Munich Personal RePEc Archive

Remittances, Inflation and Exchange Rate Regimes in Small Open Economies

Ball, Christopher and Lopez, Claude and Reyes, Javier and Cruz-Zuniga, Martha

Quinnipiac University, University of Cincinnati, University of Arkansas

May 2010

Online at https://mpra.ub.uni-muenchen.de/22648/
MPRA Paper No. 22648, posted 11 May 2010 19:04 UTC

Remittances, Inflation and Exchange Rate Regimes in Small Open Economies

Christopher P. Ball (Quinnipiac University)
Claude Lopez (University of Cincinnati)
Javier Reyes (University of Arkansas)
Martha Cruz-Zuniga (Catholic University of America)

May 2010

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: 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 that the countries follow an unchanged exchange rate regime. Table 1 reports the regime changes for the countries of interest and 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 Vacaflores (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 include 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, increased remittance flows temporarily increase the rate of inflation and the nominal money supply. In contrast, under a flexible regime, increased remittance flows temporarily decrease the rate of inflation but do not have any impact on the nominal money supply. Note that, while the first results are consistent with Caceres and Saca (2006), the latter results are at odds with most of the literature's findings.

[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.

The empirical section investigates whether there is any evidence of the theoretical predictions using yearly and quarterly data for seven Latin American countries. The impulse response functions (IRFs) derived from the panel vector autoregressive analysis support the predictions. They are robust to the estimation of different models and show 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.

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

where c_t^T, c_t^N, and $m_t\left(\equiv M_t / E_t\right)$ denote consumption of the traded good and the non-traded good, and real money balances in terms of the traded good, respectively. *M* is the nominal stock of money and *E* is the nominal exchange rate. The law of one price holds for tradable goods and the foreign price for the traded good is equal to one so E is the price of the traded good.

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 abroad.[2] This is expressed in the following flow budget constraint

[2] We assume exogenous remittance flows for a number of reasons. First, there is no consensus in the literature on how they are endogenous with respect to the domestic economy. Thus, it is not clear how to model 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.

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

where y_t^T represents the traded good, y_t^N, the non-traded good, $e_t\left(\equiv E/P_N\right)$, the real exchange rate, a_t, net asset holdings, τ_t, government transfers and, f_t, the value of remittances. P_N is the price of the non-traded good.

Production in this economy uses a single input: labor.[3] 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:

$$y_t^T = A_t l_t^{\alpha} \qquad 0 < \alpha \leq 1 \tag{3.a}$$

and

$$y_t^N = B_t \left(1-l_t\right)^{\beta} \qquad 0 < \beta \leq 1 \tag{3.b}$$

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.

$$\frac{\gamma}{c_t^T} = \lambda \tag{4}$$

$$\frac{1-\gamma}{c_t^N} = \frac{\lambda}{e_t} \tag{5}$$

$$\frac{\alpha}{m_t} = \lambda i_t \tag{6}$$

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

[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).

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.

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

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

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

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

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

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

i. Equilibrium Conditions

Interest parity requires

$$i_t = i_t^* + \varepsilon_t \tag{10}$$

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

$$y_t^N = c_t^N \qquad for\ all\ t. \tag{11}$$

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, $e_t = \overline{e}$, $y_t^N = \overline{y}$, and $c_t^N = \overline{c}^N$.

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

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

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.

$$\overline{c}^T = rk_0 + \overline{y}^T + \overline{f}, \tag{13}$$

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.

$$\overline{e} = \frac{y^N}{rk_0 + y^T + f} \cdot \frac{\gamma}{1-\gamma} \tag{14}$$

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 (Calvo, 1983) pricing mechanism.

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

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.[4]

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.

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

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

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

---

[4] Note that this is actually Calvo's (1983) original formulation which was done in continuous time.

[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. Since increased remittances always lead to a decrease in the real exchange rate (i.e.,the "Dutch disease"), the final steady state must have a lower real exchange rate, $e_t\left(\equiv E/P_N\right)$. Under a FIX regime, the nominal exchange rate, *E*, is constant while an increase in home goods prices leads to a fall in *e* during the transition. More specifically, 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 and maintain equilibrium in the money market, leaving the nominal interest rate and exchange rate unchanged as required by the FIX regime, leading to Result 2. Upon impact, 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, of the non-traded good, $n\left(\equiv M / P^{N}\right)$, 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

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

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

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

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

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 assumption.[5]

[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. Since increased remittances always lead to a decrease in the real exchange rate (i.e.,the "Dutch disease"), the final steady state must have a lower real exchange rate, $e_t\left(\equiv E/P_N\right)$. Under a FLEX regime, the nominal exchange rate, E, jumps to its new, lower steady state value immediately. P_N, a state variable, is slower to adjust. The initial impact of the increased remittance flow is an increase in real money demanded. Under a FLEX, the central bank does not respond by changing the nominal stock of money which leads to Result 4. The drop in the nominal exchange rate clears the real money market in terms of the traded good. But

5 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.

this leaves the real money balances in terms of the non-traded good, n, unchanged and thus the n-money market out of equilibrium (relatively to steady state). To reach the new steady state equilibrium in this market, real money balances, $n\left(\equiv M/P_N\right)$, must increase during transition. Since the nominal stock of money, M, remains constant, the price of non-traded goods must decrease. From a real economy perspective, this comes about because the nominal exchange rate fell, lowering returns to producing the traded good and thus encouraging a reallocation of resources from traded and into non-traded good production. This is an increase in non-traded good production relative to non-traded good demand and thus leads to a decline in the price of non-traded goods. Graphically, upon impact, inflation jumps downward to point B. 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, real money balances, n, 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

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).[6] 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 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.[7] 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.

