Remittances and the Informal Economy

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Abstract  

Many developing countries are characterized by a large informal sector, and are also often heavily dependent on remittance inflows from abroad. We develop a general equilibrium framework to understand better the dynamic absorption of remittances in a two-sector small open economy, by incorporating many of the stylized features of the informal sector. Calibrating the model to yield a long-run equilibrium consistent with sample averages for 40 developing countries for the period 1999-2007, we show that the effect of remittances depend critically on how they impinge on the recipient economy, i.e., whether these inflows are (i) permanent or temporary, (ii) associated with a collateral effect to securitize borrowing, (iii) exogenous or countercyclical. We also identify the conditions under which remittances are associated with an expansion of the informal sector, as well as the Dutch Disease effect. The welfare consequences of these different mechanisms are analyzed.

Keywords: Remittances, informal sector, real exchange rate, Dutch Disease, labor mobility

JEL Classification: E2, E6, F2, F3, F4

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1. Introduction

Most developing countries are characterized by a large informal sector, populated mainly by small, unregistered firms having low productivity, and producing basic non-traded goods and services. As Schneider et al. (2010) and La Porta and Shleifer (2014) document, this sector absorbs a disproportionately large share of the labor force, with very limited outward mobility, and has little or no access to credit and capital. At the same time, many of these countries are also often heavily dependent on large capital inflows, such as remittances sent by migrant workers living and working abroad.\(^1\) Table 1 reports the average share of the informal sector and remittances in GDP for 40 developing countries, for the period 1999-2007. The average share of the informal sector’s output in GDP was about 42% during this period, while the average share of its employment varied between 49-54%.\(^2\) During this period these countries received, on average, about 6.5% of their GDP in the form of remittances, with a range varying from 0.08% to 51%. Even though the dynamic absorption of remittances has recently emerged as an important area of research, very little is known about the effects of these inflows in the presence of a large informal sector in recipient economies. The central objective of this paper, therefore, is to propose a quantitative general equilibrium framework that analyzes the dynamic effects of remittances not only on the aggregate economy, but also on the evolution of its formal and informal sectors.

Figure 1 depicts the intertemporal co-movement between remittance inflows and the share of the informal sector for a selected group of countries between 1999-2007. As can be seen, remittances and the size of the informal economy seem to be strongly positively correlated over time. By contrast, Figure 2 depicts the relationship between averages of these two variables across a wider set of countries during the sample period.\(^3\) From this cross-country standpoint, the relationship appears to

\(^1\) Over the last two decades, remittances have overtaken foreign aid as the second largest flow of capital across the world, second to only FDI (Yang, 2011).

\(^2\) It is important to clarify here that there are varying definitions of employment in the informal sector. For example, The International Labor Organization makes a distinction between “employment in the informal sector,” which is an enterprise-based concept, defined as jobs in unregistered/unincorporated private enterprises, and “informal employment,” which is a job-based concept covering all employment, both in the formal and informal sector that lack basic social and legal protections; See ILO (2011). For the purpose of this paper, we adopt the enterprise-based measure, i.e., “employment in the informal sector.”

\(^3\) We restrict the sample size in Figure 2 to countries that receive at least 1 percent of their GDP in the form of remittances and also have data on the size of the informal sector for the sample period (1999-2007).
be rather ambiguous, suggesting that any link is likely to reflect country-specific structural elements and policy responses. Though the trends in Figures 1 and 2 do not necessarily imply a causal relationship, the average size of remittance inflows and the informal sector in our sample (as reported in Table 1) underscore the need to examine their relationship, given that they represent two key structural characteristics of developing countries.

_A priori_, there are several underlying mechanisms that may potentially drive the relationship between remittances, the macroeconomy, and its sectoral composition. First, by augmenting the financial resources of recipient households, remittances may be allocated to either the consumption of formal or informal sector goods, or saved, with the decision having very different consequences for the aggregate economy and its sectoral structure. Second, households in developing countries typically face intersectoral adjustment costs, especially with respect to labor mobility, and this may have important consequences for the absorption of these flows in the formal or informal sectors, and more generally for the aggregate economy. The presence of an informal sector also raises issues related to the Dutch Disease, whereby an appreciation of the real exchange rate precipitates an aggregate contraction in GDP together with an expansion of the share of informal production. Third, whether remittances can serve as a collateral for borrowing purposes may have important consequences for investment, intersectoral labor mobility, and sectoral production. Fourth, the duration of remittance inflows may also matter: recipients may respond very differently to an inflow of remittances that is temporary relative to one that is permanent. Finally, if remittance inflows from abroad are countercyclical, i.e., driven by adverse productivity shocks in the recipient economy, they may have important business cycle smoothing effects.

We embed all of the above issues within a unified framework to understand better the dynamic absorption of remittances in a small open economy. In doing so, we address an important, and seemingly neglected aspect of economic development. To our knowledge, research on the informal economy, and that on remittances, have evolved independently of each other. For example, studies on the informal economy have generally focused either on (i) the measurement of its relative size to GDP (Schneider and Enste 2000, La Porta and Shleifer 2008, 2014, and Gomis-Porqueras et al. 2014), or on (ii) issues pertaining to tax policy and enforcement (Rauch 1991, Ihrig and Moe 2004, Turnovsky...
and Basher 2009, Prado 2011, and Ordonez 2014). On the other hand, the literature on remittances has focused mainly on economic growth and the macroeconomic adjustment of what can be characterized as being formally structured economies; See, for example, Yang (2008), Giuliano and Luiz-Arranz (2009), Acosta et al. (2009), Durdu and Seyan (2010), Mandelman and Zlate (2012), and Mandelman (2013). In either case, there has been no systematic analysis linking the role of remittances and the evolution of the informal economy, despite the time series evidence suggesting their co-movement over time. Embedding both in a general equilibrium model thus enables us to investigate this important, but neglected, relationship.

We develop a two-sector model of an open economy that incorporates many of the stylized features of the informal sector, as reported in La Porta and Shleifer (2014). Specifically, the economy produces two goods: a traded good that can be used for consumption or investment, manufactured in the formal sector, and a non-traded consumption good (such as services) produced in the informal sector. Both sectors use labor for production, with the key difference being that while the formal sector additionally employs private capital for production, the informal sector has no access to private capital. Thus, private capital is traded internationally, but being restricted only to the formal sector is immobile \textit{internally}. Households consume both goods, allocate time to work in both sectors, invest in formal sector firms, and receive a flow of remittances from abroad. However, in apportioning their labor across the two sectors, households face convex mobility costs, which reflect the inflexibilities in labor markets characteristic of developing economies. The presence of these costs, in conjunction with gradual success in the job search process and the probability of job separation, generate sluggish mobility of labor between the informal and formal sector, in line with the findings of La Porta and Shleifer (2014), as well as long-term unemployment. For the household, income (capital and labor) from the formal sector is subject to taxation by the government, but labor income derived in the informal sector manages to avoid being taxed.\footnote{Ihrig and Moe (2004) and Turnovsky and Basher (2009) focus on issues relating to auditing and penalties imposed on potential tax evaders in the informal sector. We do not address such issues here.}

The government receives tax revenues from the formal sector (via household income) and provides a government consumption good. The model is closed by assuming that both households and
the government have access to an internationally traded bond that can be used to accumulate debt over time, in the event that current expenditures exceed income. The key feature here is that both agents face an endogenous borrowing cost, determined by a mark-up over the world interest rate, with the markup itself reflecting the economy’s debt-servicing capacity. In defining the economy’s debt-servicing capacity, we introduce a new role for remittances that has received attention recently in policy circles, but is yet to be studied analytically. Specifically, we assume that remittance inflows may be used to securitize debt at the aggregate level, by acting as a collateral. Indeed, as Figure 3 shows, the collateral effect of remittances can significantly reduce the present value of outstanding external debt for developing countries. Further, Ratha (2007) reports that commercial banks in emerging market countries such as Brazil, Egypt, El Salvador, and Mexico, among others, have been able to raise cheaper and longer-term financing (more than $15 billion since 2000) from international capital markets via the securitization of future remittance inflows. We introduce the collateral effect of remittances as a financial policy in our model which, when combined with GDP, augments the economy’s aggregate debt-servicing capacity.

The analytical model we develop generates a high order dynamic system, requiring a numerical solution. We calibrate the model to yield a long-run equilibrium consistent with sample averages for 40 developing countries for the period 1999-2007. In doing so, we ensure that the macroeconomic equilibrium is representative of a developing economy with a large informal sector, long-run unemployment, and one that receives a substantial share of its GDP in the form of remittances. Given the benchmark calibration of the analytical model, our results indicate that the effect of remittances depend critically on how they impinge on the recipient economy, i.e., whether these inflows are (i) permanent or temporary, (ii) exogenous or countercyclical, and (iii) associated with a collateral effect. We also identify the conditions under which remittances are associated with an expansion of the informal sector, as well as the Dutch Disease effect.

