Remittances, Monetary Policy and Partial Sterilization

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Abstract: Remittances play a large and important role in certain economies, where they became a significant share of GDP. Official government records of these flows have improved systematically since we realized its importance, but a significant percentage of remittances are still unrecorded. This, together with the shadow economy, may pose a problem for monetary policy. This paper uses a limited participation model to examine the differential effect that higher shares of remittances can have on monetary policy, and describes the impact of remittances on a small open economy under partial sterilization. It demonstrates how a typical monetary shock will lead to a more pronounced liquidity effect when remittances become a higher proportion of GDP. It also shows that a positive remittances shock improves consumption and lowers the interest rate, but as it also reduces work effort it momentarily lowers output. Such dynamics are exacerbated as the degree of partial sterilization is accentuated.

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I. Introduction

Remittances have been increasing for the last several decades. International estimates of official remittances flows suggest that the total amount of worker remittances have increased to 300 billion U.S. dollars in 2010 (Inter-American Development Bank). This increase may in part be attributed to the rapid growth of money transfer institutions, which has reduced the average transaction cost and has made them more visible, but it may be also indicative of an actual increase in these monetary transfers due to increased migration flows. They now represent approximately 45 percent of net private capital flows to developing countries.

The importance of remittances for remittances-receiving developing countries does not just come from their size but mainly from its potential and actual effects on both the society and the individual. Remittances affect labor market decisions, school retention, export-sector competitiveness, and financial deepening (Funkhouser (1992), Glytsos (2002), Cox-Edwards and Ureta (2003), Amuedo-Dorantes and Pozo (2004), Chami *et al.* (2005) and Giuliano and Ruiz-Arranz (2009)). In terms of consumption, remittance flows have gone from satisfying basic needs to also provide a vast array of durable goods for the recipient households. They can thus potentially promote economic growth and development through higher domestic demand, if they are motivated by altruism, or through enhanced productive capacity, if they are motivated by self-interest.

Most of the remittances' literature focuses on the microeconomic implication of such flows, for the sender or the receiver of these funds. Based on survey data, this trend of the literature has examined the motivation to remit – contractual arrangements, altruism, repayment of migration costs, etc. – and the uses of these funds in the home

country – for education, health care, entrepreneurial initiatives, social works, etc. At the macro level, the literature on the impact of remittances on the recipient country is sparse but growing, as we realize that it could have important effects on the overall economy.

However, the examination of the potential influence that higher levels of remittances can have on the implementation of monetary policy has been overlooked, and thus still limited. Since remittances provide a secondary income to the household, it would affect its decision with respect to labor supply and consumption, which can alter the effectiveness of monetary policy when this additional income is a significant portion of the household's income. In addition, while domestic governments usually try to sterilize capital flows to sustain a given policy, the high levels of informality in some developing countries and the significant portion of remittances that continue to flow through informal channels makes monetary targeting more problematic. Given these potential complications, monetary policy could potentially have a differential impact depending on the remittances' share of GDP, and fluctuations in remittances can affect the amount of money in circulation and thus economic performance. Accounting for such influences thus became imperative for stabilization policy.

This study examines the potentially different impact that monetary policy can have on output depending on the relative share of remittances as a percentage of GDP, and the differential effect that remittances shocks can have on the main macroeconomic aggregates when economies do not fully sterilize such inflows, channels never explored before. It builds on the theoretical model developed by Jansen *et al.* (2010), explicitly incorporating remittances in a small open economy framework, and is able to show that monetary policy has a differential effect on output depending on the relative size of this remittances. Higher remittances dependence accentuates the reduction in work effort, outweighing the improvement in investment from the pronounced liquidity effect and thus depressing the output response. It also shows that partial sterilization of such flows exacerbates the remittances effect, especially in terms of the interest rate and work effort. While increases in the effect of remittances on money growth produce a more pronounced liquidity effect, the bigger wealth effect that accentuates the drop in worked hours creates a larger transitory drop in output.

The remainder of this paper is organized as follows. Section II presents a brief summary of the literature review. Section III formulates a theoretical model to analyze this topic. Section IV discusses the results and section V summarizes and concludes.

II. Literature Review

The reasons why migrant workers send money back to their relatives in their home country has already been extensively examined, especially through the microeconomic literature on migration and remittances. However, residents of labor exporting countries are receiving substantial annual flows of remittances, in many cases exceeding other capital inflows, becoming important at the macro level too. For example, of the estimated 60 billion U.S. dollars flowing to Latin America and the Caribbean in 2010 in the form of remittances, Mexican households have received 21 billion U.S. dollars. While such flows make Mexico the biggest recipient in the region, other countries of the region are experiencing significantly higher inflows as a share of GDP, like Honduras (17.6%), El Salvador (16.7%) and Guatemala (11%).

This has generated an interest in the examination of the effect of remittances on macroeconomic aggregates and its potential impact on the receiving economy.

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Remittances can influence consumption patterns, if migrants remit for altruistic reasons, or investment levels, if the motivation is self-interested (Lucas and Stark (1985)). Irrespective of the motivation, remittances thus can stimulate economic activity both directly (investment) and indirectly (consumption), leading to potential increases in production, employment and disposable income (Durand *et al.* (1996), Widgren and Martin (2002)), Heilman (2006)). While the literature continues to provide potential links to economic growth, it also acknowledges that remittances can also bring challenges (Keely and Tran (1989), León-Ledesma and Piracha (2004) and De Haas (2006)).

Of particular interest for this paper are the effects on inflation, the exchange rate, work effort, and policy responsiveness. Heilman (2006) argues that the inflows of remittances can generate inflationary pressure, especially if they stimulate internal demand for imported goods. Narayan *et al.* (2011) confirm this effect in a set of 54 developing countries for the period 1995-2004, showing that remittances generate inflationary pressures, which becomes accentuated in the long run. The findings in Vacaflores *et al.* (2011) also imply that remittances give rise to inflation. They examine empirically the determinants of international reserves in Latin America and show that remittances exerts a positive and significant effect on the accumulation of international reserves – to the extent that Central Banks have to inject money into the economy to redeem these foreign currency remittances, they increase the money supply if they do not fully sterilize such flows.

In terms of exchange rate effects, since remittances usually come in dollar form they can create "Dutch Disease" effects in the receiving economies as they could appreciate the domestic currency, making domestic products relatively more expensive

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then foreign products and thus affecting exports (Acosta *et al.* (2009), Amuedo-Dorantes and Pozo (2004)). While this result is being taken as standard, Barajas *et al.* (2009) warns that it can be arising from specific modeling assumption in theoretical models, and thus could be moderated or even reversed by reasonable modification. Furthermore, while they corroborate empirically the finding that remittances affect the real exchange rate, they conclude that such effect is quantitatively very small. Acosta *et al.* (2009b) also indicate that the effect of remittances on the real exchange rate diminishes as the degree of financial development increases, and Mongardini and Rayner (2009) point out that this relationship would be dependent on the use of remittances on nontradables and tradables.

