Remittances, Output, and Exchange Rate Regimes: Theory with an Application to Latin America

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Abstract: This study explicitly incorporates remittances in a small open economy and examines the behavior of the main macroeconomic aggregates in response to a remittances shock under alternative exchange rate regimes. Using a simple stochastic limited participation model we are able to reproduce dynamics consistent with the empirical literature, but find that the dynamics of labor, inflation, and output are dependent on the parameterization of the utility function and the monetary rule governing the evolution of the interest rate. We find that a more flexible exchange rate regime exacerbates the initial drop of output resulting from a remittances shock, but while the subsequent recovery of output is slower in the more flexible exchange rate regimes, it ends up being much stronger. These results are corroborated by the empirical evidence from a basic growth specification for 11 Latin American countries.

Keywords: Remittances; Exchange Rate Regimes; Latin America; Limited participation model.

JEL Classification: F47; F24; J61; O11; N16

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1. Introduction

The increasing amount of funds that residents of labor exporting countries are receiving from relatives and friends from abroad has generated a wave of research on the impact of remittances, both at the micro and macro levels. Remittances to Latin America and the Caribbean reached 61.3 billion U.S. dollars in 2013, with Mexico being the largest recipient at 21.6 billion U.S. dollars³ (Inter-American Development Bank (2014)). While other countries in the region are receiving smaller inflows of remittances, the relative importance of such inflows can be much greater. For example, remittances were almost 5% of GDP in Ecuador, above 10% in Guatemala, over 16% in El Salvador, and approaching 18% in Honduras. Remittances also represent an increasing share of all financial flows entering developing countries – around 45 percent. They rival FDI in size.

Remittances, as any other increase in income, provide an infusion of funds that affect the behavior and well-being of the recipient household, in terms of education, nutrition, health care, entrepreneurial activities, etc. Because a significant portion of the population is receiving these remittances, the effect on macroeconomic aggregates is also important. Numerous studies have found that remittances can have an influence on consumption and inflation (Heilman (2006), Narayan et al. (2011), Vacaflores (2012)), on the exchange rate and trade competitiveness (Amuedo-Dorantes and Pozo (2004), Acosta et al. (2009)), on the amount of labor that is supplied (Funkhouser (1992), Hanson (2007), Chami et al. (2008), Acosta et al. (2009)), on economic growth (Cáceres and Saca (2006), Osili (2007)), and on the nature of the optimal policy response to economic shocks (Chami et al. (2008), Mandelman (2012), Vacaflores (2012)).

³ Official remittances to Mexico are around 2% of GDP.
Remittances are sent in foreign currency, and need to be exchanged for the domestic currency before being used for consumption, savings, or investment. The propagation of a change in remittances and its effect on the macroeconomic aggregates will depend in part on the way in which a country manages its exchange rate. Remittances provide foreign exchange liquidity, and the Central Bank of the recipient country must determine the way in which it manages these capital inflows. If the country is operating under a fixed exchange rate regime, the Central Bank will intervene and buy all the foreign currency, which would otherwise lead to an increase in the money supply that could generate inflationary pressure. Central Banks neutralize such an effect by withdrawing some liquidity through the sale of domestic bonds. This preserves the trade balance, inflation, interest rate, and exchange rate, and mutes the propagation mechanism to the rest of the macroeconomic aggregates. The case of full sterilization is then one in which remittances has little effect on the economy.

Alternatively, if the economy is operating under a flexible exchange rate regime, the inflow of remittances leads to an increase in the demand for the domestic currency, and will tend to appreciate the domestic currency. Even if the Central Bank is using the interest rate as monetary policy target and targeting the inflation rate, the increased liquidity in the banking sector and financial markets adds pressure in additional dimensions: the higher demand for the domestic currency leads to an appreciation of the currency and causes the trade balance to deteriorate, possibly forcing the Central Bank to intervene in the foreign exchange market to avoid a rapid or severe appreciation. Alternatively, the Central Bank could accommodate the remittances inflows, in which case we expect an increase in inflationary pressure (if the

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4 For some countries that are dollarized, even partially, remittances sent in dollars would not have to be exchanged for the domestic currency. We are not modeling dollarization; our model will not strictly apply to dollarized countries.

5 Blanchard et al. (2010) recommend that Central Banks acknowledge their foreign exchange intervention.
economy is not growing rapidly) or some increase in production (due to lower interest rates, higher consumption, and increased investment). The link between remittances and economic activity then is enhanced under a flexible exchange rate regime.

This paper extends the dynamic stochastic general equilibrium (DSGE) model used in Jansen et al. (2012) and incorporates alternative exchange rate regimes to study the macroeconomic effects of an increase in remittances. The model is able to replicate the stylized facts emanating from a remittances shock, and provides evidence of a differential effect from alternative degrees of exchange rate flexibility. The results show that the more rigid exchange rate regimes are able to reduce the inflationary pressure from the additional inflow of remittances, thus enhancing the consumption of the recipients, but also lead to a less persistent liquidity effect, which diminishes the increase in investment and accumulation of capital, resulting in a weaker recovery of output. This differential response of output under alternative exchange rate regimes is empirically corroborated for a set of 11 Latin American countries, where increases in remittances initially reduces the growth rate of GDP but then recovers much faster in economies with a more rigid exchange rate regime in place.

The paper is organized as follows. Section 2 presents a brief summary of the literature review. Section 3 formulates the theoretical model and Section 4 discusses the results emanating from a remittances shock. Section 5 provides empirical evidence to corroborate the results from the model. Section 6 summarizes and concludes.

2. Literature Review

The existing literature has already uncovered some effects of remittances on the main macroeconomic aggregates. There is a growing consensus that remittances lead to increases
in consumption, health, and human capital (allowing for more and higher quality education), arguably creating opportunity for economic growth in the receiving countries. However, there is an influential trend that argues that directing a higher proportion of these inflows towards investment – so-called self-interested remittances – would be more effective in generating economic growth (Woodruff and Zenteno (2007), Jansen et al. (2012), Lartey (2012)).

Irrespective of the use of these inflows between consumption and investment, the inflow of remittances should generate higher levels of demand for goods and services, providing an upward pressure on production. However, there is still debate on how labor responds to these inflows and thus on the expected short-run impact on output. Most studies show that remittances have a negative effect on the work effort of the receiving household (i.e. Funkhouser (1992), Chami et al. (2008), Acosta et al. (2009), Hanson (2007)), and thus should exert a downward pressure on production. But if one considers that remittances are not just a gift from relatives but instead is a household decision regarding labor allocation, then these inflows may not have as large a bearing on work effort. Some evidence of this more limited effect is found by Cox-Edwards and Rodriguez-Oreggia (2009), for Mexico, and Funkhouser (2006) for Nicaragua. This means that the expected influence of remittances on labor, and thus output, could well be ameliorated or overturned.