Our results indicate that a permanent and exogenous remittance shock leads to a reallocation of labor and production away from the formal to the informal sector, a decumulation of private capital, a real exchange rate appreciation, and a long-run contraction of GDP. These represent all the classic
symptoms of a long-run Dutch Disease effect for the recipient economy.\(^5\) On the other hand, if the remittance shock is temporary, the aggregate economy’s response is expansionary, with private capital and output increasing in transition. Though the informal sector expands on impact of the shock, driven by a temporary appreciation of the real exchange rate, it contracts along the transition path. Thus, in sharp contrast to the permanent case, temporary increases in remittance inflows are not associated with the Dutch Disease effect. In the case where remittance inflows are not exogenous but, say, countercyclical, and driven by a negative productivity shock in the recipient economy, we find that these inflows can have a business cycle smoothing effect by partially muting the resulting contraction of the aggregate economy. Also, countercyclical remittance shocks are not associated with an expansion of the informal sector.

We also find that when remittances can serve as collateral to securitize debt, they have an expansionary effect on the economy, irrespective of the duration of the shock. Indeed, the pure collateral effect tends to be expansionary and also leads to a gradual expansion of the formal sector over time. This is an interesting result from a policy perspective, in that it suggests that one way to reduce the relative size of the informal sector – thereby preventing the Dutch Disease-type phenomenon associated with an increase in remittances – might be to introduce a collateral policy that enables at least some portion of remittances to securitize debt. From a welfare standpoint, we find that the welfare gains from remittances that are associated with a collateral effect exceed those from a pure exogenous remittance increase. Similarly, when remittance inflows are countercyclical, the welfare loss from a negative productivity shock is smaller than if these inflows were exogenous.

The contribution of this paper is two-fold. First, by linking remittances to the informal economy, we bridge an important gap in the existing literature on these issues. We also characterize the conditions under which remittances may be positively associated with the evolution of the informal economy. Second, we take a step towards reconciling the ambiguity in the literature on the aggregate effects of remittances. For example, several authors such as Durand et al. (1996), Brown and Ahlburg

\(^5\) Acosta et al. (2009), in their study of remittances in El Salvador, document a similar effect, albeit through a different channel, namely the presence of binding credit constraints and rule-of-thumb households. Similarly, Amuendo-Dorantes and Pozo (2004) document that remittances tend to reduce the competitiveness of the export sectors in their panel study of 13 Latin American and Caribbean countries.
Combes and Ebeke (2011) have documented that remittances mainly finance household consumption. On the other hand, Woodruff and Zeneno (2007), Yang (2008), and Alcaraz et al. (2012) find that remittances are associated with higher investment. Our results indicate that both sets of findings in the literature can be reconciled if one carefully characterizes the underlying nature of remittance inflows; i.e., exogenous versus countercyclical, permanent versus temporary, and whether they are associated with a collateral effect. Our results on the collateral effects also represent a new angle to understanding the dynamic absorption of remittances in developing countries.

The rest of the paper is organized as follows. Section 2 outlines the theoretical model, Section 3 describes the macroeconomic equilibrium and fiscal sustainability, and Section 4 discusses the calibration of the benchmark equilibrium. Section 5 considers permanent remittance shocks and the collateral effect, along with a sensitivity analysis, while Section 6 examines temporary shocks, including the case of countercyclical remittances. Finally, Section 7 concludes.

2. Analytical Framework

We begin by outlining the analytical framework. The description below is general, with the specific functional forms employed in the simulations being introduced in Section 4.

2.1. Production

Production in the economy takes place in two sectors: a formal sector, which produces a traded good that can be used either for consumption or investment, and an informal sector, which produces a basic non-traded consumption good (e.g., services). The general two-sector production structure is similar to those of previous studies, such as Ihrig and Moe (2004) and Turnovsky and Basher (2009). However, in contrast to our approach, those papers focused on a closed economy and abstract away from issues related to the absorption of external transfers such as remittance inflows. In our context of an open economy, the two sectors produce distinct goods (traded and non-traded), generating an endogenously determined real exchange rate, thereby raising issues associated with a small “dependent” economy.
while the formal sector uses private capital as a factor complementary to labor in production, the informal sector employs labor as the only factor of production. Since the informal sector is typically much more labor intensive, this polar case serves as a convenient benchmark.

The production technology of a representative firm in the formal sector (denoted by the subscript $f$) is described by:

$$Y_f = A_f F(K_f, L_f) \equiv Y_f(K_f, L_f) \quad (1a)$$

where $Y_f$ is the flow of output, $L_f$ is the employment of labor, and $K$ is the total stock of private capital, fully employed in the formal sector. The production function (1a) has the usual neoclassical properties with respect to the two factors of production. In addition, $A_f$ denotes the sector-specific level of productivity.

The representative firm in the informal sector (denoted by the subscript $s$) uses only labor for production:

$$Y_s = A_s H(L_s) \equiv Y_s(L_s) \quad (1b)$$

where, $A_s$ is the sector-specific level of productivity, and $L_s$ is labor employment. Several studies have documented that informal sector firms are characterized by extremely low capital-labor ratios; see, for example, Thomas (1992), de Paula and Scheinkman (2007), Di Giannatale et al. (2011), and also La Porta and Shleifer (2014). However, as Ordonez (2014) points out, whether the existence of low capital-labor ratios in the informal sector are a signal of credit constraints or self-financing is an open question. Our assumption of a zero capital-labor ratio in the informal sector, while agnostic to the underlying cause, maintains analytical tractability while remaining consistent with stylized facts.\(^8\)

The formal sector is assumed to include a well-defined factor market, so that profit maximization yields the usual first-order conditions

\[^8\] The assumption that all capital is employed in the formal sector is also adopted by Ihrig and Moe (2004) and Turnovsky and Basher (2009). We can also interpret the production function (1b) as being of the form $Y_s = A_s H(L_s, \bar{K}_s)$ where $\bar{K}_s$ is fixed and does not accumulate. Garcia-Penalosa and Turnovsky (2005) assume that capital is intersectorally mobile but that the informal sector has a lower capital-labor ratio. The qualitative results remain essentially unchanged from the present assumption that private capital is intersectorally immobile.
\[ w_f = \frac{\partial Y_f}{\partial L_f} \equiv w_f(K, L_f); \quad r_k = \frac{\partial Y_f}{\partial K} \equiv r_k(K, L_f) \]  

(2)

where \( w_f \) and \( r_k \) represent the real wage of labor and the rental rate for capital employed in the formal sector. In contrast, in the informal sector, with no capital, we assume that all income accrues to labor.

2.2. Households

The economy is populated by an infinitely-lived representative household that maximizes utility:

\[
\int_0^\infty [U(C_f, C_s) + V(G_c)] e^{-\beta t} dt
\]  

(3)

where, \( C_f \) and \( C_s \) represent the private consumption of goods produced in the formal and informal sectors, respectively, \( G_c \) is government consumption expenditure on the traded good, and \( \beta \) is the rate of time preference. The function \( U(\cdot) \) has the standard curvature properties, i.e., both consumption goods yield positive but diminishing marginal utility. For simplicity and without loss of generality we assume that the utility of the government good is additively separable.\(^9\) The household allocates part of its time to working in the formal and informal sectors, and earns a return on private capital rented out to the formal sector.\(^10\) Households also accumulate debt (through an internationally traded bond) to finance any excess expenditure over earnings:

\[
\dot{N} = rN + C_f + pC_s + \Omega(I, K) - (1 - \tau)\left[r_kK + w_fL_f\right] - pY_s(L_s) + T_f - R
\]  

(4)

where \( N \) is the current stock of household debt, \( r \) is the borrowing interest rate, \( p \) is the relative price of the informal sector good, \( \Omega(\cdot) \) incorporates a convex adjustment cost associated with accumulating private capital (and is homogeneous of degree one), \( I \) is the rate of private investment (in the formal sector), \( \tau \) is the tax rate on income earned in the formal sector, \( T_f \) is a lump-sum tax, and \( R \) represents an inflow of remittances received from abroad.\(^11\) A key feature of the economy is that while household

\(^9\) The reason for introducing \( G_c \) is to facilitate the matching of the calibration to the empirical data.

\(^10\) Since we do not model an endogenous labor-leisure choice in our model, time not spent working by the household is characterized by involuntary unemployment. We discuss this further in Section 2.3.

\(^11\) In our baseline specification, we assume that remittance inflows are exogenous in nature. However, in Section 6 we also consider the case of endogenous (counter-cyclical) remittance inflows that depend on shocks to aggregate productivity.
labor and capital income derived from the formal sector are subject to taxation by the government, labor income from the informal sector is outside the tax radar of the government, and hence escapes taxation.\textsuperscript{12} Further, since the formal sector produces the economy’s traded good (taken as numeraire) and the informal sector produces the non-traded good, the relative price of the informal sector good, $p$, mirrors the economy’s real exchange rate.\textsuperscript{13} As such, an increase (decrease) in $p$ denotes a real appreciation (depreciation) of the exchange rate.