It has also been found that remittances can be detrimental to economic growth since they reduce the work effort of recipient households (i.e. Funkhouser (1992), Chami *et al.* (2008), Acosta *et al.* (2009), Jansen *et al.* (2010)), putting downward pressure on output. While this effect is becoming standard, if one treats the migration process as a household decision then these remittances are not just a gift from relatives, altering the behavior of the receiving household and mitigating the negative effect on leisure (Jansen and Vacaflores (2011)). In fact, Cox-Edwards and Rodriguez-Oreggia (2009) find in a recent cross-sectional study for Mexico that persistent remittances has limited effect on labor force participation rates while Funkhouser (2006) finds no major effect of remittances on labor status in Nicaragua using longitudinal data – only teenagers in remittances' receiving households experience a decline. Mandelman (2011) goes beyond this trend and uses a DSGE model with heterogeneous agents to actually generate an increase in labor as a result of a remittances shock.

Increasing levels of remittances can have an effect on policy responsiveness too. Since remittances provide a secondary source of income, the behavioral response of the recipients can affect the effectiveness of monetary policy, especially if this additional income is a significant portion of the household's income. In fact, higher remittances enable the household to insulate itself from government policy to some degree, allowing for consumption smoothing without large fluctuations in work effort. In addition, the high levels of informality in some developing countries and the significant portion of remittances that continues to flow through informal channels makes the sterilization of these capital flows more problematic. Higher inflows could then accentuate this problem and make monetary policy less effective.

Some recent studies have started to examine the implication of this potential influence. Chami *et al.* (2008) developed a stochastic dynamic general equilibrium (DSGE) model that includes government policies to study the implication of remittances for monetary and fiscal policy in the recipient country. They show that optimal monetary policy will differ between the remittance-dependent economy and an economy with no significant remittances. In economies that rely in labor income taxes, higher remittances forces governments to increase their money growth to raise revenue from a smaller base of domestic production, as work effort is reduced. In a recent paper, Mandelman (2011) develops a DSGE model with heterogeneous agents, monopolistic competition and market frictions to analyze the role of monetary policy in remittances receiving countries, and find that a positive remittances shock generates inflation that is controlled by the monetary authority through a contraction of the money supply – a rise in the interest rate.

His paper includes a monetary policy rule $a \ la$ Taylor – more representative of more developed countries – that triggers an automatic response to fluctuations.

Similar in spirit, Giuliano and Ruiz-Arranz (2009) use a panel of 73 developing countries to show that remittances provide a solution for liquidity constraints in countries with less developed financial systems. Remittances become an alternative way to finance investment, in a sense loosening the credit constraint of the recipients and thus altering the effectiveness of monetary policy. Jansen *et al.* (2010) also look at this issue, and using a DSGE model they are able to unveil a differential effect of remittances shocks for economies with different degrees of sterilization. They find in one of their robustness checks that a positive remittances shock enhances the drop in the interest rate as they allow for partial sterilization, and that the labor-leisure tradeoff is exacerbated due to indirect effects on the money growth and inflation.

The model specification here is similar to Jansen *et al.* (2010), but additional constrains are added to improve the strength of the model – the interest on foreign bonds is allowed to be determined by domestic fluctuations, adjustment costs on physical capital are introduced, an interest rate differential on foreign bond holdings is used to provide stability on the behavior of bonds, and a log-linear utility function is used instead of their CES function. Also, remittances are only used for consumption here.

III. Theoretical Model

We model a small open economy that includes a representative consumerhousehold, a goods-producing firm, a central bank, and a financial intermediary. The Limited Participation Model used requires agents to hold money balances to finance consumption, and agents incur an adjustment cost when altering their money holdings.

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This model has been used to rationalize a large and persistent liquidity effect. The monetary shock is assumed to occur after households have decided on their deposit balances, generating a liquidity effect. However, this is not sufficient to yield a persistent liquidity effect, so adjustment costs on cash money holdings, M_t^c , are also introduced.

We model the cost of changing money holdings similarly to Hairault *et al.* (2004), who take into account the time spent on reorganizing the flow of funds. The adjustment cost equation is given by:

$$\Omega_t = \frac{\xi}{2} \left(\frac{M_{t+1}^c}{M_t^c} - \theta \right)^2 \tag{1}$$

Here the long run value of $\frac{M_{t+1}^{c}}{M_{t}^{c}}$ is equal to the money growth parameter θ , so both the

level of Ω_t and its derivative with respect to $\frac{M_{t+1}^c}{M_t^c}$ is zero in the steady state. The cost of

changing M_t^c is an increasing function of the parameter ξ , which calibrates the time spent rearranging money balances.

The cost of adjusting money holdings implies that bank deposits would not change significantly following a monetary shock, and consequently, the firm will have more funds to absorb as the decrease in the interest rate is stronger and more persistent. Given uncovered interest rate parity (UIP) this large and persistent fall in the interest rate differential generates an overshooting in the exchange rate in accord with the stylized facts.

3.1. Structure of the model

The goods market is characterized by perfect competition, with domestic firms and the rest of the world competing in the production of an identical good, whose price in domestic currency 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, and keeping in mind that the small open economy assumption implies that the price of the good in foreign currency (P^*) is exogenous, then purchasing power parity is given by:

$$P_t = s_t P^* \tag{2}$$

3.1.1. The household

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

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

where *C* is 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. The per-period utility function is log-linear in consumption and leisure, given by

$$U(C_t, L_t) = \log C_t + \gamma \log(1 - H_t - \Omega_t)$$
(4)

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

$$P_t C_t \le M_t^c + s_t \mathfrak{R}_t \tag{5}$$

where M_t^c denotes the amount of cash hold by the household for consumption purchases at the beginning of the period, and \Re_t is the amount of money received as remittances by the household¹.

The household can hold foreign assets that yield a risk-free nominal interest rate i_t^* . In each period the household buys foreign assets B_{t+1} (denominated in the foreign

¹ Remittance flows come in foreign currency, so the nominal exchange rate (s) determines its purchasing power in the domestic economy.

currency). Thus, the nominal exchange rate becomes a key variable in the portfolio decision of the household.