Since a significant portion of remittances are being used to satisfy consumption needs, it has been also found that they can generate inflationary pressure through the stimulation of internal demand for imported goods (Heilmann (2006), Narayan et al. (2011), and Vacaflores (2012)). In addition, since remittances usually come in dollar form, they can induce Dutch Disease effects in the receiving economies, as they can appreciate the domestic
currency and make domestic goods relatively more expensive compared to traded goods (Amuedo-Dorantes and Pozo (2004), Acosta et al. (2009) and Narayan et al. (2011)). Of course, the degree of inflation and exchange rate pressure would be dependent on the degree of sterilization and foreign-currency intervention by the Central Bank.

In terms of policy response to the inflationary pressure, Chami et al. (2008) shows that the optimal monetary response to remittances shocks deviates from the Friedman rule in economies where remittances are a significant portion of the economy, with governments having to resort to the use of the inflation tax to protect the performance of the economy. Vacaflores (2012) shows that increasing sterilization of a remittances shock leads to a more pronounced drop in the interest rate, with the labor-leisure tradeoff being exacerbated due to indirect effects on money growth and inflation. A similar increase in inflation resulting from a remittances shock is found by Mandelman (2012), although the monetary policy rule used in his model forces the monetary authority to control inflation with a contraction of the money supply – a rise in the interest rate.

With regards to the exchange rate pressure brought by the inflow of remittances, Mandelman (2012) shows that the inflation generated by the remittances shock will lead to an increase in the policy interest rate, which attracts foreign investment and puts downward pressure on the exchange rate (appreciation). This initial appreciation also triggers a decline in the policy interest rate that diminishes the initial appreciation, and higher levels of the feedback coefficient (more rigid regimes) are better able to contain the appreciation of the exchange rate. The results suggest that more rigid regimes exacerbate the expansionary effects of remittances – on output – by containing the appreciation in the exchange rate.
Vacaflores et al. (2014) use a panel of 7 Latin American countries to show that remittances have a contemporaneous positive effect on international reserves, with countries operating under a more rigid exchange rate regime experiencing a magnified effect. The way in which countries treat capital inflows and manage their exchange rate will influence how the inflow of remittances propagates through the economy, according to the degree of sterilization of these inflows. Countries that operate under a more fixed exchange rate regime will mute this propagating mechanism, ameliorating the initial impact but also diminishing the subsequent effects on macroeconomic aggregates.

3. Theoretical Model

We expand the limited participation model developed in Jansen et al. (2012) to allow for a utility function that eliminates the wealth effect of a remittances shock, and we incorporate an interest rate rule that accommodates different exchange rate regimes. The model requires money balances be held to finance certain types of purchases, with households deciding on the distribution of these money balances – between cash and deposits – before the current period. Our model rationalizes a large and persistent liquidity effect by introducing an adjustment cost on cash money holdings, $M_i^c$. This adjustment cost is a time cost – a reduction in leisure in order to spend time adjusting money balances – and is modeled as:

$$\Omega_i = \frac{\varepsilon}{2} \left( \frac{M_{i+1}^c}{M_i^c} - \theta \right)^2$$

(1)

where the long run value of $\frac{M_{i+1}^c}{M_i^c}$ is equal to the steady state growth rate of money, represented by the parameter $\theta$. The cost of changing $M_i^c$ is an increasing function of the
parameter $\xi$, and implies that bank deposits are slow to change following a monetary shock, and consequently increases in cash holdings create a strong and persistent decline in the nominal interest rate.

3.1. **Structure of the model**

The goods market is characterized by perfect competition and flexible prices, with domestic firms and the rest of the world producing an identical good whose price in domestic currency (e.g., pesos) is given by $P_t$. The law of one price holds. Letting $s_t$ denote the price of foreign currency in terms of domestic currency (e.g., pesos per dollar), and keeping in mind that the small open economy assumption implies that the price of the good in foreign currency ($P^*$) is exogenous, purchasing power parity is given by:

$$P_t = s_t P^*$$  \hspace{1cm} (2)

In this economy the exchange rate changes one for one with the domestic price level, or the domestic price level changes one for one with the exchange rate.

3.1.1. **The household**

The representative agent’s objective is to choose a path for consumption and asset holdings to maximize

$$\sum_{t=0}^{\infty} \beta^t U(C_t, L_t)$$  \hspace{1cm} (3)

where $C$ is real consumption and $L$ is leisure hours. We normalize the time endowment to unity, so leisure is given by $L_t = 1 - H_t - \Omega_t$, where $H$ is worked hours and $\Omega$ is time spent adjusting money balances.

We use a utility function that defines consumption and labor as complements, as proposed by Greenwood, Hercowitz, and Huffman (1988). This specification has important characteristics useful for the analysis of economies with different degrees of idle resources,
and suppresses the wealth effect of the remittances shock. That is, increased consumption does not lead to reductions in labor. The per-period utility function is given by

\[ U(C_t, L_t) = \frac{(C_t - \chi(1 - H_t - \Omega_t)^{1-\gamma^{-1}})^{1-\sigma^{-1}}}{1-\sigma^{-1}} \]  

where \( \gamma \) is the Frisch-elasticity of labor supply \((0 < \gamma)\), and \( \sigma \) is the inverse of the inter-temporal elasticity of substitution in the usual Constant Elasticity of Substitution (CES) utility function.

The cash-in-advance (CIA) constraint takes the form:

\[ P_t C_t \leq M_i^c + \eta_t \mathcal{R}_t \]

where \( M_i^c \) denotes cash brought forward from period \( t-1 \). Here \( \mathcal{R}_t \) is remittances in foreign currency (e.g., dollars) and \( s_t \) is the nominal exchange rate, so \( s_t \mathcal{R}_t \) are nominal remittances in domestic currency terms received by the domestic household. The parameter \( \eta \) take values between 0 and 1, and indicates the percentage of remittances immediately available for consumption, as opposed to being held as bank deposits and only available for consumption in future periods.\(^6\)

Remittances are modeled to be partially exogenous to better identify the effect of these transfers from abroad on the recipient economy. We model foreign-currency-denominated remittances as responding to income deviations from the steady state in the recipient nation. Intuitively, we specify that remitters in the large economy monitor conditions in the receiving country and remit more when the receiving country’s income declines, thus helping reduce contractions of consumption. Our particular remittances specification is given by:

\(^6\) See Jansen et al. (2012) for further properties of this specification.
\[ \mathcal{R}_t = E_t \left[ \frac{1}{s_t} \left( \frac{Y^*}{Y_t} \right)^\gamma \right] \]

Note that when \( \tau > 0 \) remittances rise when the state of the economy worsens (countercyclically), when the receiving country’s price level rises, or when the receiving country’s currency depreciates.

