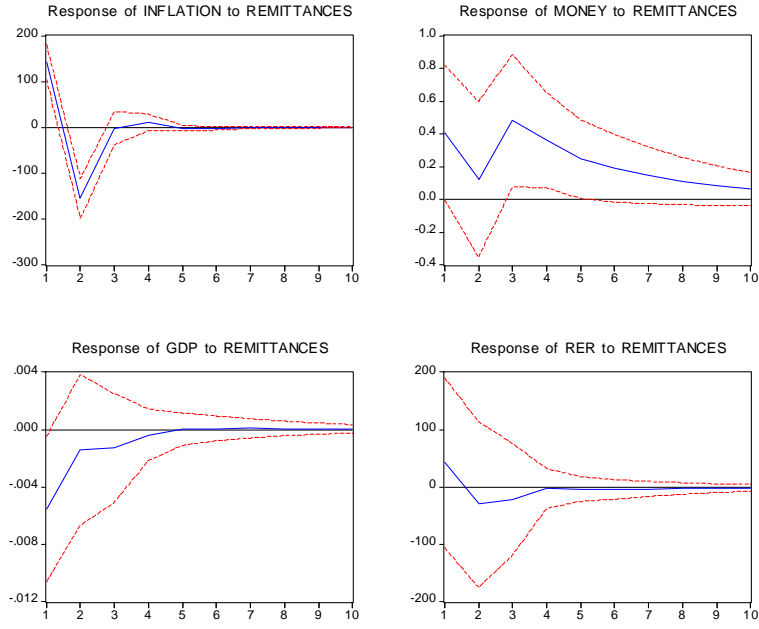


Figure 8. Quarterly FIX Impulse Responses

Model1: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$

Model2: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{Money}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{RER}_{i,t})$

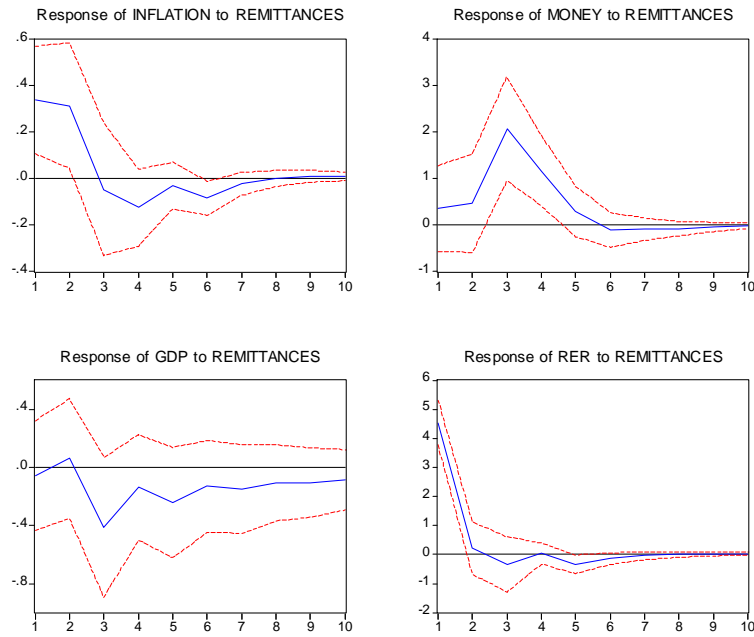


Figure 9. Quarterly FLEX Impulse Responses

Model 3: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{RER}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{Money}_{i,t})$

Model 4: $\Delta \ln(\text{remittances}_{i,t}), \Delta \ln(\text{GDP}_{i,t}), \Delta \ln(\text{RER}_{i,t}), \Delta \ln(\text{Inflation}_{i,t}), \Delta \ln(\text{Money}_{i,t})$