The household budget constraint is given by:

$$M_{t+1}^{c} + M_{t+1}^{b} + s_{t}B_{t+1} + P_{t}C_{t} \leq M_{t}^{c} + s_{t}\mathfrak{R}_{t} + P_{t}w_{t}H_{t} + (1+i_{t})M_{t}^{b} + s_{t}(1+i_{t}^{*})B_{t} + D_{t}^{f} + D_{t}^{b}$$
(6)

Thus 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} . Household income is determined by the real wage w_t , and the profits (or dividends) received at the end of the period from the firm and the bank, D_t^f and D_t^b . The domestic nominal interest rate on deposits is given by i_t .

The household's maximization problem can be represented by the value function

$$V(M_{t}^{c}, M_{t}^{b}, B_{t}) = \max_{\{C_{t}, H_{t}, M_{t+1}^{c}, M_{t+1}^{b}, B_{t+1}\}} \left\{ U(C_{t}, 1 - H_{t} - \Omega_{t}) + \beta E_{t} V(M_{t+1}^{c}, M_{t+1}^{b}, B_{t+1}) \right\}$$

subject to the cash-in-advance constraint (5) and the budget constraint (6). Letting λ_t denote the Lagrangian multiplier associated with the budget constraint, the first order necessary conditions for the household's choice of consumption, labor, money deposits, money-cash holdings, and foreign assets take the form

$$\lambda_{t} = \beta E_{t} \left[(1 + i_{t+1}) \lambda_{t+1} \right]$$
(7)

$$-U_{H_t} = w_t P_t \lambda_t \tag{8}$$

$$s_t \lambda_t = \beta E_t [s_{t+1} (1 + i_t^*) \lambda_{t+1}]$$
(9)

$$P_{t}w_{t}\lambda_{t}\frac{\xi}{M_{t}^{c}}\left(\frac{M_{t+1}^{c}}{M_{t}^{c}}-\theta\right)+\lambda_{t}=\beta E_{t}\left[\frac{U_{Ct+1}^{c}}{P_{t+1}}\right]$$
$$+\beta E_{t}\left[P_{t+1}w_{t+1}\lambda_{t+1}\frac{\xi M_{t+2}^{c}}{(M_{t+1}^{c})^{2}}\left(\frac{M_{t+2}^{c}}{M_{t+1}^{c}}-\theta\right)\right]$$
(10)

We denote the shadow price associated with the household real wealth by $\Lambda_t = P_t \lambda_t$. Equation (7) requires equality between the costs and benefits of bank deposits, while equation (8) requires equality between the marginal disutility of working and the marginal benefit – the real wage multiplied by the Lagrange multiplier. Equation (9) 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, and equation (10) equates the costs and benefits related to the choice made at time *t* of money holdings available for consumption in the following period. It is clear that if the adjustment costs are zero ($\xi = 0$) then equation (10) will just equate the household's cost of holding money in the current period to the marginal utility of consumption in the following period, properly discounted. However, when adjustment costs exist ($\xi \neq 0$), the household will compare the cost of changing money holdings (cash) today to the benefits accrued in the next period with respect to the purchasing power of money holdings and the in-advance time saved rearranging the household portfolio.

3.1.2. The Firm

The production technology of the firm is given by the Cobb-Douglas function

$$Y_t = e^{z_t} K_t^{\alpha} H_t^{1-\alpha} \tag{11}$$

where $\alpha \in [0,1]$ and *K* is the usual 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 its owner, the household. Thus the firm's decision trades off paying dividends at the end of the current period versus reinvesting those dividends in physical capital of the firm. The firm receives its profits at the end of the period, so the firm 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 profits of the firm are given by²

$$D_{t}^{f} = P_{t}Y_{t} - P_{t}w_{t}H_{t} - P_{t}(1+i_{t})I_{t} - P_{t}\Theta_{t}$$
(12)

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

$$I_{t} = K_{t+1} - (1 - \delta)K_{t}$$
(13)

and with δ being the (constant) depreciation rate. The parameter Θ in equation (12) is the adjustment cost of capital, and is given by

$$\Theta_{t} = \frac{\nu}{2} (K_{t+1} - K_{t})^{2}$$
(14)

The decision about the use of dividends, either payments to households or reinvestment in the firm, is captured by the ratio of the multipliers associated with the budget constraint of the household in the value function (see equation (7)), as it reflects the consumer's variation in wealth. The value function of the firm is then

$$V(K_t) = \underset{\{H_t, K_{t+1}\}}{Max} \{ D_t^f + E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \right] V(K_{t+1}) \}$$
(15)

 $^{^{2}}$ 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.

Note that the discount factor $\beta \frac{\lambda_{t+1}}{\lambda_t}$ can be written as $[E_t(1+i_{t+1})]^{-1}$, reflecting

the fact that the appropriate discount rate is time varying and reflects the marketdetermined interest rate.

The first order necessary conditions for the household's choice of labor and capital take the form:

$$w_t = (1 - \alpha) \frac{Y_t}{H_t} \tag{16}$$

$$(1+i_{t}) + \upsilon (K_{t+1} - K_{t}) = \beta E_{t} \left[\frac{P_{t+1}\lambda_{t+1}}{P_{t}\lambda_{t}} \left(\alpha \frac{Y_{t+1}}{K_{t+1}} + (1-\delta)(1+i_{t+1}) + \upsilon (K_{t+2} - K_{t+1}) \right) \right]$$
(17)

Equation (16) indicates that the cost of hiring an additional worker should equal that worker's marginal productivity, and equation (17) requires equality between the cost and benefit of the marginal investment.

3.1.3. The Central Bank

The money supply in the economy is given by

$$M_{t+1} = M_t + X_t \tag{18}$$

Equation (18) indicates that money growth in the economy depends on the existing stock of money M_t and the monetary injection implemented by the Central Bank X_t . The Central Bank's money injection is defined as

$$X_t = (\theta_t - 1)M_t \tag{19}$$

and where θ_t represents the monetary growth factor, itself possibly a function of the inflow of remittances.

3.1.4. The financial intermediary

At the beginning of the period, the commercial bank (our financial intermediary) receives deposits from the household M_t^b and receives the monetary injection from the monetary authority, X_t^3 . These funds are then available for lending to the firm to pay for the firm's investment in physical capital. At the end of the period, the firm repays its loans, and the bank returns deposits to the household along with the appropriate interest payment.

To make this clearer, the bank's asset balance is given by

$$P_t I_t = M_t^b + X_t \tag{20}$$

where $P_t I_t$ are the loans made to the firm and the right hand side lists sources of funds including deposits and the monetary injection.

Bank profits per period are equal to the interest on loans minus interest paid on deposits and on remittances deposited in banks. Note that the monetary injection directly into banks is a subsidy to the bank in that there is no interest on those funds.

$$D_t^b = (1+i_t)P_t I_t - (1+i_t)M_t^b$$
(21)

Putting both expressions together results in profits of the intermediary depending only on the money injection provided by the monetary authority

$$D_t^b = (1 + i_t) X_t$$
 (22)

3.1.5. Closing the model

³ The monetary injection X_t is a helicopter drop with the additional condition that is to be injected into the financial intermediaries at the beginning of the period; they can lend it out, and then are distributed to the households, together with the earned interest. For simplicity, the deposit and borrowing interest rates are assumed to be the same.