---

6 Our final regime classification data is available upon request.

7 The results are available upon request.

The initial econometric model takes the following reduced form:

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

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 $\Gamma(L) = \Gamma_1 L + \Gamma_2 L^2 + \ldots + \Gamma_s L^s$). $u_{i,t}$ 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).[8,9] The exchange rate regimes are assumed to be exogenous. The econometric model becomes:

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

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 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

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

[9] 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.

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 of 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:

$$Model1: \ \Delta\ln(remittances_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(Money_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(RER_{i,t})$$
$$Model2: \ \Delta\ln(remittances_{i,t}), \Delta\ln(Money_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(RER_{i,t})$$

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:

$$Model \ \ 3: \ \Delta\ln(remittances_{i,t}), \Delta\ln(RER_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(Money_{i,t})$$
$$Model \ \ 4: \ \Delta\ln(remittances_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(RER_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(Money_{i,t})$$

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).[10] 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.

Both equations (23) and (24) are estimated for each data set, at quarterly and annual frequencies. The resulting IRFs, reported in Figures 5 to 10 along with the corresponding 95% confidence intervals, show the impact of a change in remittances for the cases of combined and dissociated regimes, respectively.

The IRFs highlight the behavior of each variable depending on the regime considered and the frequency of the data. Table 4.a reports a statistically significant difference in the responses of inflation, and money supply to a change in remittances when using yearly data. The quarterly data's responses contrast for the GDP, inflation, money supply and RER.

Table 4b summarizes the theoretical predictions and our empirical results, for inflation, and the nominal money growth rate. Two of our main results come across clearly here. First, the IRFs under a FIX (FLEX) are robust to the ordering suggested by Models 1 and 2 (3 and 4).[11] Second, the empirical results are consistent with our theoretical predictions, independently from the frequency of the data as long as the relevant regime is considered. If not, then the results may be spurious.

A closer look at the IRFs allows a more detailed comparison of the results. Since the ordering does not have an impact on the variables' responses, we report only one set of IRFs per regime. Furthermore, our model makes clear predictions regarding inflation and the money supply, hence we focus first on those two variables.

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

[10] Bun (2001) discusses in detail the case when *T* is larger than *N*.

[11] Similarly, the results are robust to the ordering when the data does not discriminate between the regimes

Annual Results, Figure 5, 6 and 7

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 for both variables. The impact remains positive for the money supply and oscillates between (statistically) positive and (statistically) negative for inflation. In contrast, 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, Figure 7 shows that if the different regimes are not modeled, the dynamics are similar to a FIX but with noticeably lesser effects. This result illustrates how important controlling for exchange rate regimes is.

[INSERT FIGURES 5, 6, AND 7]

Quarterly Results, Figure 8, 9 and 10

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 reports 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, a comparison of both figures with Figure 10, where controls for the regimes are ignored, confirms that ignoring the exchange rate regimes can lead to spurious results.

[INSERT FIGURES 8, 9, AND 10]

Overall, 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 response of the real exchange rate, from non-statistically significant to a statistically significant and positive, that varies in amplitude across the regimes.

Some authors have argued that the different responses of GDP to remittance flows are relevant for understanding whether remittances are sent for reasons of benevolence or as investment. [12] 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. These results are also robust to an ordering that considers GDP as the most exogenous variable, followed by remittances. Yet, the response of remittances to a change in GDP under a FIX shows a small temporary decrease while, under a FLEX, it reports a lagged but also small increase..[13] Hence, our work draws no clear conclusions concerning the role of exchange rate regimes in affecting the cyclicality of remittance flows.

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.

[12] For an excellent discussion and survey of the literature on this issue see Chami, Barajas, Cosimano, Fullenkamp, Gapen, and Montiel (2008).

[13] IRFs are available upon request.

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 exogenity 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. To explore the role of such reverse causality for our results, we generate a new set of IRFs where RER is the most exogenous variable, followed by remittances and then the other variables in the same order as before.

Table 5.a confirms that, under the new ordering, the IRFs still statistically differ according to the exchange rate regime. The results are similar to Table 4.a except for two cases: the response of RER when considering annual data is now different depending on the regime, while the money supply response is not when considering the quarterly data. Table 5.b. summarizes the dynamic responses of inflation, money supply and RER.[14]

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

The responses of inflation and the 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 supply.[15]

Our work argues theoretically and empirically that exchange regimes are important for 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, although this has been largely ignored in other studies.

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

[15] Which is also confirmed by previously reported results using GDP as the most exogenous variable

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. The literature on remittances has focused on real effects and trade-theoretic models while deemphasizing the monetary nature of the transfers. Hence, the potential impact of monetary regimes has been mostly ignored.

In this paper, we aim to fill this gap by analyzing the responses of strictly monetary variables such as inflation and the nominal money supply to changes in remittances, under different monetary regimes.