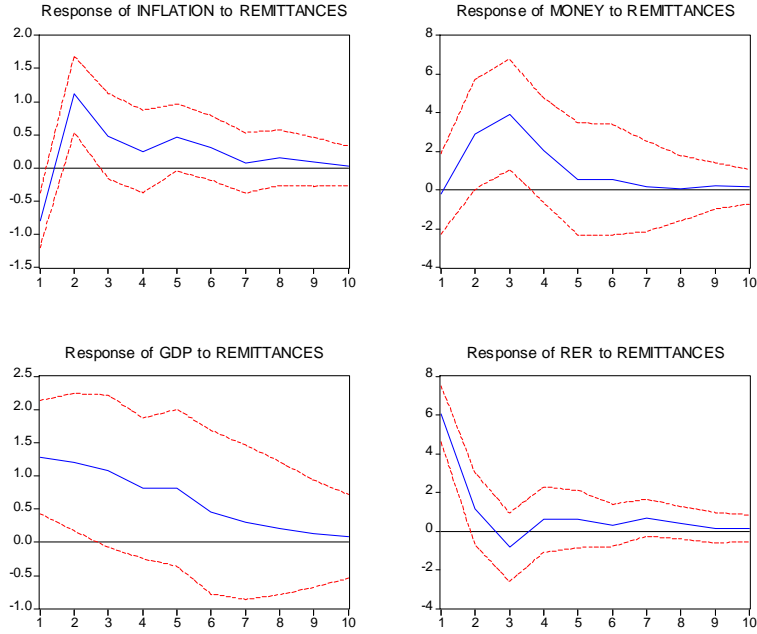
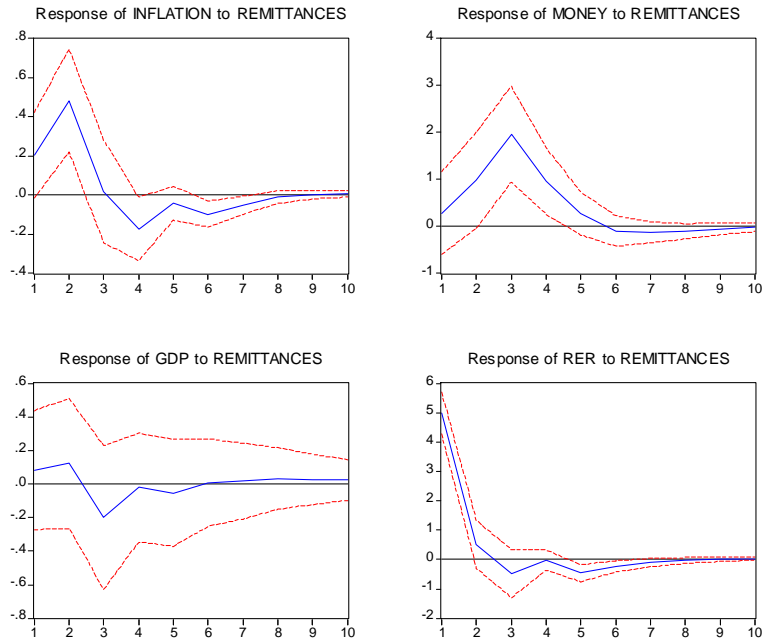


Figure 10. Quarterly Both Regimes Impulse Responses

Any model



Mathematical Appendix

Most of the proofs in this section rely on one or more of the following equations. We present them here to avoid clutter in the exposition below.

Differentiating (14) yields

$$(A.1.) \quad \frac{d\bar{e}}{df} = \frac{-y^N}{(rk_0 + y^T + f)^2} \cdot \frac{\gamma}{1-\gamma} < 0.$$

Implicitly differentiating (7) yields

$$(A.2.) \quad \frac{dl}{de} = -\frac{1}{\frac{\beta}{\alpha} \frac{B}{A} (\beta-1)(1-l)^{\beta-2} l^{1-\alpha} - \frac{\beta}{\alpha} \frac{B}{A} (1-\alpha)(1-l)^{\beta-2} l^{-\alpha}} > 0.$$