We define remittances as follows. We assume remittances are exogenously determined but are negatively correlated with income deviations from the steady state in the receiving country. Thus remittances increase when the receiving country experiences an economic downturn, as in Chami *et al.* (2008). The remittances function is thus written as

$$\Re_{t} = E_{t} \left[\vartheta P_{t} \left(\frac{Y^{ss}}{Y_{t}} \right)^{t} e^{g_{t}} \right]$$
(23)

We also introduce the interest rate differential on bond holdings as

$$i_t^* = i^W - \varphi \frac{s_{t-1} B_t}{P_{t-1}}$$
(24)

where the interest in bonds is determined by the world interest rate and the net real foreign asset position, with φ 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. The reason for this assumption is to avoid an instability problem with non-stationary behavior on bonds (Karame *et al.* (2008), Kollman (2002), Ghironi (2006)).

Since we are modeling a small open economy with international assets freely traded, combining equations (7) and (9) and expressing it in terms of deviations from steady state produces the standard uncovered interest rate parity condition (UIP):

$$\frac{i}{1+i} \mathop{E}_{t} \hat{i}_{t+1} - \frac{i^{*}}{1+i^{*}} \mathop{E}_{t} \hat{i}_{t+1}^{*} = \mathop{E}_{t} \hat{s}_{t+1} - \hat{s}_{t}$$
(25)

In order to analyze the dynamics of the main macroeconomic aggregates we define the monetary growth factor θ_t , the growth rate of remittances g_t , and the technological shock z_t as first-order autoregressive processes:

$$\log(\theta_{t+1}) = (1 - \rho_{\theta})\log(\overline{\theta}) + \rho_{\theta}\log(\theta_{t}) + \varepsilon_{\theta, t+1}$$
(26)

$$\log(g_{t+1}) = (1 - \rho_g)\log(\overline{g}) + \rho_g\log(g_t) + \varepsilon_{g,t+1}$$
(27)

$$\log(z_{t+1}) = (1 - \rho_z)\log(\bar{z}) + \rho_z \log(z_t) + \varepsilon_{z,t+1}$$
(28)

Here $\varepsilon_{g,t+1}$, $\varepsilon_{\theta,t+1}$ and $\varepsilon_{z,t+1}$ are white noise innovations with variance σ_g^2 , σ_θ^2 and σ_z^2 , respectively.

3.2. Equilibrium

Note that the household can hold any quantity of foreign assets that it finds optimal, subject only to its budget constraint. From equation (6) and market equilibrium we can infer that foreign asset holdings evolve according to

$$s_t B_{t+1} - s_t (1 + i_t^*) B_t = P_t (Y_t - C_t - I_t - \frac{\nu}{2} (K_{t+1} - K_t)^2) + s_t \Re_t$$
(29)

Equation (29) 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.

The set of equations given by the first order conditions, the market equilibriums, and the laws of motion for physical capital, 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. 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 below lists the values that are assigned to the basic parameters. The first three parameters have a standard calibration. The capital share, α , is set to 0.4. The subjective discount factor β is set at 0.988, implying a real interest rate equal to 1.2% per quarter. The deprecation rate on capital is set to 2.5% per quarter. We set the parameter H to 0.25, which implies that the representative household devotes 75% of its time endowment to non-working activities. The parameter ν represents the average of the trade balance to GDP, and is used to determine the long-run real debt-to-GDP ratio in our steady state calculation. The long run inflation factor is given by π , and is based on the average inflation factor of the countries in our sample (θ). Remittances are calibrated to be 2 percent of GDP – by setting the parameter ϑ and the exchange rate (s).

$\alpha = 0.4$	$\beta = 0.98$	H = 0.25	

s = 3

 $\varphi = 0.00019$

 $\delta = 0.25$

g = 0.0076

 $\tau = 5.76$

v = 0.01

	Т	he ca	libratio	n of specif	fic paran	neters is bas	sed in the 1	2 La	tin Americ	an countries
used	in	this	study:	Bolivia,	Brazil,	Colombia,	Ecuador,	El	Salvador,	Guatemala,

 $\theta = 1.04$

 $\xi = 3$

v = -0.035

 $\rho_{g} = 0.1143$

 $\rho_{\theta} = 0.30$

 $\rho_z = 0.95$

g = 1.038

 $\sigma_{g} = 0.0766$

 $\sigma_{\theta} = 0.044$

 $\sigma_z = 0.00816$

Honduras, Mexico, Nicaragua, Paraguay, Peru, and Uruguay. I estimate the autoregressive parameters for remittances and money using quarterly data. The persistence coefficient of the remittance's shock, ρ_g , and the standard deviation of the remittance's innovation, σ_g , are obtained from regressions on the growth rate of remittances, while the persistence coefficient of the monetary shock, ρ_{θ} , and the standard deviation of the monetary innovation, σ_{θ} , are obtained from regressions on the monetary shock per shock the monetary growth rate of the countries in the sample. The parameters characterizing the technological shock are the same than in Jansen *et al.* (2010). The data was collected from individual Central Banks, for remittances, and the IMF (International Financial Statistics), for measures of money, output, CPI, and the trade balance.

We explicitly consider the case of a small adjustment cost, $\xi = 3$, which represent around 2 minutes per week of lost time rearranging the portfolio. The system of equations that describes the small open economy is presented in the appendix while the loglinearized system – following Uhlig's (1999) methodology – is available in the author's web page. Nominal variables are made stationary by dividing them by the lagged domestic price level. The main variables are:

$$m_{t} = M_{t} / P_{t-1}; m_{t}^{b} = M_{t}^{b} / P_{t-1}; \pi_{t} = P_{t} / P_{t-1}; b_{t} = s_{t-1} B_{t} / P_{t-1}; \Gamma_{t} = s_{t} \Re_{t} / P_{t-1}$$

3.4.1 Steady state equilibrium

In the long-run equilibrium we assume the domestic inflation rate is given by the money growth rate, so that $\pi = \theta$, and that adjustment costs disappear in the steady state. Given the parameter values of Table 1, it is straight forward the derivation of steady state values for the variables of the system of equation⁴. Table 2 shows the steady state values for the small open economy for three alternative levels of remittances as a percentage of GDP - 0 percent, 2 percent, and 5 percent of GDP.