First, 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. The model also suggests that, if the remittances are purely exogenous, the real exchange rate's transition path differs according to the exchange rate regime as well.

Second, our work shows empirically how these predictions hold in the data. Using a panel vector autoregressive approach that controls for regime differences, we explore impulse response functions specific to each regime and to 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. The predictions for inflation and the money supply are borne out in the data, which is not always the case for the real exchange rate predictions. We then investigate the potential for reverse causality between the real exchange rate and remittances. While the results show some evidence of this, the main outcome is the robustness of our findings to the variable ordering regarding inflation and the nominal money supply. Finally, our results are also robust to orderings that allow remittances to respond to changes in domestic output.

References

Acosta, Pablo, Emmanuel, Lartey, and Federico Mandelman, 2007. Remittances and the Dutch Disease. Federal Reserve Bank of Atlanta, Working Paper 2007-8.

Amuedo-Dorantes, Catalina and Susan Pozo. 2004. Workers' Remittances and the Real Exchange Rate: A Paradox of Gifts. World Development, 32: 1407-1417.

Bourdet, Yves and Hans Falck. 2006. Emigrants' Remittances and Dutch Disease in Cape Verde. International Economic Journal, 20: 267-284.

Caceres, Luis Rene and Nolvia N. Saca. 2006. What Do Remittances Do? Analyzing the Private Remittance Transmission Mechanism in El Salvador. International Monetary Fund Working Paper, WP/06/250.

Chami, Ralph, Thomas F. Cosimano, and Michael T. Gapen. 2006. Beware of Emigrants Bearing Gifts: Optimal Fiscal and Monetary Policy in the Presence of Remittances. International Monetary Fund Working Paper, WP/06/61.

Chami, Ralph, Adolfo Barajas, Thomas Cosimano, Connel Fullenkamp, Michael Gapen, and Peter Montiel. 2008. Macroeconomic Consequences of Remittances. International Monetary Fund Occasional Paper 259.

IMF. 2003.a. Classification of Exchange Rate Arrangements and Monetary Policy Frameworks, Data as of June 30, 2003, International Monetary Fund, Washington, D.C.

IMF. 2003.b. Classification of Exchange Rate Arrangements and Monetary Policy Frameworks, Data as of December 31, 2003, International Monetary Fund, Washington, D.C.

IMF. 2004.a. Classification of Exchange Rate Arrangements and Monetary Policy Frameworks, Data as of June 30, 2004, International Monetary Fund, Washington, D.C.

IMF. 2004.b. Classification of Exchange Rate Arrangements and Monetary Policy Frameworks, Data as of December 31, 2004, International Monetary Fund, Washington, D.C.

IMF. 2005.a. De Facto Classification of Exchange Rate Regimes and Monetary Policy Framework, Data as of June 30, 2005, International Monetary Fund, Washington, D.C.

IMF. 2005.b. De Facto Classification of Exchange Rate Regimes and Monetary Policy Framework, Data as of December 31, 2005, International Monetary Fund, Washington, D.C.

IMF. 2006. De Facto Classification of Exchange Rate Regimes and Monetary Policy Framework, Data as of July 31, 2006, International Monetary Fund, Washington, D.C.

Jansen, Dennis; Naufal, George; and Diego Vacaflores, 2007. The Macroeconomic Consequences of Remittances, Working Paper Department of Economics, Texas A&M University.

Lartey, Emmanuel K.K., Federico S. Mandelman, and Pablo A. Acosta. 2008. Remittances, Exchange Rate Regimes, and the Dutch Disease: A Panel Data Analysis. The Federal Reserve Bank of Atlanta. Working Paper 2008-12.

Levy-Yeyati, Eduardo and Federico Sturzenegger. 2005. Classifying Exchange Rate Regimes: Deeds vs. Words. European Economic Review, 29: 1603-1635.

Lopez, Humberto, Luis Molina, and Maurizio Bussolo. 2007. Remittances and the Real Exchange Rate. World Bank Policy Research Working Paper, WPS 4213, April.

Rajan, Raghuram G. and Arvind Subramanian. 2005. What Undermines Aid's Impact on Growth? International Monetary Fund Working Paper, WP/05/126.

Reinhart, Carmen M. and Kenneth S. Rogoff. 2004. The Modern History of Exchange Rate Arrangements: A Reinterpretation. Quarterly Journal of Economics, 1: 1-48.

The World Bank, 2006. Global Economic Prospects: Economic Implications of Remittances and Migration. Chapter 4: 85-115.

The World Bank, 2008. World Development Indicators.