Households are allowed to hold foreign assets that yield a risk-free exogenous nominal interest rate \( i_t^* \). Since household can buy foreign assets \( B_{t+1} \) denominated in the foreign currency – the nominal exchange rate becomes a key variable in the portfolio decision. The household budget constraint is given by:

\[
M_{t+1}^c + M_{t+1}^b + s_t B_{t+1} + P_t C_t \leq M_t^c + s_t \mathcal{R}_t + P_t w_t H_t + (1 + i_t) M_t^b + s_t (1 + i_t^*) B_t + D_t^f + D_t^b
\]

At time \( t \) the household determines consumption \( C_t \) and labor supply \( H_t \), as well as the amount of money deposited in banks, \( M_{t+1}^b \), the amount of money kept as cash, \( M_{t+1}^c \), and the foreign asset position \( B_{t+1} \). The household’s income is determined by the real wage \( w_t \) and the profits (or dividends) received at the end of the period from both the firm and the bank, \( D_t^f \) and \( D_t^b \), as well as interest on deposits and on foreign bonds.

The household’s maximization problem is subject to the cash-in-advance constraint (equation 5) and the budget constraint (equation 7), and yields the standard first order conditions:

\[
\lambda_t = \beta E \left[ (1 + i_{t+1}) \lambda_{t+1} \right]
\]

\[
w_t P_t \lambda_t = -\frac{\chi (1 - H_t - \Omega_t)^{-\gamma_i}}{\left( C_t - \frac{\chi (1 - H_t - \Omega_t)^{1-\gamma_i}}{1 - \gamma_i} \right)^{\sigma_i}}
\]
\[ s_t \lambda_t = \beta E_t \{ s_{t+1}(1+i^r)\lambda_{t+1} \} \]  

\[ P_t w_t \lambda_t \frac{\xi}{M_t} \left( \frac{M_{t+1}^c}{M_t^c} - \theta \right) + \lambda_t = \beta E_t \left[ \frac{1}{P_{t+1} \left( C_{t+1} - \frac{\chi (1-H_{t+1} - \Omega_{t+1})}{1-\gamma^{-1}} \right)^{\sigma^{-1}}} \right] \]

\[ + \beta E_t \left[ P_{t+1} w_{t+1} \lambda_{t+1} \frac{\xi M_{t+2}^c}{(M_{t+1}^c)^2} \left( \frac{M_{t+2}^c}{M_{t+1}^c} - \theta \right) \right] \]  

Equation (8) has the form of the standard intertemporal asset pricing equation. It specifies equality between the costs of holding an additional unit of bank deposits today and the discounted future benefits of that bank deposit made today.

Equation (9) requires equality between the marginal disutility of working and the marginal benefit – the real wage multiplied by the Lagrange multiplier. Equation (10) requires equality of the current marginal cost of buying foreign assets (in terms of wealth) with the gains in the following period from holding such assets today, another asset pricing equation, and equation (11) equates the costs and benefits related to the choice made at time \( t \) of money holdings available for consumption in the following period. Note that equations (8) and (10) imply uncovered interest parity.

### 3.1.2. The Firm

We specify the firm’s production technology using a Cobb-Douglas functional form:

\[ Y_t = \varepsilon^{\alpha} K_t^{\alpha} H_t^{1-\alpha} \]  

Here \( \alpha \in [0,1] \) and \( K \) is physical capital. The firm’s objective is to maximize the discounted stream of dividend payments, where we consider the value of this discounted dividend stream to households. The firm receives its profits at the end of the period, and borrows funds from the bank to invest in physical capital at the beginning of the period, with the cost of
borrowing given by the nominal interest rate $i_t$. Consequently, the nominal profits of the firm are given by:

$$D_t^f = P_t Y_t - P_t w_t H_t - P_t (1 + i_t) I_t - P_t \Theta_t$$  \hspace{1cm} (13)

with investment evolving according to the law of motion of the stock of physical capital,

$$I_t = K_{t+1} - (1 - \delta) K_t$$  \hspace{1cm} (14)

where $\delta$ is the (constant) depreciation rate. The parameter $\Theta$ in equation (13) is the adjustment cost of capital, and is given by $\Theta_t = \frac{\nu}{2} (K_{t+1} - K_t)^2$.

The first order necessary conditions for the household’s choice of labor and capital take the following forms:

$$w_t = (1 - \alpha) \frac{Y_t}{H_t}$$  \hspace{1cm} (15)

$$(1 + i_t) + \nu (K_{t+1} - K_t) = \beta E_t \left[ \frac{P_{t+1} \lambda_{t+1}}{P_t \lambda_t} \left( \alpha \frac{Y_{t+1}}{K_{t+1}} + (1 - \delta)(1 + i_{t+1}) + \nu (K_{t+2} - K_{t+1}) \right) \right]$$  \hspace{1cm} (16)

Equation (15) indicates that the cost of hiring an additional worker should equal that worker’s marginal productivity, and equation (16) requires equality between the cost and benefit of the marginal investment.

### 3.1.3. The Central Bank

The money stock evolves according to $M_{t+1} = M_t + X_t$, where the Central Bank’s money injection is defined as $X_t = (\theta_t - 1) M_t$. Thus $\theta_t$ represents the gross growth rate of money. Money growth thus depends on the existing stock of money $M_t$ and the monetary injection implemented by the central bank $X_t$.

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7 Note that we assume that firms can only borrow for incremental investments, which need to be paid off completely by the end of the period.
Following Blanchard et al.’s (2010) recommendation that exchange rate stability should be explicitly recognized by Central Banks in small open economies, we incorporate a monetary policy rule governing the behavior of the interest rate. This Taylor rule indicates that the nominal interest rate will adjust according to fluctuations in inflation, output, and the exchange rate.

\[
\frac{1 + i_t}{1 + i} = \left(1 + \frac{i_{t-1}}{1 + i}\right)^{\pi_t} \left(Y_t \cdot s_t \cdot \theta_t \cdot \pi_t \cdot 1\right) \cdot e^{\eta_{ir}}
\]  

(17)

The shocks to our small open economy come through the interest, technology, and remittances, all specified as AR(1) processes,

\[
\log(i_{r+1}) = (1 - \rho_{ir}) \log(i_t) + \rho_{ir} \log(i_{r+1}) + \epsilon_{ir,t+1}
\]  

(18)

\[
\log(z_{r+1}) = (1 - \rho_z) \log(z_t) + \rho_z \log(z_{r+1}) + \epsilon_{z,r+1}
\]  

(19)

\[
\log(g_{r+1}) = (1 - \rho_g) \log(g_t) + \rho_g \log(g_{r+1}) + \epsilon_{g,r+1}
\]  

(20)

Here \( \epsilon_{g,t+1}, \epsilon_{ir,t+1}, \) and \( \epsilon_{z,t+1} \) are independent white noise innovations with variance \( \sigma^2_g, \sigma^2_{ir}, \) and \( \sigma^2_z, \) respectively.

3.1.4. The financial intermediary

The financial intermediary provides loans to the firm to pay for the firm’s investment in physical capital, raising funds from deposits from the household, \( M^{b}_t, \) from the portion of remittances that is deposited, \( (1 - \eta)s_{t}\mathcal{R}_t \) and from the potential monetary injection from the Central Bank, \( X_t. \) \( ^8 \) The bank’s nominal asset balance is thus given by

\[
P_tI_t = M^{b}_t + (1 - \eta)s_{t}\mathcal{R}_t + X_t
\]  

(21)

where \( P_tI_t \) are the loans made to firms.

