Beware of Emigrants Bearing Gifts: Optimal Fiscal and Monetary Policy in the Presence of Remittances

Ralph Chami
International Monetary Fund
700 19th Street, N.W.
Washington, D.C. 20431

Thomas F. Cosimano
Department of Finance
Mendoza College of Business
University of Notre Dame
Notre Dame, IN 46556
Phone: 574-631-5178
Email: Thomas.F.Cosimano.1@nd.edu

Michael T. Gapen
Board of Governors of the Federal Reserve System
20th and Constitution Avenue, N.W.
Washington, D.C. 20551

October, 2008

Acknowledgements: The authors thank Adolfo Barajas, Jeff Bergstrand, Peter Egger, Connel Fullenkamp, Jürgen Von Hagen, Federico Mandelman, Peter Montiel, Carlos Ramirez, Stephanie Schmitt-Grohe, Chris Waller, Volker Wieland, and conference participants at the University of Bonn, University of Frankfurt, University of Munich, IMF Institute, Allied Social Science Association (ASSA) meetings, the 12th International Conference on Computing in Economics and Finance, and the Atlanta Federal Reserve Bank for helpful comments and suggestions. Remaining errors are those of the authors.

Beware of Emigrants Bearing Gifts: Optimal Fiscal and Monetary Policy in the Presence of Remittances

Abstract

Remittance flows are quickly surpassing private capital flows and official aid in magnitude and rate of growth, making them the single most important form of income flows into developing economies. This paper uses a stochastic dynamic general equilibrium model to investigate the influence of countercyclical remittances on economic variables and the conduct of fiscal and monetary policy in a business cycle setting. We find that remittances have both positive and negative effects. Remittances raise household consumption and insure against income shocks, thereby raising household welfare. However, remittances increase the correlation between labor and output, producing a more volatile business cycle. Remittances alter the conduct of optimal policy by improving the ability of the government to service debt, leading to an increase in its use. In economies with labor taxation, remittances inhibit the ability of policy makers to enact the Friedman rule while, instead, increasing the incentive to use the inflation tax. However, policy makers can restore optimality of the Friedman rule if the government has access to a consumption tax. The results highlight the need for independent policy instruments in countries faced with such flows.

JEL Classification Numbers: F2; E44; E63
Keywords: Remittances, Ramsey policies, Optimal monetary policy, Optimal taxation.

1. Introduction

The World Bank's recent *Global Economic Prospects* (World Bank, 2006a) estimates official remittances received by developing countries in 2005 were $167 billion, up 73 percent from 2001.[1] When estimates of unrecorded remittances – or remittances flowing through unofficial channels – are added, the magnitude rises by about 50 percent, bringing the total estimate of these flows to around $250 billion. According to World Bank (2006a), the magnitude of remittances in many developing countries has surpassed official development assistance (ODA), private equity flows, and foreign direct investment (FDI), and their rate of growth has outpaced that of official and private capital flows. Yet remittances, which flow through the current account of the balance of payments, have not received the same attention and careful scrutiny as private capital flows.

The existing literature on remittances has mainly focused on the motivation for these transfers and their microeconomic implications.[2] On the motivation to remit, the literature has examined whether remittances as person-to-person private income transfers are altruistically motivated or behave more like investment-related capital flows. Chami, Fullenkamp, and Jahjah (2005) show that remittances, unlike capital flows, are countercyclical and may have unintended consequences for economic growth. Analysis in World Bank (2006a), IMF (2005), and Mishra (2005) have confirmed the countercyclicality result. Therefore, remittance behavior appears to be altruistically motivated, compensating for poor economic performance in the home country.

However, the existing literature has been largely silent on the impact of remittances as countercyclical income transfers on government policy and the macro economy in the context of a fully specified general equilibrium framework. Two recent examples of remittances in a general equilib-

[1] World Bank (2006a) defines remittances in the broadest possible terms to include workers' remittances, compensation of employees, and migrant transfers.

[2] See Taylor (1999), Hagen-Zanker and Siegel (2007), and Aguinas (2006) for reviews of the literature on remittances.

rium setting include Durdu and Sayan (2007), who investigate remittances in Turkey and Mexico, and Acosta, Larty, and Mandelman (2008), who investigate the Dutch disease effects of remittances. Other recent studies examining the macroeconomic implications of remittances have relied on surveys of households in different countries (Adams 2004; Amuedo-Dorantes, Bansak, and Pozo 2005; and McKenzie 2005).[3] In the absence of a unifying framework, a positive aura has surrounded and colored the role of remittances and the policy prescription towards these flows. The conventional wisdom, with few exceptions, is that remittances: (i) represent a stable and reliable source of foreign exchange, (ii) reduce poverty, (iii) insure consumption against bad shocks, (iv) reduce macroeconomic volatility, (v) enhance investment in physical and human capital, and (vi) alleviate credit constraints. Consequently, there is an emphasis among policy makers to highlight remittances as a cure to the economic challenges facing developing countries. Without careful analysis of the macroeconomic implications of such transfers, policies aimed at encouraging remittances may create unintended consequences for the recipient economies.