Vegh, Carlos, 2007. Non-Traded Goods and Relative Prices. In Open Economy Macroeconomics in Developing Countries. MIT press, Chapter 4. Forthcoming. http://www.econ.umd.edu/~vegh/Book/chapters/chapter4.pdf

Table 1. Selected Empirical Studies and Exchange Rate Regimes

Amuedo-Dorantes and Pozo (2004)

1979 - 1998	Number of Regimes	FIX (y/n)	FLEX (y/n)
Argentina	3	yes	yes
Belize	1	yes	no
Bolivia	3	yes	yes
Colombia	2	no	yes
Dominican Republic	3	yes	yes
Jamaica	3	yes	yes
Mexico	3	yes	yes
Nicaragua	2	yes	no
Peru	2	no	yes
Trinidad & Tobogo	3	yes	yes

Bourdet and Falck (2006)

1975 - 2005	Number of Regimes	FIX (y/n)	FLEX (y/n)
Cape Verde	3	yes	yes

Caceres and Saca (2006)

1995 - 2004	Number of Regimes	FIX (y/n)	FLEX (y/n)
El Salvador	1	yes	no

Lopez, Molina, and Bussolo (2007)

1990-2003	Number of Regimes	FIX (y/n)	FLEX (y/n)
Argentina	3	yes	yes
Belize	1	yes	no
Bolivia	2	yes	no
Brazil	3	yes	yes
Chile	2	no	yes
Colombia	2	no	yes
Costa Rica	3	yes	yes
Dominican Republic	2	no	yes
Ecuador	3	yes	yes
El Salvador	3	yes	yes
Guatemala	2	no	yes
Haiti	2	yes	yes
Honduras	3	yes	yes
Jamaica	3	yes	yes
Mexico	3	yes	yes
Nicaragua	2	yes	no
Panama	1	yes	no
Paraguay	2	no	yes
Peru	2	no	yes
Venezuela	3	yes	yes

Rajan and Subramanian (2005)

1980s	Number of Regimes	FIX (y/n)	FLEX (y/n)
Bangladesh	n.a.	n.a.	n.a.
Bolivia	3	yes	yes
Botswana	1	yes	no
Burundi	3	yes	yes
Congo	1	yes	no
Honduras	1	yes	no
Jamaica	3	yes	yes
Kenya	3	yes	yes
Madagascar	2	yes	no
Malawi	2	yes	yes
Papua New Guinea	1	yes	no
Senegal	1	yes	no
Sri Lanka	3	yes	yes
Swaziland	1	yes	no
Tanzania	2	no	yes
Zambia	3	yes	yes

1990s	Number of Regimes	FIX (y/n)	FLEX (y/n)
Bolivia	2	yes	no
Cameroon	2	yes	no
Costa Rica	2	no	yes
Egypt	2	yes	no
Ethiopia	3	yes	yes
Indonesia	2	yes	no
Jordan	3	yes	yes
Kenya	3	yes	yes
Mauritius	3	yes	yes
Morocco	n.a.	n.a.	n.a.
Panama	1	yes	no
Philippines	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		RER
1	-1.038	9.692	***	4.730	***	-0.320
2	-0.522	-1.833	**	2.760	***	-0.955
3	-0.892	3.480	***	2.601	***	-0.507
4	0.203	-2.865	***	3.757	***	-0.412
5	0.292	1.068		2.683	***	-0.119
6	0.640	0.486		2.962	***	-0.242
7	0.588	-0.408		0.727		-0.017
8	-0.003	-2.047	**	-0.229		-0.079
9	-0.298	-0.077		0.092		-0.075
10	-0.282	0.338		0.100		-0.067

Quarterly data

T	GDP		Inflation		Money		RER	
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

	Inflation		Money	
Theory	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[16]	↔	↑, 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

[16] 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		RER	
1	-1.074		9.834	***	4.803	***	NA	
2	-0.716		-1.859	**	2.833	***	-1.280	*
3	-1.041		3.631	***	2.644	***	-0.840	
4	0.200		-2.978	***	3.778	***	-0.512	
5	0.252		1.102		2.722	***	-0.131	
6	0.626		0.467		2.994	***	-0.213	
7	0.627		-0.410		0.717		-0.129	
8	0.009		-2.126	**	-0.238		-0.141	
9	-0.310		-0.085		0.072		-0.024	
10	-0.281		0.324		0.092		-0.024	

Quarterly data

t	GDP		Inflation		Money		RER	
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	

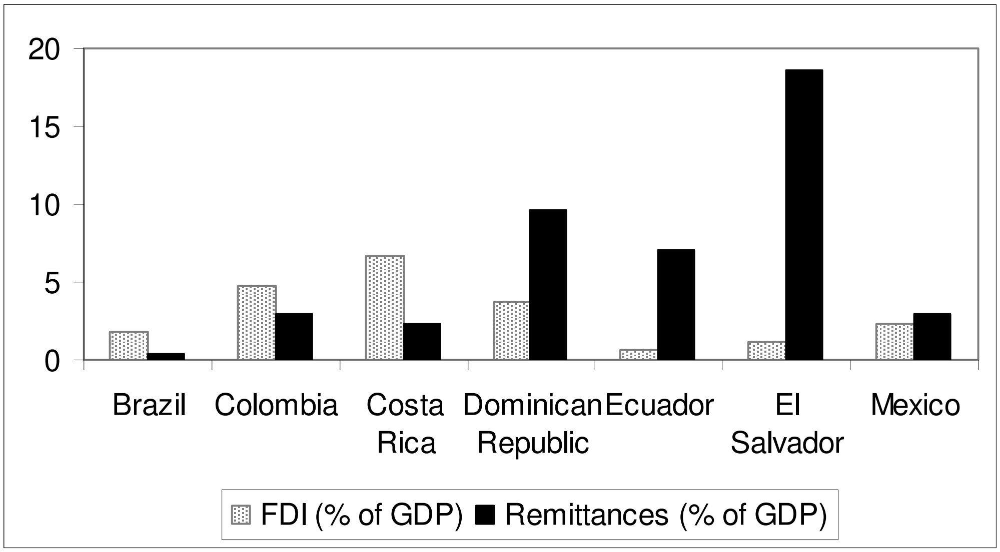
***, **, and * stand for statistical evidence that the coefficients of the IRF from the different regimes are different at the 1%, 5% and 10% level.