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\( ^8 \) The monetary injection \( X_t \) can be conceptualized as a “helicopter drop” on banks. These funds can be lent in the current period \( t, \) earning interest that is then distributed back to the households at the end of the period.
Bank profits per period are equal to the interest on these loans minus interest paid on deposits and on remittances deposited in banks, with the monetary injection being a subsidy to the bank in that there is no interest expense incurred by the bank on those funds. Assuming equality between the loan rate and the deposit rate, the bank earns zero economic profits when there is no monetary injection.

3.1.5. Closing the model

Since we are modeling a small open economy with international assets freely traded, the no-arbitrage condition leads to the uncovered interest rate parity condition (UIP) – by combining equations (8) and (10). To avoid an instability problem with non-stationary behavior on bond holdings (see Kollman (2002) and Ghironi (2006) for more on this issue) we introduce the following interest rate differential on bond holdings

\[ i_t^* = i^w - \varphi \frac{s_{r+1}B_t}{P_{r+1}} \]  

(22)

where the interest on bonds is determined by the world interest rate and the net real foreign asset position, with \( \varphi \) calibrating the asset position. This assumption leads to a lower bond rate as the country’s net asset position improves. That is, the more foreign bonds held (valued in local currency), the lower is the interest rate on those bonds.

3.2. Equilibrium

Households hold an amount of foreign assets to maximize utility subject to their budget constraint. From equation (7) and market equilibrium we can find the evolution of foreign asset holdings as:

\[ s_t B_{t+1} - s_t (1 + i_t^*) B_t = P_t (Y_t - C_t - I_t - \frac{\nu}{2} (K_{r+1} - K_t)^2) + (1 - (1 + i_t)(1 - \eta))s_t R_t \]  

(23)
Equation 23 relates domestic production and absorption to an economy’s foreign asset position, giving the balance of payments equilibrium. If a country’s production is greater than its absorption, that country has a balance of trade surplus and a negative capital account, so its foreign asset holdings will increase when there are no remittances flowing into the country. Of course, the actual equilibrium impact of remittances on future bond holdings depends on its impact on output, consumption, and investment.

The set of equations given by the first order conditions, the market equilibrium conditions, and the laws of motion for physical capital, the domestic money supply, foreign assets, and the monetary growth factor constitute a non-linear dynamic stochastic system. The system’s equilibrium is characterized by the set of prices and quantities arising from the household’s maximization of its expected intertemporal utility, subject to the CIA and budget constraints, the firm’s maximization of profits, and from the behavior of the labor market, the loanable funds market, and the money market, all clearing while satisfying purchasing power parity.9 To solve this system we calibrate basic parameters and find the steady state values of the relevant variables to characterize the long-run equilibrium of the economy.

3.3. *Calibration and steady state equilibrium*

Table 1 lists the values we assign to the basic parameters. The three first parameters follow standard calibrations. The capital share, $\alpha$, is set to 0.4. The subjective discount factor $\beta$ is set at 0.988, implying a real interest rate equal to 1.2% per quarter. The depreciation rate on capital is set to 2.5% per quarter. We set the time devoted to work to 20% of total time, approximately 34 hours per week.

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9 The complete system of equation is presented in the Appendix, and it will be made available on the author’s web page.
The calibration of specific parameters is based in quarterly data from the 14 Latin American countries used in this study: Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, Peru, and Uruguay. The data covers 1995:q1 to 2011:q4, and was collected from individual Central Banks, for remittances, and the IMF (International Financial Statistics), for measures of money, output, CPI, and the trade balance. The parameter \( \nu \) represents the average of the trade balance as a percentage of GDP, and is used to determine the long-run real debt-to-GDP ratio. Remittances are calibrated to be 5 percent of GDP by setting the parameter \( \theta \).

| \( \alpha = 0.4 \) | \( \beta = 0.988 \) | \( \delta = 0.025 \) | \( \nu = 0.2 \) | \( \rho_r = 0 \) | \( \sigma_r = 0.00194 \) |
| \( \theta = 0.045 \) | \( s = 3 \) | \( H = 0.2 \) | \( g = 1.041 \) | \( \rho_g = 0.96 \) | \( \sigma_g = 0.14 \) |
| \( \tau = 2 \) | \( \xi = 10 \) | \( \phi = 0.8 \) | \( \gamma = 0.85 \) | \( \rho_z = 0.95 \) | \( \sigma_z = 0.00816 \) |
| \( \varphi = 0.0019 \) | \( \theta = 1.045 \) | \( \sigma = 1.1 \) | \( \nu = -0.08 \) |
| \( \chi_r = 1.35 \) | \( \chi_x = 0.06 \) | \( \chi_y = 0.02 \) | \( \chi_s = 0.01 \) | \( \chi_\theta = 3 \) |

The persistence coefficient of the remittance’s shock, \( \rho_g \), and the standard deviation of the remittance’s innovation, \( \sigma_g \), are obtained from a panel specification of remittances, while the persistence coefficient of the monetary shock, \( \rho_r \), and the standard deviation of the monetary innovation, \( \sigma_r \), are obtained from a panel specification of the monetary growth rate of the countries in the sample. We calibrate the technology shock, persistence and variance, to standard levels.

We explicitly consider the case of a small but positive adjustment cost parameter, \( \xi = 10 \), to allow for the liquidity effect – representing approximately 6 minutes per week of
lost time rearranging money cash balances. The system of equations that describes the small open economy is presented in the appendix (A.1), together with the log-linearized system. Nominal variables are made stationary, and real, by dividing them by the lagged domestic price level. These real variables are defined as:

\[ m_t = M_t / P_t; \quad m_t^b = M_t^b / P_t; \quad \pi_t = P_t / P_{t-1}; \quad b_t = s_t B_t / P_{t-1}; \quad \Gamma_t = s_t R_t / P_{t-1} \]

### 3.4.1 Steady state equilibrium

It is assumed that in the long run the domestic gross inflation rate is given by the gross money growth rate (\( \Pi = \theta \)). Further, adjustment costs disappear in the steady state. Given the parameter values of Table 1, it is straightforward the derivation of steady state values for the variables of the system of equation. Table 2 presents the steady state values of a small open economy that uses 80 percent of remittances for consumption and the remaining 20 percent for investment.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Rate of Inflation</td>
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<tr>
<td>Nominal Interest Rate</td>
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<tr>
<td>Investment</td>
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<td>Output</td>
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<td>Consumption</td>
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</tr>
<tr>
<td>Trade Balance</td>
<td>-0.0752</td>
</tr>
<tr>
<td>Utility Index</td>
<td>13.1541</td>
</tr>
</tbody>
</table>

Note: Steady state values calculated for a given g

---

10 We follow Uhlig’s (1997) methodology. This appendix will be made available on the author’s web page.
11 Derivation of steady states is also available in the appendix (author’s web page).
As it can be observed, our small open economy has a (net) inflation rate of 4.5 percent per quarter, and a nominal interest rate of 5.77 percent per quarter. Investment is just over 25 percent of GDP (not considering the part of remittances flowing to investment), while consumption is approximately 86 percent of GDP, with the trade deficit allowing for these higher levels (around 8 percent of GDP).