Private investment expenditures lead to the accumulation of physical capital, which as eq. (1a) indicates, is used as an input in the formal production sector:

$$\dot{K} = I - \delta_k K$$

where $\delta_k$ is the rate of depreciation of capital. All investment is denominated in terms of the formal (traded) good. Informal (non-traded) output is solely used for consumption, i.e., $s = Y_f$, for all $t$.

We assume that the borrowing rate on debt is a mark-up over the world interest rate, $r^*$, with the borrowing premium, $\omega(.)$, increasing with the economy’s aggregate stock of debt relative to its debt-servicing capacity:

$$r = r^* + \omega \left( \frac{N + B}{Y + \kappa R} \right), \quad \omega' > 0, \quad \kappa \in [0,1]$$

where $N + B$ is the stock of aggregate national debt of the economy, comprising the sum of private (household) debt, $N$, and public (government) debt, $B$. We assume that the economy’s capacity to service its outstanding debt is determined by two factors: (i) its aggregate GDP, $Y = Y_f + pY_s$, measured in units of traded output, and (ii) its inflow of remittances, $R$, which may serve as a collateral for borrowing purposes. This collateral effect is captured by the parameter $\kappa$, which we take to lie in the range $(0, 1)$. Thus, if $\kappa = 0$, remittances cannot serve as collateral for borrowing, while if $\kappa = 1$ remittances can be fully applied as collateral. Thus, $\kappa > 0$ lowers the borrowing premium by enhancing the economy’s debt-servicing capacity and, as such, reduces the present value of the

\textsuperscript{12} This raises issues relating to the costs and benefits of auditing the informal sector and incentives to force compliance with tax payments. These issues, addressed by Turnovsky and Basher (2009), lie outside the scope of the present paper.

\textsuperscript{13} See, for example, Betts and Kehoe (2008), who provide evidence of a strong positive correlation between the relative price of non-traded goods and the real exchange rate.
economy’s outstanding debt (see, for example, Figure 3).

Several authors, including Gupta et al. (2007), Ratha (2007), and Hughes (2011) review evidence pointing to the growing importance of remittances acting as a collateral for debt. This applies either to small-scale businesses in the informal sector that may rely on micro-finance as the only source of credit, or enabling commercial banks in developing and emerging-market countries to relax constraints imposed by sovereign ratings ceilings through the securitization of future remittance inflows. The specification in (6) is intended to incorporate this effect. In essence, the collateral parameter $\kappa$ can be viewed as a policy variable, reflecting institutional aspects of credit markets or central bank policy. Being atomistic, in the international financial market, households treat the borrowing rate in (6) as given, although the equilibrium private borrowing rate is determined endogenously as a consequence of the collective private and public borrowing decisions.\textsuperscript{14}

2.3. Labor Market

An important feature of the economy is the presence of labor market rigidity, which reflects the structural inefficiencies characteristic of developing economies. The result is to generate unemployment due to time spent on job search in moving from one sector to another. These inefficiencies reflect factors such as the absence of formal institutions to promote coordination between employer and employee, the reliance on social networks involving friends and relatives, and ethnic and religious associations to facilitate the job search.\textsuperscript{15} Because of such structural inefficiencies, the job search period in developing countries in general is high, varying between one and four years. This contrasts with developed countries like the United States, for example, where the average job search period is about twelve to sixteen weeks.\textsuperscript{16}

\textsuperscript{14} A basic issue in modelling small open economies such as this is the closure of the financial market; see Turnovsky (1997) and Schmitt-Grohé and Uribe (2003) where several alternatives are detailed. These include introducing an endogenous borrowing premium, as in (6), which is most appropriate in the case of the developing economy being analyzed here. This approach originated with Bardhan (1967), and many variants can be identified in the literature.

\textsuperscript{15} For example, more than 72 percent of those who work in the shadow economy and more than 52 percent of those who work in the formal sector rely on the social networks to move from one sector to another in Venezuela (Marquez and Ruiz-Tagle 2004). These networks pay off only when someone is already unemployed for a while (Marquez and Ruiz-Tagle 2004, Gong, van Soest, and Villagomez 2004, Serneels 2007).

\textsuperscript{16} See Turnovsky and Basher (2009) for documentation. By comparison we may note that in Europe the average job search time is of the order of 12-15 months.
Our specification of the labor market follows Turnovsky and Basher (2009). Households are endowed with one unit of time that can be used to either working in the formal sector (\(L_f\)), the informal sector (\(L_s\)), or remaining unemployed (\(L_U\)). This implies the following time allocation\(^\text{17}\)

\[
L_f + L_s + L_U = 1
\]  

Suppose an agent seeks to increase his employment in the formal sector, by reducing his employment in the informal sector at the rate \(u\). In the process of this reallocation, we assume \((\chi/2)u^2\) amount of labor time is temporarily lost in job searching.\(^\text{18}\) The parameter \(\chi\) determines the rate of this loss and reflects the underlying rigidity in the labor market.\(^\text{19}\) We also assume that at every point of time, a fraction \(\sigma\) of the current pool of unemployed gets re-employed, while on the other hand a fraction \(z\) of those employed in the formal sector experience job separation.\(^\text{20}\) Thus, the exodus out of the informal sector and the evolution of unemployment are described by

\[
\dot{L}_s = -u \quad (8a)
\]

\[
\dot{L}_U = \frac{\chi}{2}u^2 + zL_f - \sigma L_U \quad (8b)
\]

Taking the time derivative of (7) and combining with (8a) and (8b), yields the rate at which employment in the formal sector is evolving

\[
\dot{L}_f = u - \frac{\chi}{2}u^2 - zL_f + \sigma L_U \quad (9)
\]

Thus the net rate of change of employment in the formal economy equals the net outflow from the informal economy, exclusive of job searchers, plus the inflow from the existing unemployed, less

\(^{17}\) By assuming that labor is supplied inelastically, we abstract from the labor-leisure choice. This assumption not only aids analytical tractability but is plausible for a developing economy. Given the low rates of consumption in such economies, it is unlikely that much leisure is consumed.

\(^{18}\) This quadratic structure of the loss of labor implies that the mobility of labor from one sector to another, in either direction, creates temporary unemployment. The use of the quadratic function to specify adjustment costs has a long tradition in economics; see Turnovsky and Basher (2009) for references to earlier key examples.

\(^{19}\) In our analysis we take the rigidity parameter, \(\chi\), to be given. However, one could argue that one of the benefits of remittances is to reduce the labor market rigidity and facilitate migration to the formal sector.

\(^{20}\) Since the status of workers employed in the informal sector is undocumented we cannot identify people losing employment in the informal sector.
those terminated. The presence of labor mobility costs, as described in (8) generates sluggishness in the adjustment of sectoral labor supply, which implies that the sectoral labor allocation decisions $L_f$ and $L_s$, represent investment decisions, analogous to those involving asset accumulation. Our specification of labor movements as a gradual process contrasts with that of some earlier contributions (e.g. Ihrig and Moe 2005, García-Peñalosa and Turnovsky 2005) who allow labor to move instantaneously, but is a more accurate description of the process in developing countries.\footnote{The instantaneous movement of labor across sectors is obtained by setting $\sigma = 0$, and $\sigma \rightarrow \infty$. An alternative approach to modeling intersectoral movements of labor would be to build on the more recent search and matching literature as applied to developing countries. Though our approach to the labor market is somewhat more reduced-form, the main results remain unaffected by these modeling choices. Moreover, our principal focus is not the structure of the labor market per se, but rather the dynamic absorption of remittances in the presence of an informal sector.}

2.4. The Government and Current Account

We assume that the government accumulates debt to finance excess public expenditures net of revenues

$$\dot{B} = rB + G_c - \tau \left( r_f K + w_f L_f \right) - T_f$$

(10)

where $B$ is the current stock of government (public) debt, and with the borrowing cost being given by the interest rate specification in (6). The evolution of the economy’s current account is obtained by combining the household and government budget constraints

$$\dot{V} = r(.)V + C_f + \Omega(.) + G_c - Y_f - R$$

(11)

where, $V \equiv N + B$ denotes the aggregate stock of debt of the economy. In deriving (11), the informal sector market clearing condition, $Y_s = C_s$, has been imposed.