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	↔	↔	↔	↔

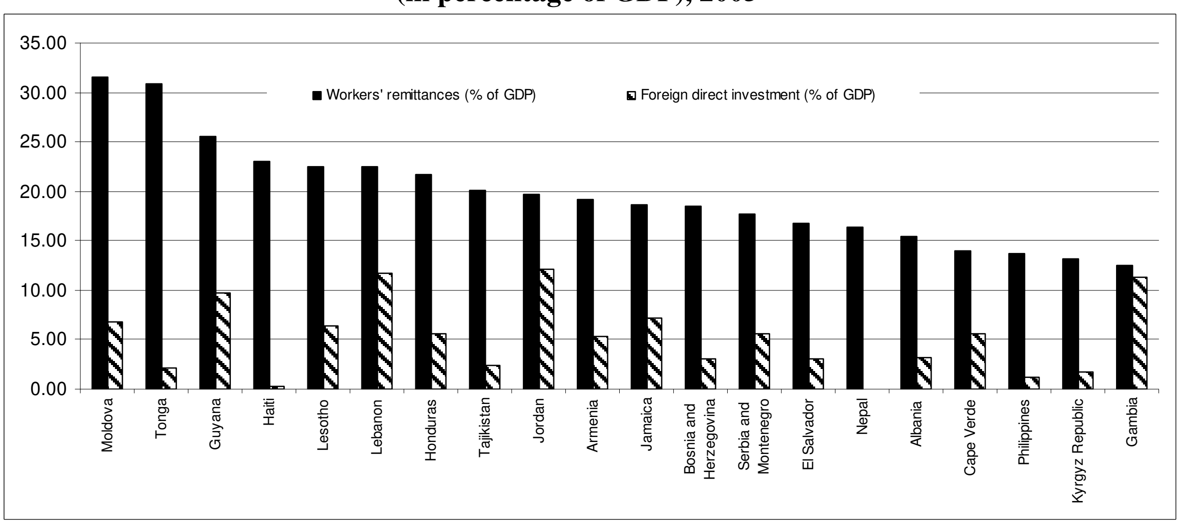
↑ (↓) stands for an increase (a decrease) significant at a 5% level, and ↔ for no statistically significant changes