	Remittances 0% of GDP	Remittances 2% of GDP	Remittances 5% of GDP
Inflation	1.0400	1.0400	1.0400
Nominal Interest Rate	0.0526	0.0526	0.0526
Nom. Interest on Bonds	0.0526	0.0526	0.0526
Capital/output ratio	10.2300	10.2300	10.2300
Investment	0.3013	0.3013	0.3013
Capital	12.0521	12.0521	12.0521
Output	1.1781	1.1781	1.1781
Real Wages	2.8275	2.8275	2.8275
Consumption	0.9181	0.9409	0.9721
Remittances	0	0.0237	0.0562
Bonds	3.3950	3.3950	3.3950
Real Money Balances	1.2194	1.2194	1.2194
Real Money Cash	0.9548	0.9548	0.9548
Real Money Deposits	0.2646	0.2646	0.2646
Λ	1.0348	1.0097	0.9773
γ	2.1944	2.1412	2.0725
Trade Balance	-0.0412	-0.0412	-0.0412
Utility	-0.7168	-0.6770	-0.6246

 Table 2: Steady State Values

As it can be observed, the small open economy presents an inflation rate of 4 percent per quarter, which leads to a nominal interest rate of 5.26 percent. Investment in the economy is almost 25 percent of GDP and consumption is around 79 percent of GDP, with the trade deficit allowing for these higher levels (around 3.5 percent of GDP). The representative agent holds 78 percent of real money balances in cash to allow for

⁴ Derivation of steady states is also available in the author's web page.

consumption, and keeps 22 percent in the form of deposits. The calibration that allows for positive remittances only affects the level of remittances, consumption, the shadow price associated with the household real wealth (Λ), the relative weight of leisure (γ), and utility. As it can be observed below, when the percentage of remittances as a share of GDP increases from 0 percent to 2 percent (from 2 percent to 5 percent), the additional funds allows for an increase in consumption of 2.5 percent (3.3 percent). The additional remittances affects the relative weight of leisure (γ) and the shadow price associated with the household real wealth (Λ) through its improvement in resources, lowering both. Consequently, higher consumption levels for the same level of work effort (or leisure) generate an improvement in utility⁵.

IV. Results

Given the steady states values from the previous section, we analyze the aggregate dynamics of the nominal interest rate, output, the nominal exchange rate, and consumption following expansionary monetary and remittances shocks. We examine such dynamics for different levels of remittances as a percentage of GDP and for alternative levels of correlation of these inflows with the rate of money growth in the domestic economy. Since we consider a small open economy, exogenous foreign variables are held constant and drop from the dynamics.

4.1 Monetary Shock

The impulse response functions presented in this section are those following a 1% increase in the domestic money growth rate in the initial period, with the case of no

⁵ The limited effect on other macroeconomic aggregates arises from our fixed amount of time for working activities, which constraints labor to react to alternative levels of remittances. This could be relaxed by fixing γ instead, but choosing a value for the weight of leisure is harder to identify.

remittances in the economy illustrated with solid lines. The monetary shock puts an upward pressure on prices, which reduces the value of real money balances and induces households to increase their holdings of money cash to sustain a given level of consumption. However, since the monetary expansion goes through the financial intermediary and the households cannot withdraw their deposits within the period, it creates an excess supply of funds that outweighs the inflationary pressure to lower the nominal interest rate. The interest rate drops slightly on impact by approximately 5 base points. This is the typical liquidity effect, and its persistent effect on the interest rate can be observed below in the top-left panel of Figure 1. It is only in the following period that the household's reduction of money deposits (M_{t+1}^b) to satisfy consumption will exert an upward pressure on the interest rate to bring it back to steady state.



Figure 1: Dynamic response to a 1% monetary shock
_____0% ------ 2% 5% of GDP

The spike in inflation has a direct effect on the exchange rate, leading to an instantaneous depreciation of the nominal exchange rate, by 1.7 percent. The

overshooting of the nominal exchange rate shown in the bottom-left panel of Figure 1 is due to the uncovered interest rate parity, which requires the interest rate differential to be equal to the expected rate of appreciation of the following periods, leading to the subsequent appreciation until it returns to its steady state, as the liquidity effect dissipates. The fall in the nominal interest rate also reduces the return on domestic savings, and forces the household to reallocate more funds towards foreign assets.

As it is typically found in the literature, an expansionary monetary shock generates a positive wealth effect, which is allocated to increases in leisure in the first period. Since capital is fixed for the period, this lower work effort leads to the slight drop in output on impact, which is shown in the top-right of Figure 1. However, from the second period onwards the observed improvement of investment from the below steadystate interest rate, with its consequent effect on capital, and the improvement in work effort from real wages at above-steady-levels pushes output upwards. Output returns to its original steady state level one and a half quarters after the monetary shock and peeks after 5 quarters before starting to decline again – the typical hump-shape response.

The consumption dynamics following the monetary injection are mainly generated by inflationary pressures during the period of the shock. Given that the consumption level is determined by the cash-in-advance constraint, and since the amount on money-cash available for consumption is predetermined, inflation generated by the larger money supply reduces consumption instantaneously. The consumption dynamics from the second period onwards arises from the rearrangement between money-cash and money-deposits. Since agents anticipate inflation, and in order to preserve their consumption in the future, households increase their future amount of nominal moneycash the period of the shock (M_{t+1}^c) . Because it is costly to change the ratio $\frac{M_{t+1}^c}{M_t^c}$ when there are positive adjustment costs, this ratio would be adjusted smoothly and thus induce persistence in the adjustment of consumption – bottom-right panel in Figure 1.

Also included in Figure 1 are the dynamics resulting from the monetary shock when remittances are a significant portion of GDP. For compactness, we include the cases when remittances are 2 percent of GDP (with dashed lines) and when remittances are 5 percent of GDP (with dotted lines). At it can be observed, the relative weight of remittances as a percentage of GDP has some implications for the effectiveness of monetary policy. As the percentage of remittances becomes positive, and increases, the monetary shock produces slightly higher inflation but the liquidity effect is enhanced. When remittances are a bigger portion of the funds required to finance consumption, the inflationary pressure exerts an upward pressure on the interest rate but the funds available for lending are enhanced – having a greater proportion of funds coming from remittances enables the representative household to allocate more funds into deposits and thus withdraw lower proportions of deposits to smooth consumption – and thus the decline in interest rate is enhanced.

This higher proportion of remittances as a percentage of GDP also affects the shadow price associated with the household real wealth (Λ_t), which experience an accentuated decline, and creates a more pronounced fall in worked hours emanating from the wealth effect created by the monetary injection. This lower work effort produces the bigger drop in output observed in the period of the shock, and the subsequent dynamics respond to the enhanced investment and recovery of work effort from similar

improvements in the real wages. Now labor responds to two sources of income, and as the proportion of remittances increases, households will respond by reducing their work effort for the same magnitude of the monetary shock, making labor more pro-cyclical. This finding is corroborated by Chami *et al.* (2008), although the setting is different.