3. Macroeconomic Equilibrium

The household maximizes (3), subject to (4), (5), (7), (8) and (9), while taking into account (2). Note that, in making its allocation decisions, the household takes the borrowing rate specified in (6) and government policy as given. The resulting optimality conditions are
\[
\frac{\partial U(C_f, C_s)}{\partial C_f} = q_1 \quad (12a)
\]
\[
\frac{\partial U(C_f, C_s)}{\partial C_s} = pq_1 \quad (12b)
\]
\[
\Omega_f(I, K) = q_K \quad (12c)
\]
\[
u = \frac{1}{\chi} \left( \frac{q_f - q_s}{q_f} \right) \quad (12d)
\]
\[
\beta - \frac{\dot{q}_s}{q_1} = r \quad (12e)
\]
\[
\frac{\dot{q}_K}{q_K} + \frac{(1 - \tau)r_K}{q_K} - \frac{\Omega_f(I, K)}{q_K} - \delta_K = r \quad (12f)
\]
\[
\frac{\dot{q}_f}{q_f} + \frac{(1 - \tau)\omega_f}{q_f} - (\sigma + z) = r \quad (12g)
\]
\[
\frac{\dot{q}_s}{q_s} + \frac{\partial Y_s(L_s)}{\partial L_s} p(q_1, L_s) - \frac{\sigma}{\partial} \left( \frac{q_f}{q_s} \right) = r \quad (12h)
\]

where, \(q_1\) is the shadow value of household debt (traded bonds) and \(q_K, q_f\) and \(q_s\) denote the shadow values of private capital, employment in the formal and informal sectors, respectively, the latter three shadow values being normalized by \(q_1\).\(^{22}\) In addition, the following transversality conditions apply:

\[
\lim_{t \to \infty} q_t Ne^{-\beta t} = \lim_{t \to \infty} q_K K e^{-\beta t} = \lim_{t \to \infty} q_f q_f L_f e^{-\beta t} = \lim_{t \to \infty} q_s q_s L_s e^{-\beta t} = 0 \quad (13)
\]

Eqs. (12a) and (12b) equate the marginal utility of consumption for the two consumption goods to the shadow price of household debt, while Eq. (12c) equates the marginal cost of private investment to the shadow price of capital. Eq. (12d) describes the rate at which labor moves from one sector to the other. This rate is determined by the difference in the shadow values in the two sectors, and varies

\(^{22}\) That is, if we let \(\mu_K\) denote the shadow (utility) value of capital, then \(q_K \equiv \mu_K / q_1\) and similarly for \(q_f, q_s\). Written in this way, the normalized prices become “asset prices” independent of utility units, and the optimality conditions (12g) and (12h) treat labor as an asset, analogous to capital.
inversely with the rigidity in the labor market, as parameterized by $\chi$. Observe that $u \geq 0$, implying that agents may also move from the formal to the informal sector, depending upon the relative shadow values. The remaining four conditions, (12e)-(12h) are intertemporal efficiency conditions, equating the return on consumption, the return on capital, and the net returns on employment investment in the formal and informal sectors, respectively, to the marginal cost of borrowing.

3.1. Equilibrium Dynamics

The internal equilibrium dynamics for the economy can be expressed in terms of the evolution of the following quantities: (i) private capital, (ii) employment in the two production sectors, (iii) national debt, and (iv) the shadow values of debt, private capital, and the sectoral employments.

To derive the equilibrium dynamics, we first solve the static first-order conditions, (12a) and (12b), for the equilibrium sectoral consumption quantities

$$C_j = C_j(p,q_i), \ j = f, s$$

(14)

Using (14) in conjunction with the market-clearing condition for the informal sector,

$$C_s(p,q_i) = Y_s(L_s)$$

(15a)

we can derive the short-run equilibrium real exchange rate:

$$p = p(q_i,L_s)$$

(15b)

It is straightforward to show that $\partial p/\partial q_i < 0$, and $\partial p/\partial L_s < 0$. An increase in the shadow value of household debt, or an increase in employment in the informal sector each increase the excess supply of the informal (nontraded) good, causing the real exchange rate to depreciate in order for the informal goods market equilibrium to be maintained. Combining (15a) and (15b) we obtain

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23 The parallels between (12d) and the corresponding relation in the pioneering Harris-Todaro (1970) migration model are apparent. That paper postulated the movement of labor between rural and urban areas to be proportional to the current wage differential between the two sectors. In contrast, we find that labor movement is proportional to the differential asset price, which upon integrating the arbitrage relationships (12g) and (12h) forward, is the discounted sum of expected future sectoral after-tax wage differentials.
\[ C_j = C_j[q_1, p(q_1, L_s)] = C_j[q_1, L_s], \quad j = f, s \]  

(15a’)

Next, solving (12c) yields

\[ I = \psi(q_K)K \]  

(15c)

enabling us to write \( \Omega(I, K) = \Omega(\psi(q_K))K \) and \( \Omega_K(I/K) = \Omega_K(\psi(q_K)) \). Also, from (6), (1a), (1b), and (15b) we obtain the reduced-form expression for the borrowing rate, \( r = r(L_f, L_s, K, q_1, V, \kappa R) \).

Using these relationships we can express the macroeconomic equilibrium as

\[
\dot{K} = (\psi(q_K) - \delta_K)K
\]

(16a)

\[
\dot{L}_f = \frac{q_f - q_s}{\chi q_f} - \frac{\chi}{2} \left( \frac{q_f - q_s}{\chi q_s} \right)^2 - zL_f + \sigma (1 - L_f - L_s)
\]

(16b)

\[
\dot{L}_s = -\left( \frac{q_f - q_s}{\chi q_f} \right)
\]

(16c)

\[
\dot{V} = r(.)V + C_f(q_1, L_s) + \Omega(\psi(q_K))K + G_C - Y_f(K, L_f) - R
\]

(16d)

\[
\dot{q}_1 = (\beta - r)q_1
\]

(16e)

\[
\dot{q}_K = (r(\cdot) + \delta_K)q_K + \Omega_K(\psi(q_K)) - (1 - \tau)r_K(K, L_f)
\]

(16f)

\[
\dot{q}_f = (r(\cdot) + \sigma + z)q_f - (1 - \tau)w_f(K, L_f)
\]

(16g)

\[
\dot{q}_s = r(\cdot)q_s + \sigma q_f - \frac{\partial Y_f(L_s)}{\partial L_s} p(q_1, L_s)
\]

(16h)

Taken together, (16a)-(16h) yield an autonomous macro-dynamic equilibrium in terms of \( K, L_f, L_s, N, q_1, q_K, q_f, \) and \( q_s \).

### 3.2. Steady-State Equilibrium

The steady state (denoted by tildes) is attained when \( \dot{K} = \dot{L}_f = \dot{L}_s = \dot{V} = \dot{q}_1 = \dot{q}_K = \dot{q}_f = \dot{q}_s \). Imposing these restrictions on (16a)-(16h) yields
\[ \psi(\bar{q}_K) = \delta_K \]  

\[ \sigma(1 - \tilde{L}_f - \tilde{L}_s) = zL_f \]  

\[ \bar{q}_f = \bar{q}_s \]  

\[ \beta \tilde{V} + C_f(\bar{q}_1, \tilde{L}_s) + \Omega(\delta_K) \tilde{K} + G_C - Y_f(\tilde{K}, \tilde{L}_f) - R = 0 \]  

\[ \tilde{r} = r^* + \omega \left( \frac{V}{Y_f(\tilde{L}_f, \tilde{K}) + p(\bar{q}_1, \tilde{L}_s)Y_s(\tilde{L}_s) + \kappa R} \right) = \beta \]  

\[ \tilde{q}_K = \frac{(1-\tau)\rho(\cdot)}{(\beta + \delta_K)} - \Omega_K \left( \frac{\delta_K(\cdot)}{\beta + \delta_K} \right) \]  

\[ \tilde{q}_f = \frac{(1-\tau)w_f(\tilde{K}, \tilde{L}_f)}{(\beta + \sigma + z)} \]  

\[ \tilde{q}_s = \frac{p(\bar{q}_1, \tilde{L}_s)\partial Y_s(\tilde{L}_s)/\partial \tilde{L}_s}{\beta + \sigma} \]  

Eqs. (17a)-(17h) yield 8 equations that can be solved for \( \tilde{K}, \tilde{L}_f, \tilde{L}_s, \tilde{V}, \bar{q}_1, \bar{q}_K, \bar{q}_f, \bar{q}_s \). In addition, substituting the steady-state solutions obtained from (17) into (15) and the sectoral production functions (1) enables us to solve for \( \tilde{p}, \tilde{I} \), the sectoral consumption levels, \( \tilde{C}_f, \tilde{C}_s = \tilde{Y}_s \), and output of the formal sector, \( \tilde{Y}_f \). Finally, in steady state the government’s budget constraint is

\[ \tilde{r}\tilde{B} + G_C = \tau Y_f(\tilde{K}, \tilde{L}_f) + T_f \]  

Given the government’s policy choices \( G_C, \tau, \) and \( T_f, \) and the steady-state solution from (17), the budget constraint (18) can be solved for the steady-state level of public debt, \( \tilde{B} \). \(^{24}\)

From (17) the following characteristics of the steady state can be noted. First, the long-run borrowing rate equals the rate of time preference. Second, since the shadow values of employment in the two sectors are equalized in steady state, flows into and out of the informal sector cease. Third,

\(^{24}\) Writing the household budget constraint (4) as \( \tilde{N}(t) = r(t)N(t) + X(t) + T_f(t) \), the first transversality condition in (13) can be written as \( N_0 + e^{\int_0^t r(\tau)d\tau} \int_0^t [X(\tau) + T_f(\tau)]e^{-\int_0^\tau r(\tau)d\tau} d\tau = 0 \), which constrains the path for lump sum taxes.
the shadow value of capital, $\tilde{q}_K$, depends only on the depreciation rate [see (17a)]. This implies that the equilibrium rate of investment, $I/K$ is independent of remittances. With $\tilde{q}_K$ fixed, equations (17f)-(17h) together with (1) and (2) further imply that $r, w, \tilde{K}/\tilde{L}_j, \tilde{Y}_f/\tilde{K}, \tilde{q}_f$, and $\tilde{q}_s$ are also independent of remittances.