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

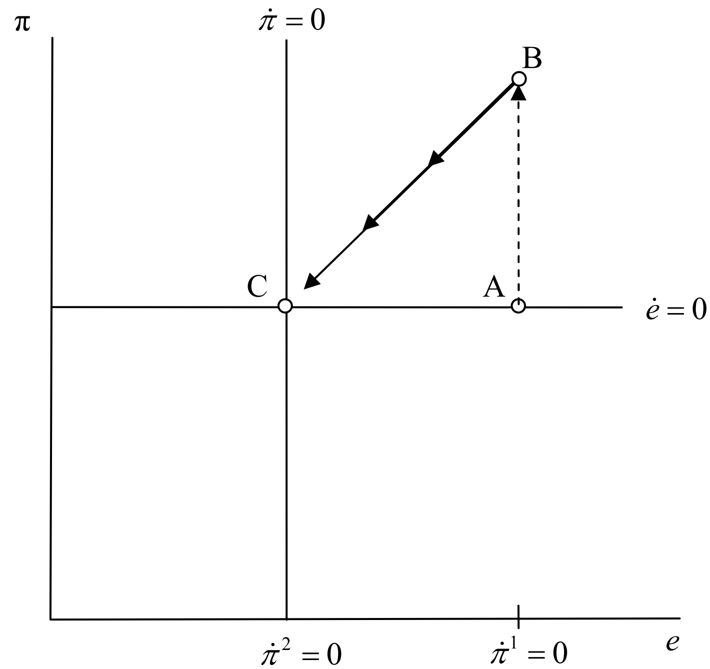


Figure 4. Shock Under FLEX

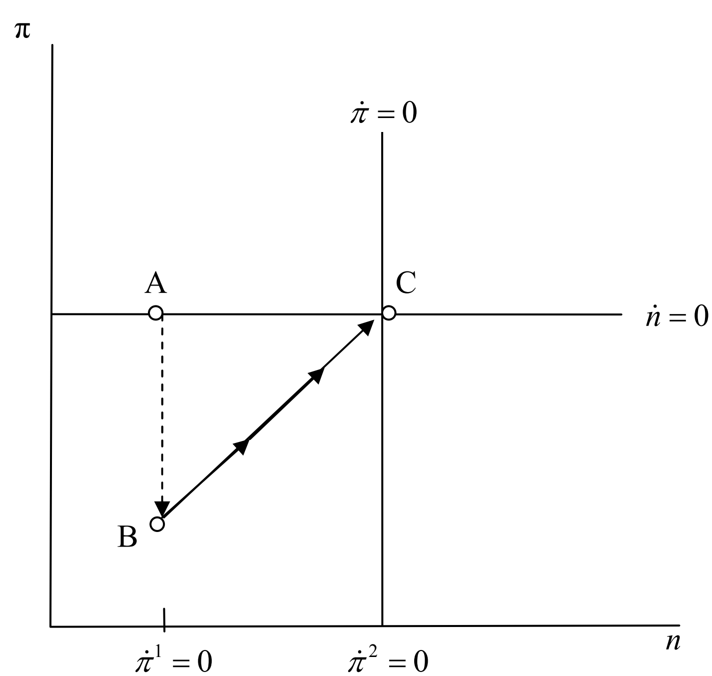


Figure 5. Annual FIX Impulse Responses[17]

$$Model1: \quad \Delta\ln(remittances_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(Money_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(RER_{i,t})$$

$$Model2: \quad \Delta\ln(remittances_{i,t}), \Delta\ln(Money_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(RER_{i,t})$$

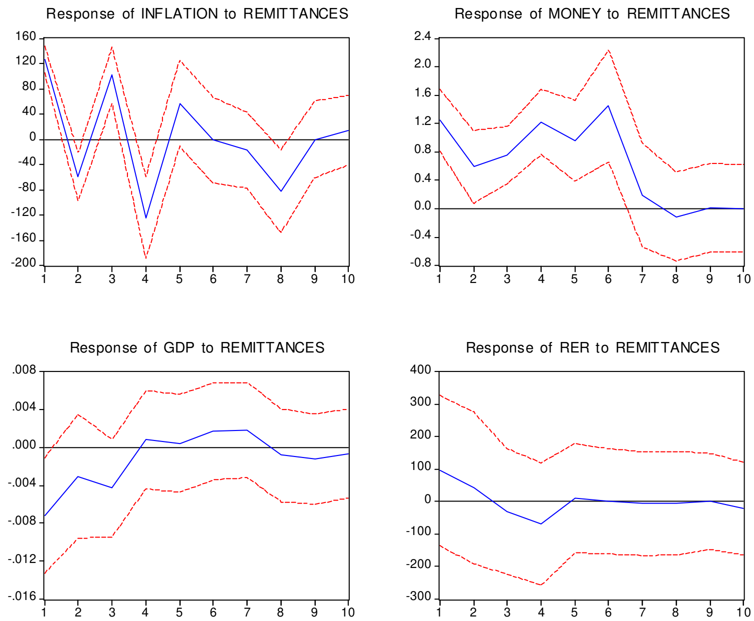
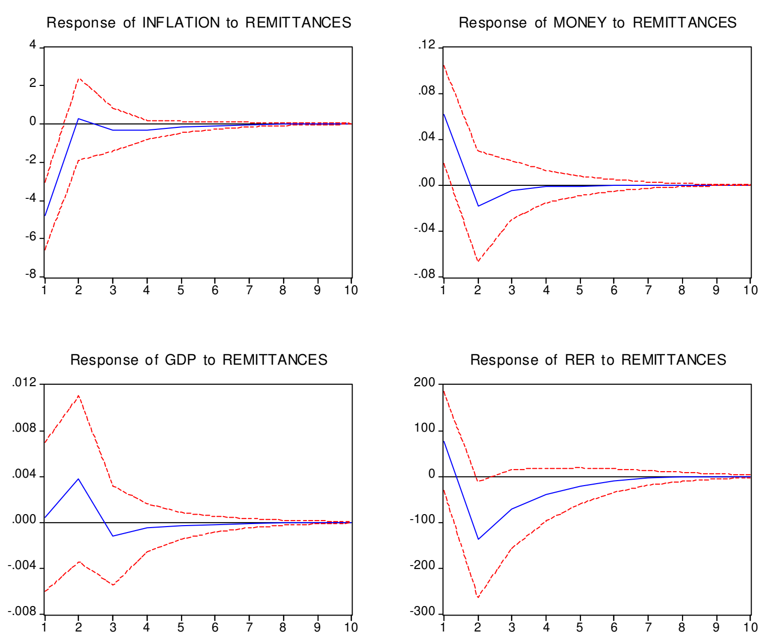


Figure 6. Annual FLEX Impulse Responses[18]

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

$$Model\ 4: \quad \Delta\ln(remittances_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(RER_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(Money_{i,t})$$



[17] The IRFs are identical for both orderings – Model 1 and Model 2.
[18] The IRFs are identical for both orderings – Model 3 and Model 4.