The response of the nominal exchange rate and consumption are barely affected, as the increase in the proportion of remittances as a share of GDP generates only a small additional increase in inflation relative to the base scenario of no remittances. The remainder economic variables have no effect or negligible effect.

4.2 Remittances Shock

Since continuous remittances flows can alter the behavior of the representative household, we now analyze the behavior of the main macroeconomic variables to a remittances shock. From here onwards the small open economy is calibrated to represent an economy with remittances being 2 percent of GDP. Although the remittances shock increases consumption – exerting an upward pressure on inflation – on the period of the shock, an initial drop in the demand for loans exerts sufficient downward pressure to lower the nominal interest rate on impact. This drop in the interest rate is less than one basis point, as shown below in Figure 2. The dynamics of the nominal interest rate after the period of the shock are governed by the dynamics of investment and money deposits. The subsequent fall in inflation below the steady state and the increase in funds allocated to deposits – since the remittances shock alleviates the need for money cash – are large enough to outweigh the upward pressure on the interest rate to a lower level for an additional period before starting to rise. Since both investment and money-deposits remain at levels above their initial steady state for a few quarters, the interest

rate begins to rise monotonically back to its original level, creating a persistent liquidity effect.



Figure 2: Dynamic response to a 1% remittances shock

The initial exchange rate response to a positive remittances shock is determined by the inflationary pressure, which leads to a proportional depreciation of the exchange rate on impact. In particular, the positive 0.00008 percent deviation from steady-state in inflation is directly translated in a 0.00008 percent depreciation of the nominal exchange rate. However, the subsequent dynamics are determined by the UIP condition, giving rise to an overshooting of the exchange rate. This fall in the domestic interest rate also forces agents to look for a better return and increase their holdings of foreign bonds immediately after the shock, with the accumulation of bonds decelerating as the domestic interest rate begins to rise and the nominal exchange rate appreciates, improving the return on domestic deposits.

The remittances shock slightly lowers the amount of hours worked on impact because of the decline in the shadow price associated with the household real wealth (Λ_t), creating a positive wealth effect. Since the capital stock is fixed on the period of the shock, this reduction in worked hours causes output to fall slightly. However, since labor experiences an additional further decline – although small – the following period, and the capital stock also drops slightly due to the small decline in investment in the initial period, output decreases for an additional period. This decline in labor is reversed only after two periods, giving rise to an increase in labor that combines with above steady-state capital to produce an increase in output that peaks 6 periods after the shock. It is only then that the decrease in investment to below steady state levels and the slow decline in worked hours force output to fall monotonically.

The consumption dynamics following a remittances shock are generated by the increase in purchasing power brought about by such inflows. Since remittances go for consumption, the small increase in inflation in the period of the shock that creates a fall in real money cash is not strong enough to depress the purchasing power brought about by the remittances shock. Consumption rises on impact by 0.025 percent. The subsequent dynamics are determined by the evolution of money cash balances and remittances, but since the adjustment in real money balances is relatively small – because of the negligible increase in inflation – it mainly follows the remittances behavior⁶.

4.3 Remittances Shock under Partial Sterilization

Having established the validity of the model to replicate the typical monetary shock and having unveiled the dynamics emanating from a remittances shock, we now turn our attention to the potential effect that remittances can have in the behavior of money. In this model, increases in remittances create inflation like in the empirical study

⁶ While the effect of the remittances shock on most macroeconomic aggregates is small, an increase of 0.00023 percent in income that is channeled towards consumption, its economical significance to understand the implications of a change in remittances is meaningful. Such magnitudes could be enhanced by increasing the relative importance of remittances, by increasing the size of the shock, or by allowing remittances to affect other measures, but the qualitative influence remains the same.

by Narayan *et al.* (2011), but its magnitude and specific channel still needs to be clarified. We concentrate in the modeling of the monetary growth specification. It is standard in the literature to describe the monetary growth factor as an autoregressive process, only dependent on the previous growth rate. In the case of complete sterilization of remittances flows this assumption holds.

However, remittances are still entering through informal channels, with some estimates of these unrecorded remittances putting it at 50 percent (Chami *et al.* (2008)), while a significant portion of economic activity is performed in the informal markets (the typical Latin American country produces in the informal sector around 40 percent of GDP (Loayza *et al.* (2009))). Consequently, the degree of sterilization that Central Banks are able – or willing – to do is to an extent uncertain.

To explore this potential influence, a dynamic panel model is estimated using the 11 Latin American countries of our sample (quarterly data)⁷. Table 3 below presents the results of the estimation of the money growth rate using the monetary growth rate of the previous four quarters as explanatory variables, but also including the growth rate of remittances, and the growth rate of real GDP⁸. The estimation is performed with the Arellano and Bond (1991) first-difference estimator, but since our sample has a small N and relative large T, and thus the Nickell bias is enhanced, I also present the estimates obtained from the Least Square Dummy Variable Correction (LSDVC) estimator⁹.

⁷ Honduras drops because of lack of data on real GDP at quarterly frequency. The growth rates are those of money (M1), remittances, and real GDP.

⁸ I have also included measures of financial development (bank deposits to GDP, financial system deposits to GDP, and bank credit over bank deposits) and the alternative measure of money (M2) in the specification, but the results showing a differential effect of remittances on money growth for the two regions are robust to their inclusion.

⁹ See Bun and Kiviet (2003) for its properties and consistency.

		Arellano-Bond	d		LSDVC	
	Latin	South	Central	Latin	South	Central
	America	America	America	America	America	America
Constant	4.821***	5.944***	2.569***			
	(1.209)	(1.663)	(.4134)			
Lag 1	1735***	1667**	1561***	1617***	1552***	1482**
-	(.0554)	(.0709)	(.0332)	(.0434)	(.0530)	(.0580)
Lag2	1970***	1928***	1217**	1921***	1882***	1168*
-	(.0423)	(.0493)	(.0512)	(.0346)	(.0470)	(.0634)
Lag3	2498***	2846***	1371***	2456***	2811***	1330**
	(.0644)	(.0770)	(.0310)	(.0380)	(.0444)	(.0631)
Lag4	.5212***	.4629***	.6971***	.5266***	.4678***	.7016***
	(.1158)	(.1406)	(.0524)	(.0358)	(.0495)	(.0627)
Remittances gr	.0291723	.0640*	0269**	.0296488	.0647**	0269
-	(.0236)	(.0372)	(.0122)	(.0216)	(.0314)	(.0302)
GDP gr	.2687***	.2614**	.1759***	.2738***	.2667***	.1773
C	(.0983)	(.1129)	(.0342)	(.0795)	(.0968)	(.1179)
Countries	11	7	4	11	7	4
Observations	440	264	176	440	264	176
AR(1) Test	0.0153	0.0443	0.0620			
AR(2) Test	0.1346	0.1121	0.5971			