From (17b) we see that in steady state, unemployment is related to sectoral employment by:

$$\tilde{L}_u = \left( -\frac{z}{\sigma + z} \right) (1 - \tilde{L}_s) = \frac{z}{\sigma} \tilde{L}_f$$

(19)

Thus, unemployment in steady state arises solely because of job termination in the formal sector and is not due to agents seeking to change jobs. Equation (19) further implies that $d\tilde{L}_s = -(\sigma + z) d\tilde{L}_u$, $d\tilde{L}_f = (\sigma/z) d\tilde{L}_u$, so that any increase in unemployment is reflected by a more than proportionate reduction in employment in the informal sector, accompanied by a smaller increase in employment in the formal sector. Further, the sectoral returns on employment, obtained by combining (17g) and (17h), while noting (17c), are related by:

$$\left(1 - \tau\right) \tilde{w}_f = \left(1 + \frac{z}{\beta + \sigma}\right) \tilde{p} \frac{\partial \tilde{Y}_f}{\partial \tilde{L}_s}$$

(20)

From (20) we see that in the steady state, workers in the formal sector earn an after-tax premium over the return to labor in the informal sector, with the wage premium being positively related to the job separation parameter, $z$, and inversely proportional to the job finding parameter, $\sigma$. When $z = 0$ or $\sigma \to \infty$, the steady-state after-tax wage rates are equalized across the two sectors, and there is no equilibrium unemployment; see (19).

4. **Calibration and Numerical Analysis**

The macroeconomic equilibrium set out in Sections 3.1 and 3.2 is described by a dynamic system comprising four state variables, $(K, L_f, L_s, V)$, and four co-state variables $(q_1, q_K, q_f, q_s)$. The high dimensionality of this dynamic system and its structural complexity renders an analytical solution intractable. We therefore proceed to analyze the model’s local dynamic properties using a numerical calibration, by linearizing the equilibrium dynamics around the steady-state equilibrium described in
Section 3.2. Table 2 specifies the functional forms used for calibrating the model, and Table 3 describes the parameterization of the benchmark model specification. Our numerical simulations confirm the existence of a saddle-point equilibrium, characterized by four stable (negative) and four unstable (positive) eigenvalues, ensuring a unique stable transitional path.

The intertemporal elasticity of substitution for consumption in utility is given by $1/(1-\gamma)$. We set $\gamma = -1.5$ implying an elasticity of 0.4, well within the range of evidence provided by Guvenen (2006). The rate of time preference, $\beta$, is set at 0.06, slightly higher than the typical value of 0.04 used in the macro-growth literature, mainly to capture two features characteristic of a developing economy: relative impatience and higher mortality rates, both of which tend to raise the rate of time preference. $\theta = 0.5$ reflects the assumption that there is no bias toward either consumption good. The world interest rate, $r^*$ and the borrowing premium are set to yield an aggregate debt-output ratio that is consistent with our reference sample (to be described below). Further, $\beta > r^*$ ensures that the economy is a net debtor in equilibrium, consequently running a current account deficit.

Information on the collateral effect is sparse. In the benchmark model we set $\kappa = 0$, so that there is no collateral effect associated with remittances. Using evidence provided by Ketkar and Ratha (2009) we also consider the case where $\kappa = 0.10$, as well as increasing $\kappa$ to 0.25, to illustrate the potential for the collateral effect to eliminate the Dutch Disease effect associated with pure remittances.25

The distributive share of private capital in the formal sector, $\alpha$, is set to 0.4, which is a standard assumption in the literature. The production function in the formal sector is assumed to be Cobb-Douglas, so that $s_f = 1/(1+\rho) = 1$ (i.e., $\rho = 0$; this will be subject to a sensitivity analysis in Section 5 below), and the adjustment cost parameter for investment, $h = 15$ is also conventional; see e.g. Auerbach and Kotlikoff (1987) and Ortiguera and Santos (1997). The depreciation rate for private capital is set at 5% per year, consistent with empirical evidence for developing countries provided by Schündeln (2013). The productive elasticity of labor in the informal sector, $\eta$, is chosen to match the

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25Ketkar and Ratha (2009, Table 2.6) suggest that in 2007 remittance flows had the potential of raising new debt equal to about 10% of the value of the remittance inflows, without raising borrowing costs. In terms of our specification of borrowing costs (6) we interpret this as asserting that $V_t/(Y+\kappa R) = V_0/Y$ where $V_t - V_0 = 0.10R$. This implies $\kappa = 0.10Y/V_0$ which at the base steady-state summarized in Table 4 suggests $\kappa \approx 0.11$. 

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observed employment share in the informal sector in our sample, and is also consistent with Turnovsky and Basher (2009). The values for the search cost and job separation rate are chosen to yield an equilibrium unemployment rate that is consistent with our reference data (to be described below in Section 4.1). The income tax rate on formal sector output is backed out from the sample means of (i) share of tax revenues in GDP, and (ii) the share of the informal sector in GDP. Finally, the sectoral productivity parameters $A_f, A_s$ are set to be consistent with the sectoral output shares we observe in the data (See Section 4.1).

4.1. Benchmark Equilibrium

The benchmark steady-state equilibrium quantities are reported in Table 4. We compare these quantities to their corresponding annual estimates from a sample of 40 countries for the period 1997-2009. The choice of countries in the sample was dictated by the joint availability of data on informal employment and output (ILO 2011 and Schneider et al. 2010). Given the poor coverage for informal employment, we use the estimates for the latest year available for the period 1999-2007 from the ILO database. The shares of private and public consumption, public and private debt, remittances, and tax revenues in GDP are obtained from the WDI. The mean real exchange rate in the sample is calculated from UNCTAD data. Finally, we use the calculations in Schneider et al. (2010) to get the average output share of the informal sector in GDP.

From Table 4, we see that the benchmark equilibrium implied by our model specification matches closely the corresponding sample averages. The consumption-output and capital-output ratios are about 0.8 and 0.96, respectively. The share of public debt in GDP is about 61%, while that of private debt is 29%. The formal sector accounts for about 59.8% of GDP, while employing 43% of the labor force. The long-run unemployment rate is about 8.7%. All of these equilibrium quantities are close to the corresponding empirical estimates, indicating that our benchmark economy is a good representation of a developing country with a sizable informal sector. The policy and transfer variables in the model are parameterized to match their corresponding averages in the data. Consequently, the share of remittances in GDP is set at 6.5%, to match its corresponding sample average. Similarly, the

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26 The list of countries is available from the authors on request.
share of government consumption is set to its sample average of about 14% of GDP.

5. Permanent Shocks

In this section, we analyze the dynamic consequences of three types of permanent shocks: (i) a 1% increase in the level of remittances, \( R \), relative to its benchmark, (ii) the introduction of a pure collateral effect through a change in financial policy, where \( \kappa \) in (6) increases from 0 to 0.10, with \( R \) remaining unchanged, and (iii) a 1% increase in remittance inflows that is accompanied by the introduction of a collateral effect. In this latter case two alternatives are considered, namely a weak effect where \( \kappa \) increases from 0 to 0.10 (close to the Ketkar-Ratha, 2009, evidence) and a stronger effect where \( \kappa \) is raised further to 0.25. The numbers reported in Table 5 and the plotted transition paths illustrated in Figures 4-6 represent percentage deviations from the pre-shock steady-state equilibrium.

5.1. Increase in Remittances

Comparing the first row of Table 5 and the dynamic time paths in Figure 4, we see that the long-run aggregate effects of a pure remittance shock are generally contractionary, but with sharp intertemporal trade-offs. As Table 5 indicates, both GDP and the capital stock decline in the steady state, together with a contraction of the economy’s output and employment shares in the formal sector. On the other hand, both aggregate consumption and welfare increase.\(^{27}\) There is a long-run real appreciation of the exchange rate, with an improvement in the economy’s net debt position.

An interesting aspect to note here is the presence of a long-run Dutch Disease effect: a remittance inflow leads to a long-run a real appreciation of the exchange rate, a contraction of the shares of output and employment of the formal sector, and a decline in aggregate GDP. Indeed, the fact that remittances may be associated with a Dutch Disease effect has been documented by Acosta et al. (2009) for El Salvador, and Amuendo-Dorantes and Pozo (2004) for a broader set of Latin American and Caribbean countries.