4. Dynamics

The baseline specification of the small open economy considers the case of small positive adjustment cost in the rearrangement of money balances of about 6 minutes per week (\(\xi = 10\)), allocates remittances to be used primarily towards consumption (\(\phi = 0.8\)), assumes an elasticity of substitution that preserves the wealth effect response to monetary shocks (\(\sigma = 0.99\)), and calibrates the economy to be representative of one with a flexible exchange rate regime in which remittances are 5% of GDP. The model generates dynamics from monetary and technology shocks that are in accord with the stylized facts. A positive monetary shock generates inflationary pressure, a prolonged drop in the nominal interest rate that allows for an increase in investment, an initial drop in work effort from the wealth effect that produces an initial drop in output, and a subsequent reversal in work effort that combines with the higher capital to produce the typical humped-shape response of output. The technological shock alleviates inflation, increases the interest rate, and pushes the real wage upwards, causing an instantaneous increase in work effort that combines with higher levels of capital to result in a prolonged increase in output.\(^{12}\)

In order to examine the impact of a remittances shock on the main macroeconomic aggregates, we introduce a 1 standard deviation shock to remittances (approximately a 14% shock).

\(^{12}\) The dynamics for these two shocks are available in the appendix (later in the author’s web page).
increase). The main results are presented below in Figure 1 and show that a positive remittances shock that is primarily directed towards consumption will lead to an increase in the demand for the consumption good, exerting upward pressure on inflation. The remittances shock generates an increase in purchasing funds, which is big enough to outweigh the fall in real money cash balances caused by the higher inflation, and leads to an increase in consumption of almost 0.5%. Since the remittances shock is highly persistent, the slow dissipation of the shock dominates the subsequent dynamics of consumption, returning to its initial steady state level smoothly.

Figure 1: Dynamic response to a 1 standard deviation remittances shock
Percent deviation from steady state in vertical axis and quarters in horizontal axis
This rise in remittances also generates an instantaneous slight reduction in the interest rate (almost 2 basis points), as the percentage of remittances that are allocated for savings increase the amount of funds available for lending enough to outweigh the slight increase in inflation. The dynamics of the nominal interest rate after the period of the shock are governed by the dynamics of investment and money deposits. Starting in the second period, a reduction in the household’s money deposits ($M^h_{t+1}$) together with the temporarily above-steady-state investment generates an upward pressure on the interest rate that forces a monotonic increase in the interest rate back to its original level. Note that the remittances shock generates a liquidity effect, as shown in the left-center panel of Figure 1.

The impact on output is dependent on the behavior of capital and labor. The remittances shock increases the purchasing power of the recipient, a wealth effect, that gives rise to a slight decline in the amount of hours worked that the household provides. Since the capital stock is fixed for a period, this reduction in labor causes a small decline in output. However, since the initial decline in hours worked produce an increase in wages, the household reverses its behavior in terms of labor and starts to supply more labor from the second quarter onwards. At the same time capital accumulation is large enough during the first three quarters that enables capital to be slightly but persistently above steady state levels for a prolonged period. This higher labor participation and availability of capital lead to a small but prolonged hump-shape increase in output that peaks 14 quarters after the shock, as shown above in the bottom section of Figure 1. It is only then that the decrease in investment – and capital – combined with the slow decline in worked hours will force output to fall monotonically.
The remittances shock also generates an overshooting of the exchange rate. Higher remittances lead to an increase in consumption that produces an upward pressure on inflation, which is directly translated in an increase of the exchange rate (depreciation from purchasing power parity). The subsequent appreciation of the exchange rate arises from the interest rate differential, which is required to be equal to the expected rate of appreciation of the following periods from the uncovered interest rate parity condition. While not shown in Figure 1, the remittances shock also induces agents to increase their holdings of foreign bonds, as the domestic return is lowered. Of course, as the domestic interest rate returns to its steady state and the domestic currency appreciates the household reduces its bond holdings.

These dynamics are in accord with the reference model and the empirical evidence. An increase in remittances creates inflationary pressure in our model, as documented in Narayan et al. (2011) and Vacaflores (2012). It also generates a persistent liquidity effect, in line with the evidence provided by Giuliano and Ruiz-Arranz (2008) that remittances provide an additional alternative to finance investment. Here we find that such reduction of the interest rate leads to an increase in investment, allowing for an accumulation of physical capital that gives rise to the recovery of output, as shown by Cáceres and Saca (2006) for El Salvador. With regards to its effect on consumption, only microeconomic studies are able to measure the positive contribution to the consumption of the remittances-receiving households (Keely and Tran (1989), Leon-Ledesma and Piracha (2004) and De Haas (2006)), while macroeconomic studies only suggest that remittances increase consumption (Ratha (2003), Cáceres and Saca (2006), and Chami et al. (2008)). Our paper strengthens this link by showing that remittances when channeled for consumption do in fact increase consumption, in equilibrium.
In terms of the impact on the recipient’s work effort, our results support the finding that work effort declines due to an increase in remittances (i.e. Hanson (2007)), and that remittances have a transitory negative effect on domestic production (i.e. Funkhouser (1992), Chami et al. (2008), Acosta et al. (2009), and Vacaflores (2012)). However, the subsequent dynamics show an expansion in output similar to the ones found in studies like World Bank (2006) and Barajas et al. (2009). While we do not have an explicit measure for the real exchange rate, the dynamics that we obtain are indicative of a muted effect on the real exchange rate in the period of the shock (the percent deviations in inflation and the exchange rate are identical) but a real exchange rate appreciation thereafter, as suggested by Amuedo-Dorantes and Pozo (2004), Caceres and Saca (2006), and Acosta et al. (2009).

While our results of the remittances shock under flexible exchange rate regimes are consistent with previous findings, the response of the macroeconomic aggregates arising from alternative exchange rate regimes is still unanswered. The introduction of the interest rate rule in our model allows us to change the degree of responsiveness of the interest rate to changes in the nominal exchange rate, with increases in $\chi_s$ prompting a more aggressive response of the Central Bank to deviation in the exchange rate (thus reducing the importance of inflation and output in the policy rule). This allows us to examine more rigid exchange rate regimes by increasing the parameter $\chi_s$. We retain our flexible exchange rate regime used in the baseline calibration ($\chi_s = 0.01$) and model an intermediate regime with the in-between calibration ($\chi_s = 0.5$) and a more rigid exchange rate regime with the highest calibration ($\chi_s = 2$).\footnote{Of course, the completely fixed exchange rate regime would be modeled by setting this value to an arbitrarily high value, as it would theoretically approach infinity.}

13
The benchmark calibration still has remittances being 5 percent of GDP, has 80% of remittances being directed for consumption, and maintains the responsiveness parameters of the utility function. Since the exchange rate is directly related to inflation via purchasing power parity, the reduction of flexibility in the exchange rate (the increase in $\chi$, ) forces the Central Bank to reduce the growth rate of money by a greater proportion to reduce the inflationary pressure brought about by the increase in remittances. Lower inflation consequently translates to a smaller depreciation. The greater reduction in money growth thus exerts a downward pressure on the interest rate that is large enough to outweigh the upward pressure on the policy interest rate brought about by the larger response to the increase in the exchange rate, resulting in a more accentuated decline in the interest rate on impact, although it becomes less persistent, as shown below in Figure 2.\textsuperscript{14} Households benefit from this lower inflation, with the increase in remittances allowing them to consume more as the exchange rate becomes more rigid (increasing consumption by an additional 0.1 percent).