Using standard techniques that have been applied previously to developed countries, we examine the role of remittances in developing countries. Broadly stated, the purpose of this paper is to examine how remittances influence the conduct of optimal monetary and fiscal policy, and whether a preferred tax structure exists to allow policy makers to best achieve their objectives in remittance-dependent economies. The main results of this exercise, which are described below, are driven by behavioral changes in the labor market when countercyclical remittances are introduced into the model economy. Remittances enter the household budget constraint directly since they are private, unrequited, non-market income transfers between residents of different countries. Consequently, labor supply of the remittance receiver reacts to information from two channels—the domestic production process and remittance flows—when making their labor supply decision. The

[3] See also Lucas and Stark (1985) for remittances in Bostwana and Agarwal and Horowitz (2002) for remittances in Guyana.

presence of a remittance channel leads to two important changes in labor market behavior. First, initial equilibrium hours worked are lower in an economy with remittances so long as the recipient household values both consumption and leisure. Second, household labor supply becomes more procyclical in the presence of remittances. Consider the example of a negative technology shock that leads to a decrease in output through the domestic production function. The decline in domestic income leads to an increase in remittances due to the countercyclical nature of these flows. Since the recipient household is now concerned with smoothing consumption and leisure using resources from a pool that includes both income from production and remittances, the household does not increase its labor supply in response to the shock when remittances are present as much as it does when not receiving remittances. Instead, the household will take advantage of the remittance inflows to choose additional leisure over labor. The finding that labor supply becomes more procyclical in economies with remittances underlies the following main conclusions of the paper.

We find that a consumption-based tax structure is preferable to a system of labor taxation in remittance-dependent economies since it permits the government to pursue its policies with the least amount of distortionary effects. When remittances are not present, optimal monetary policy follows the Friedman rule, which is consistent with findings by Kocherlakota (2005), Alvarez, Kehoe, and Neumeyer (2004), Aiyagari et al. (2002), and Chari, Christiano, and Kehoe (1991, 1996) that the Friedman rule is optimal in a variety of monetary economies with distortionary taxes. However, introducing remittances into economies that rely on labor income taxes results in higher steady-state rates of labor taxation, debt levels, and money growth as the government seeks to finance the same level of spending while raising revenue from a tax which acts on a smaller base of domestic production. In this setting, optimal monetary policy deviates from the Friedman rule as the government finds it optimal to use the inflation tax to access remittance effects on consumption indirectly. In contrast, optimal policy maintains the Friedman rule in remittance-

dependent economies when the government uses consumption taxation. Remittances lead to an increase in the consumption tax base, meaning the government can reduce the tax on consumption while still having enough resources to cover exogenous government expenditures, pay debt service costs, and enact the Friedman rule.

We also find that the increased procyclicality of labor supply in the presence of remittances has the undesirable effect of raising business cycle volatility. Simulations indicate that volatility of output increases with the ratio of remittances to income regardless of the tax structure in place. The benefits to the household from higher consumption and leisure from remittances therefore come at a cost, one that policy makers are unable to eliminate. The increase in business cycle volatility also translates into higher risk in the labor market through higher wage and labor supply volatility. Thus, while Chami, Fullenkamp, and Jahjah (2005) use asymmetric information assumptions to argue that remittances increase labor market risk, we find this to be the case in a model with flexible prices and full information.

Remittances also reduce the burden of servicing government debt. Remittances increase total household resources and the potential revenue base for the government under both tax systems, even though the distortionary inflation tax must be used to tap these resources under labor taxation. Consequently, the economies with remittances report a lower value of the multiplier on the government budget constraint which corresponds to a lower shadow price of debt. In the context of the model, this implies that the government can service the existing amount of debt with fewer distortions or sustain a higher level of debt at the same level of distortionary costs prior to the introduction of remittances. Under either scenario, a reduction in the shadow price of debt is equivalent to a reduction in the level of country or credit risk, allowing for the conclusion that remittances can improve debt sustainability. A corollary to this result is that the government finds it optimal to increase the use of debt in a business cycle context since its marginal cost has fallen, helping to

insure the household against adverse economic shocks. The increased use of debt when its marginal cost has fallen is also consistent with Barro's (1979) finding that minimizing distortions requires using debt to minimize variations in taxes across time.