With respect to the transitional adjustment of the economy to the permanent remittance shock,

\(^{27}\) Changes in welfare are computed by an equivalent variation in consumption across steady states (taking into account the transitional adjustment path) such that the agent is indifferent between the initial welfare level and that following the underlying shock.
we see from Figure 4 that the higher inflow of remittances from abroad leads to an instantaneous real appreciation of the exchange rate, which overshoots its long-run equilibrium. On impact, this leads to an upward jump in the level of GDP, by increasing the market value of informal production. However, this increase cannot be sustained over time, and GDP declines steadily to a lower level in the long run. This is due to the fact that the increase in the relative price of the informal sector good draws labor into the informal sector, thereby reducing the productivity of private capital in the formal sector. This leads to a decumulation of private capital, which in turn leads to more labor leaving the formal sector. In transition, the lower overall productivity in the formal sector more than offsets the gains in the informal sector, and GDP contracts. The higher remittance inflow enables private consumption to increase in the short run, but the decline in output causes consumption to fall in transition, albeit to a net higher level relative to its pre-shock level. The fall in output and capital reduce the economy’s aggregate borrowing needs and this, along with the higher inflow of remittances, leads to an improvement in the economy’s net indebtedness.

5.2. Collateral Effect

The importance of remittances as a collateral in securitizing future borrowing has recently received some attention, especially for countries having a high remittance-to-GDP ratio, as well as those having a large informal sector that otherwise faces limited access to capital markets. In this section, we consider a counter-factual policy experiment, where the collateral parameter $\kappa$ in the borrowing rate function (6) is increased permanently from its benchmark level of 0 (no collateral effect of remittances) to 0.10 (where 10% of remittance inflows can be used as a collateral for borrowing). In doing so, we assume that the level of remittances remains unchanged at its benchmark level. This enables us to isolate the pure collateral effect associated with remittances. The results are reported in the second row of Table 5 and illustrated in Figure 5.

The pure collateral effect generates a dynamic response that is in sharp contrast to that of a pure remittance shock. The long-run effects are expansionary; both the stock of capital and aggregate output increase, as do the shares of output and employment in the formal sector. The real exchange rate depreciates in the long-run, with the economy increasing its net indebtedness to the rest of the
world. The real depreciation of the exchange rate and the decline in the output and employment shares of the informal sector imply that the collateral policy does not cause the long-run Dutch Disease effect that is associated with a pure remittance shock.

Figure 5 depicts the transitional responses to the change in the collateral policy for remittances. The fact that remittances can now be used to securitize future borrowing leads to an instantaneous appreciation of the real exchange rate, in anticipation of an inflow of foreign capital into the economy. This leads to an upward jump in GDP and consumption in the short run, as the real appreciation increases the market value of informal sector production. Consequently, labor flows into the informal sector on impact of the collateral shock. On the other hand, as the collateral policy enables the economy to borrow more (by increasing its debt-servicing capacity), this releases resources for private investment in the formal sector. The increase in capital accumulation in the formal sector raises the marginal product of labor in that sector, thereby leading to labor being re-allocated back to the formal sector over time. This enables the formal sector to expand relative to the informal sector, and puts downward pressure on the real exchange rate. Furthermore, the higher investment and real depreciation of the real exchange rate leads to a decline in private consumption along the transition path. The net effect is that overall welfare improves slightly by around 0.12%.

Table 5 and Figures 4 and 5 highlight the sharp differences between the effects of a remittance inflow and those of an associated collateral policy. In particular, while remittances lead to a Dutch Disease effect through a real appreciation of the exchange rate and an expansion of the informal sector, a collateral policy that mobilizes remittances for borrowing purposes has the opposite effect. This contrast raises the interesting question of whether an increase in remittances can have an expansionary effect on the economy and also avoid the Dutch Disease if it is accompanied by an appropriate collateral policy? To address this, we introduce an exogenous and permanent 1% increase in the level of remittances under two scenarios. In the first, it is accompanied by a small increase in the collateral policy, with \( \kappa \) increasing simultaneously from 0 to 0.10, consistent with the evidence cited by Ketkar and Ratha (2009). In the second, \( \kappa \) is increased to 0.25. The results are reported in the third and fourth rows of Table 5 and illustrated in Figure 6.

In both cases, the instantaneous real appreciation of the exchange rate is larger with the
collateral effect, in anticipation of an augmented inflow of foreign capital into the economy leading to a short run expansion. However, with only a small increase in $\kappa$ the long-run contractionary effect of remittances dominates, although it is alleviated somewhat, and overall welfare increases by 0.084% rather than 0.072% for pure remittances. However, increasing $\kappa$ further to 0.25 confirms that an increase in remittances that is accompanied by a sufficiently large change in the recipient economy’s collateral policy can indeed have a long-run expansionary effect and also avoid the long-run Dutch Disease phenomenon. Output and private capital increase, while the share of the informal sector declines over time. There is a net long-run depreciation of the real exchange rate, and the economy’s intertemporal welfare gain is further increased relative to the pure remittance shock.

This example highlights the potential importance of the collateral effect in enhancing the economy’s productive capacity when faced with an increase in remittance inflows. Further, from a policy perspective, these results underscore the importance of the collateral effect in reducing the relative size of the informal sector in a developing economy.

5.3. Sensitivity Analysis

In this section, we examine the sensitivity of the main results obtained to variations in two categories of structural parameters, namely

i. *productivity parameters*, where we examine the sensitivity of the results to variations in the elasticity of substitution in production for the formal sector, $s_f = 1/(1 + \rho)$, and the output elasticity of labor in the informal sector, $\eta$, and

ii. *labor market parameters*, where we vary the cost of labor mobility between the formal and informal sectors, $\chi$, the rate of job separation, $z$, and the rate of job finding $\sigma$.

The results of our sensitivity analysis are reported graphically, in Figure 7. We consider the case of an exogenous and permanent increase in the level of remittances, with no change in the country’s collateral policy.

For the productivity parameters, we consider the following: We vary the elasticity of substitution in production in the formal sector, $s_f$, between (i) $s_f = 0.75$ (low elasticity), (ii) $s_f = 1$
(Cobb-Douglas), and (iii) $s_f = 1.25$ (high elasticity). For the labor elasticity in the informal sector, we consider (i) $\eta = 0.05$, (ii) $\eta = 0.75$, and (iii) $\eta = 0.95$, allowing for a large variation in informal labor productivity. For the labor market parameters, we consider the following: we vary the intersectoral labor mobility cost, between (i) $\chi = 1$ (low cost), (ii) $\chi = 15$ (benchmark specification), and (iii) $\chi = 30$ (high cost). For the rate of job separation, we allow the parameter $z$ to assume 0, 0.01, and 0.05, respectively. For the rate of job finding, we set $\sigma = 0.05, 0.15,$ and $0.3$, respectively.

We report the dynamic responses of four key macroeconomic variables for variations in each structural parameter, namely aggregate output (GDP), the real exchange rate, the output share of the formal sector, and the employment share of the formal sector. Qualitatively, Figure 7 suggests that the model’s transitional dynamics with respect to a remittance shock are remarkably robust to variations in these key structural parameters. The one exception that deserves comment is the output elasticity of labor in the informal sector. For the case where this elasticity is low, i.e., $\eta = 0.05$, a remittance shock generates a net expansion for the economy, and a much smaller contraction of the formal sector, relative to the cases where $\eta$ is higher. In this case, the low productivity of labor in the informal sector implies a relatively large formal sector, along with a larger equilibrium wage differential between the sectors. As such, a remittance inflow leads to a smaller appreciation of the real exchange rate on impact and, when combined with the low relative productivity of the informal sector, mutes the mobility of labor to that sector. This leads to a smaller contraction of the formal sector, and prevents the net decline in aggregate output in transition.

6. Temporary Shocks

While the permanent changes considered in Section 5 are important to pin down the intrinsic mechanisms of the model, temporary shocks are arguably more realistic. In this section, we consider changes in the level of remittances and collateral policy that are temporary in nature. In this respect, an important consideration is whether the nature of the dynamic response of the recipient economy depends on the duration of the underlying shock. We examine the following three temporary shocks: (i) an exogenous increase in remittances, (ii) an increase in remittances accompanied by a change in the collateral policy, and (iii) a countercyclical increase in remittance inflows, driven by an aggregate
negative productivity shock. In each case, we assume that the underlying shock lasts for 5 periods. Figure 8 plots cases (i) and (ii) above, and Figure 9 plots case (iii).

6.1. Increase in Remittances

Figure 8 plots the dynamic response for a temporary and exogenous increase in the level of remittances by 1 percent from its benchmark level (solid line). Comparing the economy’s response to this temporary shock with its permanent counterpart in Figure 4, we see that the duration of the shock has a critical effect on its dynamic absorption. In sharp contrast to the permanent shock, a temporary increase in remittances turns out to be expansionary for the aggregate economy: the capital stock, consumption, and output increase in transition, before converging back to their pre-shock levels in the long-run. The real exchange rate does appreciate on impact, and this leads to an instantaneous contraction of the formal sector. However, in transition, the positive rate of capital accumulation in the formal sector helps this sector recover its relative share, by drawing labor back from the informal sector. The agent, knowing that the increase in remittances is temporary, uses the temporary resources to pay down its outstanding debt (the current account improves). This increases net savings for the economy, leading to the transitional accumulation of capital and expansion of output. Over all, the temporary change in remittances does not lead to an aggregate contraction or a Dutch Disease effect for the economy, in sharp contrast to the case of a permanent change.