At the bottom two rows of Figure 2 we observe the dynamics of capital and labor, which determine the behavior of output. The results indicate that while the initial decline in the interest rate leads to relatively similar initial increases in investment and capital under alternative exchange rate regimes, the weaker liquidity effect from the more rigid exchange rate leads investment to return to steady state levels at a faster pace, reducing the subsequent accumulation of capital as the exchange rate regime becomes more rigid. Although the supply of labor declines in all cases (because of the wealth effect), the smaller decline experienced as the exchange rate regime becomes more rigid leads to a corresponding

\textsuperscript{14} Mandelman’s (2012) model does not have purchasing power parity and thus the increase in inflation does not trigger a one-for-one increase in the exchange rate, but instead increases the policy interest rate and create a capital inflow that appreciates the domestic currency.
smaller decline in output – since capital is fixed for a period. However, the subsequent dynamics of labor and capital emanating from the more rigid exchange rate regime have important implication for the behavior of output. The accentuated decline in labor in the more flexible case leads to a larger and more persistent increase in wages, which produces a monotonic increase in hours worked that peaks later than in the more rigid cases, with the peak being lower as the exchange rate regime becomes more rigid – in fact, labor in the more rigid regime case does not return to the initial steady state level. This weaker recovery of labor and smaller accumulation of capital generated by the more rigid exchange rate regime.
leads to quicker but smaller recoveries of output, with the more rigid case barely returning to
the initial steady state level of output after 5 quarters, the intermediate case obtaining an
increase in output of approximately 0.01 percentage points after 8 quarters, and with the
more flexible case approaching an increase of 0.02 percentage points after 14 quarters.

With respect to the behavior of prices, the smaller initial decline in output in the more
rigid exchange rate cases lead to a smaller inflationary pressure, as relatively more goods are
available to satisfy the higher demand caused by the inflow of remittances. While it is not
shown here, it is also worth noting that in our model the larger decline in the interest rate
experienced from the more rigid exchange rate regime leads to an accentuated increase in
foreign bond holdings – there is a delayed response in foreign bonds, such that the liquidity
effect becomes the driving force.

5. Empirical Evidence

The literature contains little empirical evidence of an effect of remittances on real
GDP of the remittances-receiving country, using a number of alternative specifications,
*dangerons, controls, and time periods (i.e. World Bank (2006), Barajas et al. (2009), Giuliano
and Ruiz-Arranz (2009)). Since there is no consistent evidence that we could use to compare
with the results from our theoretical model, we specify and estimate a basic growth
relationship to uncover the relevance and influence of remittances on the growth rate of the
receiving economy. We specify the growth rate of the economy to be persistent and a
function of traditional measures that are available at quarterly frequency, and we add
remittances:

\[
gr_{t,t} = \beta_0 g_{t,t-1} + \beta_1 g_{t,t-2} + \beta_3 g_{t,t-3} + \beta_4 g_{t,t-4} + \beta_1 C_{t,t} + \beta_2 C_{t,t-1} \\
+ \beta_1 EX_{t,t} + \beta_2 EX_{t,t-1} + \beta_3 INV_{t,t} + \beta_4 INV_{t,t-1} + \beta_5 MS_{t,t} + \beta_6 MS_{t,t-1} \\
+ \beta_7 REM_{t,t} + \beta_8 REM_{t,t-1} + \beta_9 reddiff_{t,t-1} + \beta_{12} \text{gr}_{t,t-1} + \varepsilon_{t,t}
\]
Here \( gr \) is the annualized growth rate of real GDP in the remittances-receiving country, \( C \) is the share of consumption relative to GDP, \( EX \) is the share of exports to GDP, \( INV \) is the share of domestic investment to GDP, \( MS \) is the broader measure of domestic money supply (M2) as a percentage of GDP, \( REM \) is the share of remittances to GDP, \( irdiff \) is the interest rate differential (here the domestic deposit rate minus the U.S. money market rate), and \( grer \) is the annualized change in the nominal exchange rate (domestic currency per U.S. dollar). The subscript \( i \) denotes the country and the subscript \( t \) the year. The error term follows the standard one-way error specification:

\[
\varepsilon_{i,t} = \mu_i + \nu_{i,t}
\]

where \( \mu_i \) denotes the unobservable country specific effect and \( \nu_{i,t} \) denotes the remainder disturbance, i.i.d. over the whole sample with variance \( \sigma^2 \).

Table 3 presents the overall descriptive statistics for our sample over two periods, the 1990s and the 2000s. In the first decade the growth rate of real GDP averages 3.6%. The consumption share of GDP averages 83%, the export share 15%, the investment share 19%. M2 averages almost 71% of GDP. The interest rate differential (demand deposit rate minus U.S. money market rate) averages 180%, and the exchange rate annual depreciation averages 174%. Finally, remittances average 4.3% of GDP.

| Table 3. Descriptive Statistics |
|---------------------------------|-----------------|-----------------|-----------------|
|                                 | 1990’s          | 2000’s          |                 |
|                                 | Mean | Standard Deviation | Mean | Standard Deviation |
| Growth rate of real GDP         | 3.58 | 3.85             | 3.70 | 3.60             |
| Consumption (% of GDP)          | 83.81| 8.29             | 80.71| 9.46             |
| Exports (% of GDP)              | 14.95| 7.84             | 19.66| 8.49             |
| M2 (% of GDP)                   | 70.51| 42.02            | 96.96| 52.16            |
| Investment (% of GDP)           | 18.88| 3.76             | 19.68| 4.14             |
| Interest rate differential      | 179.55| 1687.13          | 5.69 | 6.95             |
| Exchange rate depreciation      | 174.31| 1466.90          | 2.82 | 13.64            |
| Remittances (% of GDP)          | 4.31 | 5.28             | 5.02 | 5.03             |
Things change in the second decade. Average real GDP growth at 3.7% is similar to the earlier period, as is consumption as a percent of GDP at 81%. Exports as a percent of GDP are higher, almost 20% in the second period, and M2 as a percent of GDP is also higher at 97%, due to the lower inflation rate in the second decade and hence lower interest rate differential, 5.7%, and exchange rate depreciation, 2.8%. Remittances as a percent of GDP are a bit higher in the second decade at 5%.