Figure 7. Annual Both Regimes Impulse Responses[19]

Any model

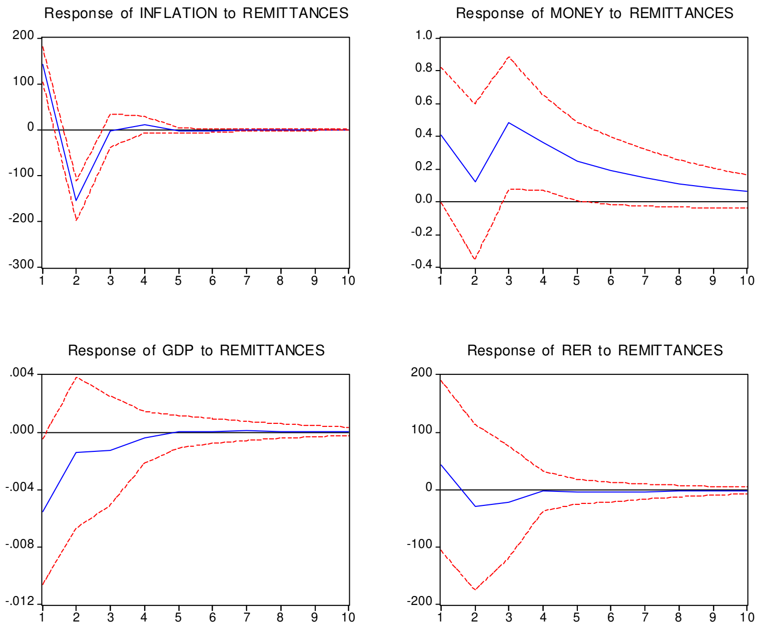
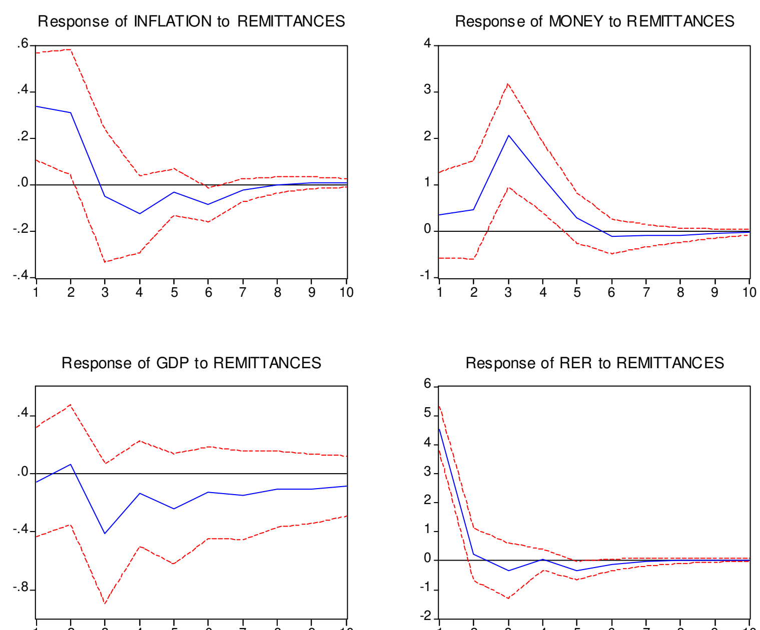


Figure 8. Quarterly FIX Impulse Responses[20]

$$Model1: \quad \Delta\ln(remittances_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(Money_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(RER_{i,t})$$

$$Model2: \quad \Delta\ln(remittances_{i,t}), \Delta\ln(Money_{i,t}), \Delta\ln(GDP_{i,t}), \Delta\ln(Inflation_{i,t}), \Delta\ln(RER_{i,t})$$



[19] The IRFs are identical for all orderings.

[20] The IRFs are identical for both orderings – Model 1 and Model 2.

Figure 9. Quarterly FLEX Impulse Responses[21]

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

$$Model\ \ 4:\ \ \Delta\ln(remittances_{i,t}),\Delta\ln(GDP_{i,t}),\Delta\ln(RER_{i,t}),\Delta\ln(Inflation_{i,t}),\Delta\ln(Money_{i,t})$$

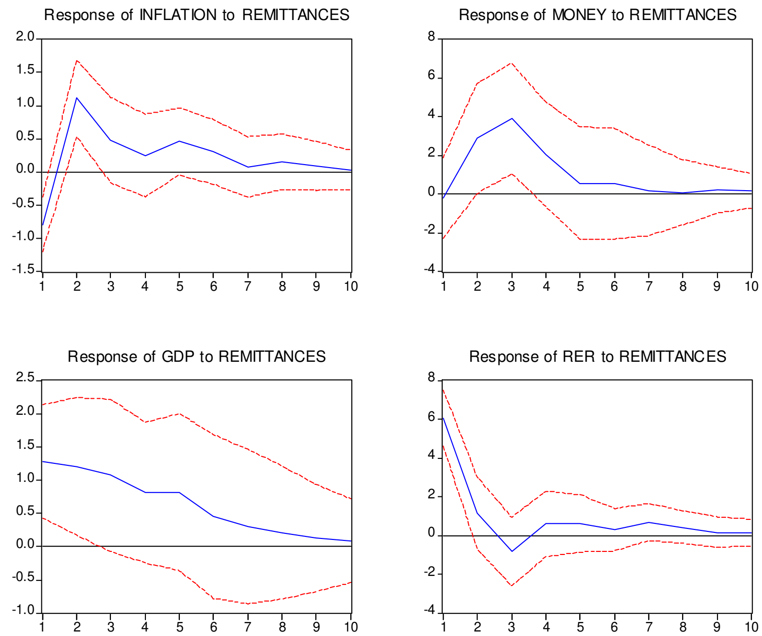
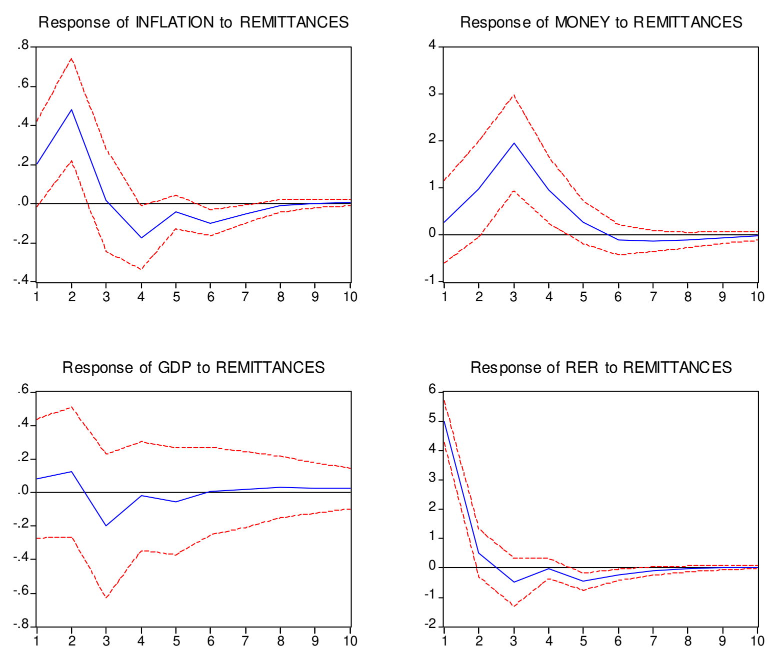