(A.1) and (A.2) together imply

$$(A.3.) \quad \frac{dl}{df} = \frac{dl}{de} \frac{de}{df} < 0.$$

Using (3.b) in equilibrium condition (11) and differentiating with respect to remittances,

$$(A.4.) \quad \frac{dc_t^N}{df} = -\beta B(1-l)^{\beta-1} \frac{dl}{df} > 0$$

Since c^N increases while the real exchange rate falls, by (15), c^T must also increase and by more than the increase in c^N . From (13) with (3.a) and using (15) to sign,

$$(A.5.) \quad \frac{d\bar{c}_t^T}{df} = \alpha A l^{\alpha-1} \frac{dl}{df} + 1 > 0.$$

Proof that Real Exchange Rate Is Constant in Equilibrium

Suppose instead that the real exchange rate increases. An increase in the real exchange rate generates an increase in labor in the traded sector, by (A.2). By (3.b), an increase in l leads to a contraction in non-traded good output which, by (11), leads to a fall in non-traded consumption. But, by (5), this leads to a contradiction since we can't have an increase in the real exchange rate and a fall in non-traded consumption. Similar logic holds for a decrease in the real exchange rate, proving the proposition that the only equilibrium is one where the real exchange rate is constant.

Result 1: Under a fixed exchange rate regime, an increase in remittances generates an increase in inflation.

Proof: Across steady states the increase in remittances leads to a lower real exchange rate, e , by (A.1), to higher traded and non-traded good consumption, \bar{c}^T and \bar{c}^N , by (A.4) and (A.5), and thus to higher non-traded good output, \bar{y}^N , by (11). On impact, traded good

consumption and the steady state level of non-traded good production in equation (19) both jump to their new, higher levels. Since the real exchange rate will be lower in the new steady state, it must be that traded good consumption changes by more than the steady state non-traded good output. Starting from steady state and given that the real exchange rate, e , is a predetermined, it follows that the right hand side of (19) turns negative upon impact of the shock to remittances. For this to hold and for the real exchange rate to reach its new, lower steady state level, the inflation rate must increase upon impact to generate the necessary dynamics according to (20). This is represented in the phase diagram in Figure 1 and proves Result 1.

Result 2: Under a fixed exchange rate regime, an increase in remittances generates an increase in the nominal money supply.

Proof: This result follows from the central bank maintaining a fixed nominal exchange rate. Rewriting (9.a) as $\frac{M_t}{E_t} = \frac{\alpha}{\gamma} \frac{c_t^T}{i_t}$. When remittances increase, traded good consumption jumps upward once upon impact by (A.5). By open economy interest parity (10), the nominal interest rate can only change if the foreign nominal interest rate or rate of nominal currency depreciation change. Neither have changed and thus the domestic nominal interest rate is constant as well. By the fixed regime, the nominal exchange rate is constant as well. Everything else in (9.a) is a constant parameter. Thus, the increase in traded good consumption on the right-hand side of (9.a) must be offset by an increase in the nominal stock of money on the left-hand side of (9.a) for this optimality condition to hold at all points in time. This proves Result 2.

Result 3: Under a flexible exchange rate regime, an increase in remittances generates a decrease in inflation.

Proof: Across steady states the increase in remittances leads to a lower real exchange rate by (A.1), to higher traded and non-traded good consumption, \bar{c}^T and \bar{c}^N , by (A.4) and (A.5), and thus to higher non-traded good output, \bar{y}^N , by (11). Real money balances in terms of the non-traded good, n , is predetermined and thus constant on impact. Likewise, i remains unchanged since under the FLEX, the nominal exchange rate jumps to its new level on impact to maintain equilibrium in the money market described by (9.a). The steady state level of non-traded good production is not constant, however, and jumps on impact to its new, higher level. The result is that, the right hand side of (22) turns positive upon impact. For this to hold and for the real exchange rate to reach its new, lower steady state level, the inflation rate must decrease upon impact to generate the necessary dynamics according to (22). This is represented in the phase diagram in Figure 2 and proves Result 3.