Note that the interest rate differential at time $t$ is approximately equal to the annual rate of depreciation in the exchange rate from date $t$ to $t+1$, assuming that the forward premium is a reasonably good predictor of future exchange rate movements. In our data set the interest rate differential is measured at time $t$ and the rate of depreciation in the exchange rate at time $t$ is the change from $t-1$ to $t$ (and, importantly, not from $t$ to $t+1$). Still, the average interest rate differential is quite close to the rate of depreciation in the exchange rate.

We estimate the growth specification and three additional extensions. The estimation method is a dynamic panel, and we employ the methodology of Arellano and Bond (1991). The data is the same than the one used for the calibration of the theoretical model, and investment and remittances are taken as endogenous. The results of the dynamic model provide reasonable parameter estimates, but since they are lengthy they are presented in the Appendix. The degree of persistence of the growth rate of real GDP is statistically significant and around 0.55. Consumption and the money supply exert a negative effect on the growth rate, with their contemporaneous effect being statistically significant at the 5% confidence level. Contemporaneous increases in exports have a positive and statistically significant effect on the growth rate of GDP, as does the lagged effect of investment (both at the 5% confidence level). We also find that an increase in the interest rate differential – an increase
in the domestic interest rate relative to the interest rate in the U.S. – reduces the growth rate of GDP, as it makes the cost of investment relatively more expensive, and that increases in the rate of depreciation of the exchange rate reduces the growth rate of GDP – perhaps as it reduces economic stability. Neither Sargan’s over-identification test nor the tests for second-order serial correlation (reported at the bottom of Table 4) detect any problems with the validity of the instruments or with the serial correlation assumptions.

The results of interest to this study are the ones that measure the relevance of remittances, and are presented in Table 4 below. The results of our baseline specification show that contemporaneous increase in the share of remittances to GDP exerts a negative effect on the growth rate of GDP. The results indicate that a 1 percentage point increase in the ratio of remittances to GDP leads to a 0.65 percentage point decline in the growth rate of real GDP, being statistically significant at the 1 percent confidence level. However, we also find that lagged remittances exert a positive and statistically significant effect on the growth rate of GDP. Further, this effect is nearly as large as the contemporaneous impact, implying that the long run impact of remittances on GDP growth is relatively small.

To get better insight, and test the robustness of these results, we introduce a dummy variable for regional differences (with SA = 1 if the receiving country is in South America, zero otherwise), another for countries in which remittances are a high fraction of GDP (with HF = 1 if the inflow of remittances is above 5 percent of GDP, zero otherwise), and for two distinct exchange rate regimes in place (with MFERR = 1 if the receiving country’s exchange rate regime is relatively more rigid, zero otherwise).15 We introduce the interaction of these

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15 We take the exchange rate classification provided by Levy Yeyati and Sturzenegger (2005). We classify them as “more flexible” if their score is 2 or 3 (float and dirty), and “more fixed” if the score is greater than 3 (dirty/crawling peg and fix). The behavior in terms of exchange rate policy did not vary significantly in the countries of the study during our sample period.
dummies with the variable of interest (remittances) one at the time in columns 2, 3, and 4.

Table 4. Effect of Remittances on real GDP growth rate, Latin American countries

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>By regions</th>
<th>By Importance of Remittances as share of GDP</th>
<th>By Exchange Rate Regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remittances</td>
<td>-0.65***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.196)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Remittances</td>
<td>0.61**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.198)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remittances in C.A.</td>
<td>-0.68**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Remittances in C.A.</td>
<td>0.62**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.210)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remittances in S.A.</td>
<td>-.417</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.488)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Remittances in S.A.</td>
<td>.433***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.161)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remittances (for remittances a Low Fraction of GDP)</td>
<td>-0.70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.594)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Remittances (for remittances a Low Fraction of GDP)</td>
<td>0.79*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.602)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remittances (for remittances a High Fraction of GDP)</td>
<td>-.644***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.155)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Remittances (for remittances a High Fraction of GDP)</td>
<td>.584***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remittances in More Flexible exchange rate regime</td>
<td>-0.63**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.229)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lag Remittances in More flexible exchange rate regime</td>
<td>0.68**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.230)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remittances in More Fixed exchange rate regime</td>
<td>-.645***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.183)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Remittances in More Fixed exchange rate regime</td>
<td>.461***</td>
<td></td>
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<tr>
<td></td>
<td>(0.111)</td>
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</tbody>
</table>

Observations: 438
AR(1) Test: 0.0064, 0.0062, 0.0065, 0.0065
AR(2) Test: 0.26, 0.30, 0.25, 0.29
Sargan (p-value): 0.21, 0.23, 0.34, 0.22

Note: The total estimates of remittances under the alternative scenarios are presented here (estimates of the interaction term are available in the Appendix). Statistical significance given by *** for 1% confidence level, ** for 5% confidence level, and * for 10% confidence level. Robust Standard Errors in parentheses. Bolivia, El Salvador, and Honduras are excluded due to insufficient data.

Table 4 presents the overall impact for each of these classifications, and not the estimated marginal effect, for easiness of exposition. When we account for regional
differences we find that the contemporaneous effect of remittances on output remains negative for both sets of countries (-0.68 in C.A. countries and -0.42 in S.A. countries), but it is statistically significant only for Central American countries. The lagged effect is positive and statistically significant in South American countries (0.43) and in Central American countries (0.62), with the latter being almost 45% larger. These results suggest that for both sets of countries the long run impact is relatively small, but perhaps more beneficial for South American countries.

Column 3 presents the results when the degree of remittances (relative to GDP) is taken into consideration, and we find that the contemporaneous effect of remittances on the growth rate remains negative for both sets of countries (-0.70 and -0.64), but it is statistically significant only for countries with remittances being more than 5 percent of GDP. In this case the lagged effect is positive for both sets of countries but statistically significant only for high-remittances countries, although the effect on low-remittances countries is 36% larger than in high-remittances countries. In these high remittances countries remittances first reduce the growth rate of GDP but then it reverses in the subsequent quarter.

Column 4 provides evidence of the differential effect that remittances have on the growth rate of GDP depending on the exchange rate regime in place. The results show that the contemporaneous negative effect of remittances on the growth rate is nearly the same in these two sets of countries (-0.63 in the more flexible regimes and -.65 in the more fixed regimes), but the subsequent recovery in the growth rate from the increase in remittances is much larger in the countries with a more flexible regimes (0.68 instead of 0.46). All

16 While the estimates of the interaction term are not statistically different than zero, testing of the overall effect indicate that both the contemporaneous and lagged total effects are statistically significant at the 1% confidence level. This also holds for the estimates from the specification controlling for the exchange rate regime in place.
estimates are statistically significant. Remittances initially reduce the growth rate of GDP irrespective of the exchange rate regime in place, but the subsequent recovery is stronger in the more flexible exchange rate regime, suggesting a more beneficial long run effect of remittances on the growth rate in countries with more flexible regimes.