6.2. Collateral Effect

The dashed plots in Figure 8 depict the case of a temporary increase in remittances (by 1 percent) which is accompanied by a temporary change in the collateral policy, with $\kappa$ increasing from 0 to 0.10 for the duration of the shock. The presence of a collateral effect magnifies the amplitude of the aggregate economy’s response: the transitional increases in the stock of capital, consumption, GDP, and the real exchange rate are significantly larger than for the case of a pure remittance shock without the collateral effect. The sectoral shifts in the output and employment share of the formal sector are also larger in this case. The presence of the collateral effect, does however worsen the current account in the short run, by allowing the agent to borrow more. However, the higher short-run borrowing
generates more resources for capital accumulation which, by expanding output, eventually improves the current account in transition. In summary, Figure 8 suggests that the presence of a collateral effect works to magnify the expansionary effect of a temporary increase in remittances.

6.3. **Endogenous (Countercyclical) Remittances**

Thus far, we have considered the impact of exogenous remittances, where inflows are independent of economic conditions in the recipient country. More recently, several authors, including Yang (2008), Acosta et al. (2009), Durdu and Seyan (2010), and Mandelman (2013), have pointed to the countercyclical nature of remittance inflows. Specifically, they suggest that remittance inflows from overseas residents are likely to increase if families or recipients back home (in the host country) face an unexpected economic hardship. This phenomenon can be captured by means of an unanticipated temporary negative productivity shock that impinges on the recipient economy and that leads to an increase in the inflow of remittances for its duration. As such, countercyclical remittances can be a form of insurance against an unanticipated negative shock in the recipient economy. Following Acosta et al. (2009), we formulate this as

\[ R = \bar{R} + R^c \]  

(21)

In (21), \( \bar{R} \) represents the exogenous component of remittance inflows, as in our specification so far, and \( R^c \) denotes the endogenous or countercyclical component, given by \( R^c = Y^\phi \), where the parameter \( \phi \) is the elasticity of the countercyclical component of remittances to GDP. Acosta et al. (2009) estimates this parameter to be about -2.5 for El Salvador, while Mandelman (2013) estimates a value of -1.98 for Philippines, both of which are high remittance-recipient countries. Based on these empirical findings, we set \( \phi = -2 \) in (21) as a reasonable approximation for this elasticity parameter.

We consider a temporary aggregate negative productivity shock, where the benchmark productivity levels in each sector decline temporarily by 1% for a 5 year period. Figure 9 plots the dynamic response in two cases: (i) when there is no countercyclical component to remittances (solid line), and (ii) when remittances are countercyclical as in (21), and increase temporarily on impact of the negative productivity shock. For this experiment, we set the collateral parameter, \( \kappa = 0 \).
Since the underlying productivity shock is negative, the economy goes through a contraction in transition, with capital, consumption, and output declining temporarily from their steady-state levels. The real exchange rate depreciates on impact of the shock, and the consequent fall in the relative price of informal sector goods drives labor mobility toward the formal sector, the output and employment share of which expand in transition. The lower aggregate output raises the economy’s debt-servicing costs, thereby worsening the current account. However, when the negative productivity shock is accompanied by an increase in countercyclical remittance inflows, the magnitude of this aggregate contraction is significantly smaller. This points to an important role for remittances in helping to smooth business cycle shocks.

In summary, the counterfactual experiments considered in Figures 4-9 help reconcile a lot of the ambiguity in the empirical literature regarding the effects of remittances at the macroeconomic level. We show how the effects of remittances on the aggregate economy depend critically on whether these inflows are permanent or temporary, exogenous or countercyclical, and on the presence of a collateral effect. Our results also suggest why it is difficult to observe a systematic pattern between remittances and the informal economy in the data, as discussed in Figures 1 and 2: while under certain conditions, remittances tend to drive a relative expansion of the informal economy over time, for others the relationship is opposite.

6.4. Welfare Effects

Table 6 reports the intertemporal welfare changes for the various temporary shocks we have considered. These reflect the impact on consumption, capital, and output as the economy adjusts along the transitional path. When the temporary remittance shock is exogenous, there is a larger welfare gain when it is accompanied by a change in the collateral policy. Moreover, the presence of countercyclical remittances significantly lowers the welfare loss from a negative productivity shock.

7. Conclusions

Developing countries that receive a large share of their GDP in the form of external transfers such as remittances are also typically associated with large informal sectors that absorb, on average, around
50 percent of their labor force and account for more than 40% of GDP. We develop a two-sector open economy model that characterizes many of the features of these economies, such as costly (and sluggish) movement of labor from the informal to the formal sector, long-run structural unemployment, and the lack of capital usage and tax collection in the informal economy. Within this context, we examine the dynamic absorption of remittance inflows, both permanent and temporary, as well as the effect of remittances serving as a collateral for borrowing. In addition, we also consider the case where remittance inflows may be endogenous, being driven by productivity shocks in the recipient economy.

By embedding remittances and the informal sector in a dynamic general equilibrium model, we bridge two important areas of research in development economics. On the one hand, the literature on the informal economy has focused mainly on the issues of size, measurement, and tax avoidance and enforcement, largely ignoring the issue of external transfers. On the other, the literature on remittances has dealt with their macroeconomic effects on the aggregate (or formal) economy, without reference to their implications for the informal sector. Our paper is the first systematic approach in bringing these two areas of work together. Further, there is a general lack of consensus in the empirical literature on the aggregate effects of remittances, with some studies finding a positive association between remittances and economic activity, while others documenting a negative or ambiguous relationship. By characterizing the different ways in which remittances may impinge on a recipient economy, our results attempt to reconcile the variety of results in the corresponding literature.

Our results indicate that though permanent increases in remittance flows may lead to a short-run economic expansion, they are unambiguously associated with an economic contraction and a larger informal sector in the long run, mimicking a Dutch Disease effect. On the other hand, when remittances play the role of collateral that securitizes future borrowing, the dynamic consequences can be quite opposite, with an expansionary effect for the economy and a decline in the share of the informal sector. The duration of remittance inflows tend to be critical to its absorption as well: while a permanent change in remittance flows can be contractionary, a temporary increase is, by contrast, expansionary, which can further be enhanced through a collateral effect. We also demonstrate that countercyclical remittances play an important role in smoothing business cycle shocks. In essence,
we show that the macroeconomic consequences of remittance inflows depend critically on their duration (permanent versus temporary), counter-cyclicality, and role as a collateral for debt.

Our analysis has abstracted from several other important features that may characterize the relationship between international transfers and the informal economy. These include (but are not restricted to) the skill composition of the labor force, formal entry barriers into the labor market, public-sector inefficiencies, borrowing constraints for households, and tax enforcement. These are undoubtedly important considerations, and we intend to pursue them in future research.
### TABLE 1. Remittances and the Informal Economy, 1999-2007

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remittances (% of GDP)</td>
<td>6.511</td>
<td>3.101</td>
<td>0.078</td>
<td>50.576</td>
<td>9.379</td>
</tr>
<tr>
<td>Informal sector output (% of GDP)</td>
<td>41.836</td>
<td>41.639</td>
<td>16.067</td>
<td>68.122</td>
<td>11.426</td>
</tr>
<tr>
<td>Self-employment (% of total employment)</td>
<td>48.816</td>
<td>46.033</td>
<td>8.289</td>
<td>91.3</td>
<td>22.792</td>
</tr>
<tr>
<td>Informal employment (% of total employment)*</td>
<td>53.689</td>
<td>59.6</td>
<td>6.1</td>
<td>83.5</td>
<td>20.319</td>
</tr>
</tbody>
</table>

Number of countries = 40

Data Source: Schneider et al. (2010), OECD, WDI, ILO
*Informal Employment data is for the latest year available in the sample (ILO, 2011)

### TABLE 2. Functional Forms

<table>
<thead>
<tr>
<th>Description</th>
<th>Functional Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility function</td>
<td>$U(C_f, C_s) = \left(\frac{C_f^{\theta} C_s^{1-\theta}}{\gamma}\right) \gamma$</td>
</tr>
<tr>
<td>Production function-Formal sector</td>
<td>$Y_f = A_f \left[ \alpha K^{-\rho} + (1-\alpha) L_f^{\rho} \right]^{-\frac{1}{\rho}}$</td>
</tr>
<tr>
<td>Production function-Informal Sector</td>
<td>$Y_s = A_s I_s^\eta$</td>
</tr>
<tr>
<td>Borrowing cost function</td>
<td>$r = r^* + e^{\frac{\phi(N+B)}{Y^*+\kappa R}} - 1$</td>
</tr>
<tr>
<td>Adjustment cost for investment</td>
<td>$\Omega = I \left(1 + \frac{h I}{2K}\right)$</td>
</tr>
</tbody>
</table>
### Table 3. Parameterization of the Benchmark Model