Table 3: Dynamic Panel Data Results for Monetary Growth

*Note: Statistical significance given by *** for 1% confidence level, ** for 5% confidence level, and * for 10% confidence level. Robust Errors in parentheses in A-B estimator.*

As it can be observed, when we use the whole sample we find no statistically significant effect of remittances growth on the monetary growth rate, irrespective of the estimator used. However, Central American countries receive larger remittances, either in magnitude or as a share of GDP, so the response by Central Banks could potentially be different. To account for this two additional regressions are performed, and when one estimates the same specification for South American countries we find a positive and significant effect of remittances growth on monetary growth. As it can be observed in the respective column, both estimators show that a one percentage point increase in remittances growth leads to 0.06 percentage point increase in the growth rate of money. For the case of Central American countries this effect disappears (while the Arellano-

Bond estimator shows a negative and statistically significant relationship, this estimate is biased according to the LSDVC estimator).

Consequently, to take this remittances effect on money growth into consideration, the monetary growth factor θ_t is allowed to respond also to remittances flows. The specification that allows for partial sterilization is written as:

$$\log(\theta_{t+1}) = (1 - \rho_{\theta})\log(\theta) + \rho_{\theta}\log(\theta_{t}) + \rho_{\theta_{\theta}}\log(g_{t}) + \varepsilon_{\theta,t+1}$$
(28)

The new specification for the monetary growth rate is calibrated to allow for partial sterilization, allowing the remittances shocks to affect the money growth rate. Here we present the case when the correlation is set at 0.025 percent with dashed lines, and the case when the correlation is set at 0.05 percent with dotted lines. Note that the baseline calibration represents an economy with remittances being 2 percent of GDP, a magnitude similar to the South American countries that exhibit positive and statistically significant effect of remittances on money growth. The results are shown in Figure 3.



Figure 3: Dynamic response to a 1% remittances shock _____0% ----- 0.025% 0.05% correlation

The 1 percent positive remittances shock increases inflation, but this increase in inflation is exacerbated as we allow for partial sterilization. When we allow for the 1 percent increase in remittances to increase the money growth rate by 0.025 percent (0.05 percent), the inflation generated by the remittances shock is 5 times larger (11 times larger). However, this partial sterilization, or voluntary accommodation by the Central Bank, implies a monetary injection that in our specification is modeled as an increase in funds available to the financial intermediaries for potential lending. These extra funds for lending outweigh the inflationary pressure on the interest rate to force a larger percentage drop in the nominal interest rate. The top-middle graph shows that the initial drop in the interest rate is almost twice as large as the effect of remittances shocks go from no correlation with money growth to 0.025 percent correlation, and almost three times larger as the remittances shocks go from no correlation.

This additional inflationary pressure caused by the partial sterilization of the remittances shock works its way through to create a greater depreciation of the exchange rate as the remittances shock correlation with money growth goes from 0 percent to 0.025 percent (to 0.05 percent), creating almost a 0.0006 percent (0.001) depreciation on impact. Of course, this greater drop in the interest rate and pronounced depreciation leads to an increase in foreign bond's holdings that only subsidy when the interest rate and exchange rate stabilize.

The remittances shock decreases output on impact irrespective of the degree of sterilization, but its long term dynamics are affected by the degree of correlation of the remittances shock and money growth. The positive wealth effect from the remittances shock is now enhanced by the typical wealth effect from the increase in money,

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generating a deeper decline in the shadow price associated with the household real wealth (Λ_i) and leading to a larger drop in worked hours. Since the capital stock is fixed on the period of the shock, this larger reduction in worked hours causes output to fall by three times (5 times) more when remittances shocks go from no correlation with money growth to a 0.025 percent correlation (to 0.05 percent correlation). From the second period onwards, both hours worked and capital accumulation determines the behavior of output. In the second period both capital and worked hours fall slightly, but while capital then recovers at a faster pace when correlation turns positive and increases, from the larger liquidity effect, the recovery in worked hours is initially faster also but quickly fades away and remains consistently below the recovery from the case of no correlation. These dynamics explain the initial faster recovery in output as the degree of correlation increases, observed in the bottom-middle graph until period 6, and the pronounced deterioration of the last few periods.

The response of consumption to the 1 percent remittances shock is not altered by the degree of correlation between the remittances growth rate and the monetary growth rate. Even if the higher inflation generated by the positive and greater correlation creates a greater need for the reallocation of real money balances, the subsequent adjustment in money cash is relatively insignificant in the determination of consumption – the 1 percent increase in remittances creates a 0.0002-0.001 percent reduction in money cash balances.

To gage the model accuracy, I report the volatility, autocorrelation, and correlation with respect to output for the main macroeconomic aggregates in Table 4. The upper portion of Table 4 shows the unconditional moments for the actual data, expressed in growth rates. As it can be observed, remittances are almost 3 times more volatile than

output for our sample of Latin American countries, the nominal interest rate over 4 times more volatile than output, and consumption almost twice more volatile than output. Remittances also present a low correlation (0.1) with output in this sample.

Table 4. Unconditional Woments							
Data	St. Dev.	Relative	Autocorrelation	Corr w/			
		St. Dev.		output			
Output	.0479	1.00	-0.5676	1.0000			
N. Interest Rate	.2021	4.22	-0.0448	-0.0388			
Remittances	.1353	2.83	-0.1969	0.1034			
Consumption	.0805	1.68	0.0801	0.2646			
Inflation (CPI)	.0235	0.49	0.6859	-0.0891			
N. Exchange Rate	.0437	0.91	0.3069	-0.0563			
Model							
Output	0.0201	1.00	-0.3329	1.00			
N. Interest Rate	0.1119	5.57	-0.3056	0.07			
Remittances	0.1950	9.70	0.0119	0.37			
Consumption	0.1095	5.45	-0.2023	0.34			
Inflation	0.0798	3.93	0.0110	-0.25			
N. Exchange Rate	0.1276	6.35	0.3564	-0.19			

 Table 4: Unconditional Moments

Note: Variables were transformed to growth rates ($\Delta ln X$) in the data estimation, using the 12 countries of the sample. Model estimates are obtained using H-P simulations.

In terms of the model simulations, the model provides volatilities that are comparable to those coming from the data – except those for inflation and nominal exchange rate¹⁰. In particular, remittances remain more volatile than output (almost 10 times) and consumption (almost twice as large). The correlation of remittances with respect to output continues to be low, although now is almost 4 times larger. While the model captures most of the autocorrelation observed in the data, it fails to match that of consumption and remittances, as well as the correlation of the nominal interest rate with respect to output. Overall, the model seems to capture relatively well the moments emanating from the data.