Figure 10. Quarterly Both Regimes Impulse Responses[22]

Any model



[21] The IRFs are identical for both orderings – Model 3 and Model 4.

[22] The IRFs are identical for all orderings.

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

Implicitly differentiating (7) yields

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

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

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

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

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

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

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, $\overline{c}^T$ and $\overline{c}^N$, by (A.4) and (A.5), and thus to higher non-traded good output, $\overline{y}^N$, 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 it's 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, $\overline{c}^T$ and $\overline{c}^N$, by (A.4) and (A.5), and thus to higher non-traded good output, $\overline{y}^N$, 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 it's 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.

Remittances and The Real Economy: Effects of the "Dutch disease"

In our model, remittances will always cause a real appreciation and a resource allocation á la the "Dutch disease" independent of the economy's monetary regime. To see this, equate (7) and (14), use (3.a) and (3.b), and rearrange to obtain an expression in terms of labor, remittances, and parameters.[23] Totally differentiating this shows that increasing remittances, *f*, requires a fall in the amount of labor employed in the traded good sector, *l*. This is the so-called "resource movement effect".

---

[23] $\left(\frac{\gamma}{1-\gamma}\frac{\alpha}{\beta}AB\right)l_t^{\alpha-1} - \left(\frac{\gamma}{1-\gamma}\frac{\alpha}{\beta}AB\right)l_t^{\alpha} - ra_0 - Al_t^{\alpha} - f_t = 0$

(A.6) $$\frac{dl}{df}=\frac{1}{\left(\frac{\gamma}{1-\gamma}\frac{\alpha}{\beta}AB\right)(\alpha-1)l_t^{\alpha-2}-\left(\frac{\gamma}{1-\gamma}\frac{\alpha}{\beta}AB\right)\alpha l_t^{\alpha-1}-A\alpha l_t^{\alpha-1}}<0$$

To see the "spending effect" (i.e., the effect on the real exchange rate), rewrite (7) in terms of the real exchange rate[24] and differentiate with respect to traded good sector labor.

(A.7) $$\frac{de}{dl}=-\frac{\beta}{\alpha}(\beta-1)(1-l)^{\beta-2}l^{1-\alpha}+\frac{\beta}{\alpha}(1-\alpha)(1-l)^{\beta-1}l^{-\alpha}>0$$

which says that an increase in labor to the traded sector increases the real exchange rate.

Combining (A.6) and (A.7), gives the full "Dutch disease" effect.

(A.8) $$\frac{de}{df}=\frac{de}{dl}\frac{dl}{df}<0\,.$$

That is, an increase in remittances always generates a fall in the real exchange rate in this economy.

Furthermore, the income effect from increased wealth in the form of remittance inflows leads to an increase in consumption of both goods. By (A.8) and (8) the final change in both levels of consumption must be such that traded good consumption increases by more than home good consumption. Analytically, by (3.b) and (11),

(A.9) $$\frac{dc_t^N}{df}=-\beta B(1-l)^{\beta-1}\frac{dl}{df}>0\,.$$

Again, since c^N increases yet the real exchange rate falls, by (A.8), c^T must also increase and by more than the increase in c^N. From (13) with (3.a) and using (A.8) to sign,

(A.10) $$\frac{dc_t^T}{df}=\alpha Al^{\alpha-1}\frac{dl}{df}+1>0$$

which imposes a restriction on the magnitude of the resource allocation effect in the traded sector such that $\left|\alpha Al^{\alpha-1}\frac{dl}{df}\right|<1$.

---

24 $e=\frac{\beta}{\alpha}\frac{B(1-l)^{\beta-1}}{An^{\alpha-1}}$