#### A. Structural Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1/(1 - \gamma)$</td>
<td>Intertemporal elasticity of substitution in consumption</td>
<td>0.4</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Rate of time preference</td>
<td>0.06</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Relative weight of formal-sector good in utility</td>
<td>0.5</td>
</tr>
<tr>
<td>$\bar{\omega}$</td>
<td>Borrowing premium-Households</td>
<td>0.022</td>
</tr>
<tr>
<td>$r^*$</td>
<td>World interest rate</td>
<td>0.04</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Collateral parameter</td>
<td>0</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>Remittance sensitivity to GDP (countercyclical case)</td>
<td>-2</td>
</tr>
<tr>
<td>$\bar{A}_f$</td>
<td>Productivity level-formal sector</td>
<td>1.5</td>
</tr>
<tr>
<td>$\bar{A}_s$</td>
<td>Productivity level-informal sector</td>
<td>1</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Share of private capital in formal sector</td>
<td>0.4</td>
</tr>
<tr>
<td>$s_f$</td>
<td>Elasticity of substitution in formal sector production</td>
<td>1</td>
</tr>
<tr>
<td>$h$</td>
<td>Adjustment cost for investment</td>
<td>15</td>
</tr>
<tr>
<td>$\delta_K$</td>
<td>Depreciation rate for private capital (annual)</td>
<td>0.05</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Share of labor in informal sector production</td>
<td>0.75</td>
</tr>
<tr>
<td>$z$</td>
<td>Rate of job separation</td>
<td>0.01</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Rate of job finding</td>
<td>0.05</td>
</tr>
<tr>
<td>$\chi$</td>
<td>Labor mobility cost</td>
<td>15</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Tax rate on formal sector output</td>
<td>0.3</td>
</tr>
</tbody>
</table>
### TABLE 4. Benchmark Steady-State Equilibrium

<table>
<thead>
<tr>
<th>Endogenous Variables</th>
<th>Description</th>
<th>Model</th>
<th>Data*</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C/Y )</td>
<td>Consumption-output ratio</td>
<td>0.804</td>
<td>0.803</td>
<td>WDI</td>
</tr>
<tr>
<td>( K/Y )</td>
<td>Private capital-output ratio</td>
<td>0.964</td>
<td>1.163</td>
<td>WDI, Gupta et al. (2014)</td>
</tr>
<tr>
<td>( B/Y )</td>
<td>Public debt-output ratio</td>
<td>0.609</td>
<td>0.604</td>
<td>WDI</td>
</tr>
<tr>
<td>( N/Y )</td>
<td>Private debt-output ratio</td>
<td>0.290</td>
<td>0.299</td>
<td>WDI</td>
</tr>
<tr>
<td>( Y_f/Y )</td>
<td>Share of formal sector in GDP</td>
<td>0.598</td>
<td>0.582</td>
<td>Schneider et al. (2010)</td>
</tr>
<tr>
<td>( L_f/L )</td>
<td>Share of formal employment (in total employment)**</td>
<td>0.431</td>
<td>0.463</td>
<td>ILO</td>
</tr>
<tr>
<td>( L_u )</td>
<td>Unemployment rate</td>
<td>0.087</td>
<td>0.086</td>
<td>WDI</td>
</tr>
<tr>
<td>( p )</td>
<td>Real exchange rate</td>
<td>1.168</td>
<td>1.028</td>
<td>UNCTAD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calibrated Variables</th>
<th>Description</th>
<th>Model</th>
<th>Data*</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Gc/Y )</td>
<td>Share of public consumption in GDP</td>
<td>0.141</td>
<td>0.141</td>
<td>WDI</td>
</tr>
<tr>
<td>( R/Y )</td>
<td>Remittances (share of GDP)</td>
<td>0.065</td>
<td>0.065</td>
<td>WDI</td>
</tr>
</tbody>
</table>

*Sample averages for 40 developing countries for the period 1999-2007.

**Employment share of the formal sector is for the latest year available in the ILO database (between 1999-2007).
**TABLE 5. Permanent Shocks: Steady-State Changes**

<table>
<thead>
<tr>
<th>Shock Description</th>
<th>dK</th>
<th>dC</th>
<th>dY</th>
<th>dp</th>
<th>dV</th>
<th>dL_u</th>
<th>dY_f/Y</th>
<th>dL_f/L</th>
<th>Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remittance Shock ($\Delta R = 1%, \kappa = 0$)</td>
<td>-0.073</td>
<td>+0.067</td>
<td>-0.016</td>
<td>+0.017</td>
<td>-0.016</td>
<td>-0.073</td>
<td>-0.056</td>
<td>-0.080</td>
<td>+0.072</td>
</tr>
<tr>
<td>Collateral Shock ($\kappa = 0$ to 0.1, $\Delta R = 0$)</td>
<td>+0.039</td>
<td>-0.036</td>
<td>+0.009</td>
<td>-0.010</td>
<td>+0.656</td>
<td>+0.039</td>
<td>+0.030</td>
<td>+0.043</td>
<td>+0.012</td>
</tr>
</tbody>
</table>

Remittance with Collateral Shock

<table>
<thead>
<tr>
<th>Shock Description</th>
<th>dK</th>
<th>dC</th>
<th>dY</th>
<th>dp</th>
<th>dV</th>
<th>dL_u</th>
<th>dY_f/Y</th>
<th>dL_f/L</th>
<th>Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $\Delta R = 1%, \kappa = 0$ to 0.1</td>
<td>-0.033</td>
<td>+0.031</td>
<td>-0.008</td>
<td>+0.008</td>
<td>+0.646</td>
<td>-0.033</td>
<td>-0.026</td>
<td>-0.036</td>
<td>+0.084</td>
</tr>
<tr>
<td>b. $\Delta R = 1%, \kappa = 0$ to 0.25</td>
<td>+0.026</td>
<td>-0.024</td>
<td>+0.006</td>
<td>-0.006</td>
<td>+1.639</td>
<td>+0.026</td>
<td>+0.020</td>
<td>+0.029</td>
<td>+0.102</td>
</tr>
</tbody>
</table>

**TABLE 6. Temporary Shocks: Welfare Changes**

Duration of Shock: $T = 5$ periods

<table>
<thead>
<tr>
<th>Welfare Change</th>
<th>Welfare Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exogenous Remittance Shock</td>
<td>+0.028</td>
</tr>
<tr>
<td>Remittance with Collateral Shock</td>
<td>+0.035</td>
</tr>
<tr>
<td>Negative Productivity Shock</td>
<td>-0.373</td>
</tr>
<tr>
<td>Countercyclical Remittance Shock</td>
<td>-0.133</td>
</tr>
</tbody>
</table>

All changes are reported as percentage deviations from the pre-shock steady state. All shocks are calibrated to equal a one percentage-point increase from their benchmark specification.
FIGURE 1. Share of Remittances and Informal Sector in GDP
Selected Countries, 1999-2007

Data Sources: Schneider et al. (2010), OECD, and WDI
FIGURE 2. Remittances and the Informal Economy  
27 Countries, 1999-2007

Data Sources: Schneider et al. (2010), OECD, and WDI
FIGURE 3. Country Creditworthiness and Remittances

Source: Ratha (2007)
FIGURE 4. Permanent Exogenous Increase in Remittances
\( \Delta R = 1\% \), \( \kappa = 0 \)
FIGURE 5. Collateral Effect

\( \kappa = 0 \) to 0.1, \( \Delta R = 0 \)
FIGURE 6. Permanent Exogenous Remittance with Collateral Shock

- Private Capital
- Output (GDP)
- Real Exchange Rate
- Relative Shadow Price-Formal Employment
- Output Share-Formal Sector
- Employment Share-Formal Sector

Legend:
- Pure Remittance Shock ($\Delta R = 1\%, \kappa = 0$)
- Remittance with Collateral Shock ($\Delta R = 1\%, \kappa = 0$ to 0.1)
- Remittance with Collateral Shock ($\Delta R = 1\%, \kappa = 0$ to 0.25)
A. Elasticity of Substitution in Production-Formal Sector \([s_f = 1/(1+\rho)]\)

B. Output Elasticity of Labor-Informal Sector \(\eta\)
FIGURE 7. Sensitivity Analysis (Continued)
Permanent Exogenous Remittance Shock

C. Intersectoral Labor Mobility Cost ($\chi$)

D. Job Separation ($z$)

E. Job Finding ($\sigma$)
FIGURE 8. Temporary Remittance (Exogenous) and Collateral Shock

Private Capital

Consumption

Output (GDP)

Current Account

Real Exchange Rate

Relative Shadow Price-Formal Employment

Output Share-Formal Sector

Employment Share-Formal Sector

Pure Remittance Shock ($\Delta R = 1\%, \kappa = 0, T = 5$ periods)

Remittance with Collateral Shock ($\Delta R = 1\%$ and $\kappa = 0$ to $0.1, T = 5$ periods)

$\Delta A_f = \Delta A_s = -1\%$ for $T = 5$ periods
References


International Labor Organization (2011), Statistical update on employment in the informal economy. ILO Department of Statistics.


Marquez, G. and C Ruiz-Tagle (2004), Search Methods and Outcomes in Developing Countries: The case of Venezuela, Inter-American Development Bank Working Paper No. 519.