One can take these estimated coefficients and calculate the long term response (IRFs) of the growth rate of real GDP from an increase in remittances. Figure 3 below presents the dynamics of the growth rate of GDP resulting from a similar 1 percent increase in remittances, with the first column presenting the dynamics arising from the coefficients of the baseline specification, the second column from the coefficients from the more flexible exchange regime case, and the third column from the coefficients from the more fixed exchange regime case. In Figure 3 the first row presents the IRFs for a permanent increase in remittances as a percent of GDP, while the second row presents IRFs for a temporary increase in remittances. All figures are produced based on the coefficients of Table 4.

For a 1 percent permanent increase in remittances, the resulting dynamics for our baseline case indicate that the growth rate of GDP will first drop by approximately 0.006 percent to then gradually increase. The effect on the growth rate dissipates by the fifth quarter. The more flexible exchange rate regime countries tend to behave like the baseline case, but the growth rate of real GDP returns to zero faster than in the baseline case (4 quarters) and overshoots reaching about 0.3 percent above the initial level before declining. In the more fixed exchange rate countries the permanent increase in remittances causes the

17 Allowing \( \omega \) to be the size of the shock, then the dynamics of a percent permanent shock in remittances are given by

\[
x_t = \beta_0 x_{t-1} + \beta_1 \omega x_{t-1} + \beta_2 \omega^2 x_{t-1} + \beta_3 \omega^3 x_{t-1} + \beta_4 \omega^4 x_{t-1} + \beta_5 \omega^5 x_{t-1} + \beta_6 \omega^6 x_{t-1} + \beta_7 \omega^7 x_{t-1} + \beta_8 \omega^8 x_{t-1} + \beta_9 \omega^9 x_{t-1} + \beta_{10} \omega^{10} x_{t-1} + \ldots
\]

and the dynamics of the temporary shock in remittances is given by

\[
x_t = \beta_{11} x_{t-1} + \beta_{12} \omega x_{t-1} + \beta_{13} \omega^2 x_{t-1} + \beta_{14} \omega^3 x_{t-1} + \beta_{15} \omega^4 x_{t-1} + \beta_{16} \omega^5 x_{t-1} + \beta_{17} \omega^6 x_{t-1} + \beta_{18} \omega^7 x_{t-1} + \beta_{19} \omega^8 x_{t-1} + \beta_{20} \omega^9 x_{t-1} + \beta_{21} \omega^{10} x_{t-1} + \ldots
\]
same initial decline in real GDP growth, about 0.006 percent, but this lower level persists for several quarters. In fact, the subsequent improvement is not enough to return the growth rate to its initial level, and it stabilizes at approximately 0.004 below the steady state level. Note that the impact of a permanent change in remittances is more beneficial – in terms of growth – in countries with more flexible exchange rate regimes, a result qualitatively almost identical to the one obtained with our theoretical model.

<table>
<thead>
<tr>
<th>Baseline</th>
<th>More Flexible Exchange Rates</th>
<th>More Fixed Exchange Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>gr real GDP</td>
<td>gr real GDP</td>
<td>gr real GDP</td>
</tr>
</tbody>
</table>

![Figure 3](image)

*Figure 3: Dynamic response of the growth rate from an increase in remittances*

*First row is impact of permanent change in remittances; second row is impact of temporary change*

*Percent change in vertical axis and quarters in horizontal axis*

In the case of a temporary increase in remittances, presented in the bottom row of Figure 3, the negative impact on the growth rate of GDP is short-lived. Our baseline results indicate that the initial decline in the growth rate is immediately reversed, and hovers at around 0.002 for approximately 4 quarters before declining slowly to its steady state level. In the more flexible case the initial impact is similar, as is the return to positive levels in quarter 2 and peaks at approximately 0.003 before starting to decline towards its steady state level. In the more fixed regime the dynamics are similar but the recovery is much weaker.
and slow, peaking at 0.0014 only after five quarters. It then declines towards the steady state level. These results indicate that temporary shocks to remittances exerts more beneficial effects on the growth rate of GDP in countries under more flexible exchange rate regimes, as it peaks sooner and at higher levels, which is only partially true in our theoretical results.

Overall, then, the impact of an increase in remittances in the more fixed exchange rate regime countries shows a bigger negative impact on real GDP growth than do the more flexible exchange rate regime countries. These dynamics emanating from the estimated coefficients provide some support for our theoretical results. In Figure 2 we showed that a flexible exchange rate regime had a bigger negative impact of a remittances shock, but a stronger rebound to positive growth rates and, overall, a more positive impact than the fixed exchange rate regime. The fixed exchange rate regime has a smaller-magnitude negative impact, but the recovery is never into positive territory (or only marginally so), and the overall impact is negative. Our empirical work needs to be interpreted cautiously, because it is about more flexible and less flexible exchange rate countries instead of the theoretical concept of completely flexible versus completely fixed exchange rate regimes. Also, our econometric specification is simple and does not incorporate feedback between investment and output changes today and output in the future. Still, we take some comfort that our regression results are roughly consistent with our theoretically inspired IRFs.

Our result that a remittances shock creates an initial reduction in output – before recovering – is in accord with Jansen et al. (2012), but opposite to Mandelman (2012), who actually find an increase in output on impact. While the labor response is at the center of these dynamics, the empirical evidence from our specification for Latin American economies renders support to a modeling where labor declines on impact, as we presented here.
6. Conclusions

Our limited participation model with remittances is able to capture the qualitative behavior of the main macroeconomic aggregates in response to a remittances shock, in accord with empirical evidence. This study extends the literature by evaluating the macroeconomic dynamics that emanate from a remittances shock under alternative exchange rate regimes by introducing an interest rate policy function. Alternative degrees of responsiveness of the policy interest rate to deviations in the exchange rate allow us to examine the relevance of more rigid exchange rate regimes in the propagation of a remittances shock.

The typical remittances shock increases consumption and lowers work effort on impact. It also results in a small one-period increase in inflation that forces the domestic currency to depreciate on impact, but since it also creates a liquidity effect it gives way to a subsequent appreciation through the uncovered interest rate parity condition. The decline in the interest rate generates an increase in investment that allows for the accumulation of capital, which combines with a recovery of labor to produce a hump-shaped expansion of output. The remittances shock leads to a delayed improvement of GDP.

Higher degrees of rigidity in the exchange rate regime are able to produce smaller inflationary pressure but also result in a less persistent liquidity effect, which reduces the subsequent accumulation of capital. Although it also produces a smaller initial decline in labor, the weaker recovery in labor combines with the smaller accumulation of capital to produce a weaker and shorter lived recovery in output. More rigid exchange rate regimes thus reduce the propagation mechanism of the remittances shock and affect negatively the subsequent recovery of output in the receiving economy. The empirical results of a simple
growth specification for a set of Latin American countries provide supporting evidence of this differential effect, showing that countries with more rigid exchange rate regimes experience a stronger negative effect on the growth rate of GDP resulting from an increase in remittances, with its lagged effect reverting the initial fall in the growth rate but such recovery being weaker in the countries with more rigid exchange rate regimes.
References