¹⁰ One of the referees has suggested the introduction of price rigidities to ameliorate the inflationary impact on consumption from monetary shocks. This could reduce the volatility of inflation and the nominal exchange rate, and would be undertaken in future research as it requires an alternative modeling specification to account for monopolistic competition.

V. Conclusions

This limited participation model for a small open economy with remittances explicitly incorporated is able to capture the behavior of the main macroeconomic aggregates to monetary and remittances shocks, in accord with empirical evidence. This study extends the literature by evaluating monetary policy in countries that experience a significant inflow of remittances and by modeling the influence of remittances flows on the domestic money growth rate.

The typical monetary injection leads to an instantaneous rise in inflation, a drop in the nominal interest rate, and an overshooting of the nominal exchange rate. It also generates a wealth effect that is translated in a decline in worked hours, which leads to an initial drop in output that is soon overturned by a reversal in work effort and an increase in investment. However, the behavior of output depends on the magnitude of remittances as a percentage of GDP. Larger inflows of remittances allows the representative household to allocate higher proportion to deposits, and thus the same monetary shocks enhances the availability of funds available for lending and produce a more accentuated liquidity effect. More resources coming from remittances also enhance the wealth effect, and thus create a further drop in work effort and output as the share of remittances increases. Even if the surge in investment is accentuated, the subsequent recovery of output does not reach the level of the case of no remittances.

With respect to the dynamics of a remittances shock, the results show that the remittances shock increases consumption and lowers work effort on impact, improving the utility of the representative household. It also results in a small decline in the interest rate, a depreciation of the exchange rate, and an increase in foreign bonds. Output

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initially drops but the subsequent dynamics of work effort and investment leads to a significant recovery that lasts for 14 quarters. When we introduce partial sterilization to account for the empirical evidence, the increase in money that results from the remittances shock leads to a more pronounced liquidity effect, a bigger wealth effect that accentuates the drop in worked hours, and a larger initial drop in output. While the lower interest rate leads a larger accumulation of capital, it is not enough to achieve a recovery large enough to raise output to levels similar to the case of full sterilization.

Properly accounting for the share of remittances and its potential influence in monetary aggregates thus provide insight that can be used by policymakers to appropriately implement stabilization policies. This should contribute to our understanding of the overall impact of remittance flows to developing countries, and if Central Banks choose to accommodate some of this additional purchasing power to generate stronger economic activity, we should consider this additional impact.

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Appendix

A.1. System of Equations

$$\begin{array}{ll} (A1) & \pi_{i} = \frac{s_{i}}{s_{i-1}} \pi^{*} \\ (A2) & \pi_{i} C_{i} = m_{i}^{c} + \Gamma_{i} \\ (A3) & \frac{\gamma}{1-H_{i}-\Omega_{i}} = w_{i} \Lambda_{i} \\ (A4) & Y_{i} = e^{z} K_{i}^{a} H_{i}^{1-a} \\ (A5) & I_{i} = K_{i+1} - (1-\alpha) K_{i} \\ (A6) & w_{i} = (1-\alpha) \frac{Y_{i}}{H_{i}} \\ (A7) & b_{i+1} - \frac{s_{i}}{s_{i+1}} (1+i_{i}^{*}) \frac{b_{i}}{\pi_{i}} = Y_{i} - C_{i} - I_{i} - \frac{\upsilon}{2} (K_{i+1} - K_{i})^{2} + \frac{\Gamma_{i}}{\pi_{i}} \\ Define & \Lambda M_{i}^{c} = \frac{M_{i+1}^{c}}{M_{i}^{c}} , \text{ and by previous the definition} \\ (A8) & \Delta M_{i}^{c} = \frac{m_{i+1}^{c}\pi_{i}}{m_{i}^{c}} \\ (A9) & m_{i+1} = m_{i+1}^{b} + m_{i-1}^{c} \\ (A10) & m_{i+1} = \theta_{i} \frac{m_{i}}{\pi_{i}} \\ (A11) & \pi_{i} I_{i} = m_{i}^{b} + (\theta_{i} - 1)m_{i} \\ (A12) & (1+i_{i}) + \upsilon(K_{i+1} - K_{i}) = \beta E_{i}^{c} \left[\frac{\Lambda_{i+1}}{\Lambda_{i}} \left\{ \alpha \frac{Y_{i+1}}{K_{i+1}} + (1-\delta)(1+i_{i+1}) + \upsilon(K_{i+2} - K_{i+1}) \right\} \right] \\ (A13) & \Lambda_{i} = \beta E_{i}^{c} \left[\frac{\Lambda_{i+1}}{\pi_{i+1}} (1+i_{i+1}) \right] \\ (A14) & \Lambda_{i} = \beta E_{i}^{c} \left[\frac{\Lambda_{i+1}}{\pi_{i+1}} (1+i_{i+1}) \right] \\ (A15) & w_{i} \Lambda_{i} \frac{\varepsilon}{\pi_{i}} \frac{\pi_{i}}{m_{i}^{c}} (\Delta M_{i}^{c} - \theta) + \Lambda_{i} = \beta E_{i}^{c} \left[\frac{1}{C_{i+1}\pi_{i+1}} \right] + \beta E_{i}^{c} \left[w_{i+1} \Lambda_{i+1} \frac{\varepsilon}{\pi_{i+1}^{c}} (\Delta M_{i+1}^{c} - \theta) \right] \\ (A16) & \Gamma_{i} = E_{i}^{c} \left[g(Y^{w})^{v} \pi_{i} s_{i} Y^{v-e} s^{v} \right] \\ (A13) & \log(\theta_{i+1}) = (1 - \rho_{g}) \log(\overline{\theta}) + \rho_{g} \log(\theta_{i}) + \varepsilon_{g+1} \\ (A13) & \log(\theta_{i+1}) = (1 - \rho_{g}) \log(\overline{\theta}) + \rho_{g} \log(\theta_{i}) + \varepsilon_{g+1} \\ \end{array}$$

(A20) $\log(z_{t+1}) = (1 - \rho_z) \log(\overline{z}) + \rho_z \log(z_t) + \varepsilon_{zt+1}$

Data Appendix

I extracted quarterly data on remittances from the respective Central Banks, where data was available at this frequency, up to 2010:4.

I also obtained data on real GDP, money (M1 and M2), consumer price index, and trade balance from the International Monetary Fund's International financial Statistics (IFS), up to 2010:4.

The measures of financial development come from the World Bank (Thorsten and Demirgüç-Kunt (2009)).