Finally, we find that remittances lead to a net increase in household welfare, as their labor-leisure trade-off and consumption smoothing effect enhance the per-period utility of the recipients of such transfers sufficiently to outweigh any negative impact of increased domestic income risk. This result confirms the widely held belief that remittances can play an important role in increasing standards of living and aiding in poverty reduction. Increases in per-period utility are highest under a system of consumption taxation, providing one possible explanation for the widespread use of such taxes in developing countries, which tend to be more remittance-dependent, relative to their developed counterparts (Gordon and Li, 2006).

The paper proceeds as follows. Section II describes some stylized facts about remittances and examines the various motivations behind remittance activity. This is followed in Section III by a discussion of the model framework. Sections IV and V describe the main results under labor income taxation and consumption taxation, respectively, while Section VI discusses welfare implications. Concluding remarks are provided in Section VII.

2. Stylized Facts and the Motivation to Remit

Remittances are private income transfers that take place between family members. In many cases, one or more family members live and work abroad while regularly transferring, or remitting, income back to the remaining family unit in the home country. The typical transfer amount does not exceed a few hundred dollars, but millions of these transfers take place worldwide through both formal and informal channels, such as the family and friends network. The choice of channel is dependent on a number of factors including the number and type of restrictions placed by recipient countries

on foreign exchange flows, the level of transaction costs imposed by financial intermediaries, as well as other types of capital controls (World Bank, 2006a).

Remittance flows to developing countries have grown substantially, increasing from $26 billion in 1990 to $104 billion in 2003; a sum that equates to 91 percent of global workers' remittances in that year and 1.4 percent of total developing country GDP.[4,5] As shown in Figure 1, the top remittance receiving developing countries recorded annual flows of between 8 and 28 percent of GDP during 2003. Annual averages over the period 1990-2003 show a similar picture, as the top 20 developing countries received remittance flows between 6 and 24 percent of GDP. Across all developing countries, IMF (2005) reports that remittances are now the second largest inflow behind FDI, but ahead of official development assistance and non-FDI private capital inflows.

The existing literature identifies two basic motivations behind remittances: altruism and self-interested exchange. Examples of the altruistic motivation can be found in Lucas and Stark (1985) and Chami, Fullenkamp, and Jahjah (2005), while the theory of exchange motivation can be found in Straubhaar (1986), Elbadawi and Rocha (1992), El-Sakka and McNabb (1999), and Buch, Kuckulenz, and Le Manchec (2002), among others.[6] Establishing the primary motivation behind remittance behavior is important since the altruistic and exchange motives have different implications for the relationships between remittances, household decisions, and other economic variables of interest in the receiving country. If remittance flows are purely exchange motivated, then remittances should behave more like investment and private capital flows, exhibiting a strong procyclical

[4] Data reflect formal flows of workers' remittances only and excludes compensation of employees, migrant transfers and estimates of remittance flows through informal channels. The World Bank (2006a) estimates used earlier in this paper also include employee compensation and migrant transfers.

[5] The dramatic growth in remittances may also reflect the concerted effort to bring these transactions into the formal transfer market as governments have intensified efforts to control money laundering and other potentially illicit transactions. Thus, some of the dramatic growth in remittance activity may simply be a measurement effect.

[6] The theory on altruistically motivated remittance flows is consistent with optimal bequest behavior and, therefore, has its roots in Becker's (1974) analysis on economics of the family. For example, Bernheim, Shleifer, and Summers (1985), Cox (1987), and Wilhelm (1996) all examine stragetic bequest motives in a framework where utility of the parents includes lifetime resources of their children.

relation to output in the receiving country. However, if remittances are primarily motivated by altruism on the part of the remitter, then remittances as unrequited compensatory income transfers would be countercyclical relative to output in the receiving country. In other words, the sender remits more when economic conditions worsen in the home country.

A series of econometric studies have tested these theoretical models of optimal remittance behavior using panel data and, taken together, reveal remittances to be compensatory in nature and primarily motivated by altruism.[7] In addition to the income level of the recipient and remitter and the degree of attachment to the family or home country, these studies have also included other explanatory variables such as the number of years in the host country and economic policies and institutions in the home country. Chami, Fullenkamp, and Jahjah (2005) use a panel of cross-country data and find that remittances are negatively correlated with home country income while, in contrast, capital flows such as FDI have a positive correlation. IMF (2005), Mishra (2005), and World Bank (2006a) also find that home country income has a significant, negative impact on remittances. With regard to other explanatory variables, these studies find that income of the remitter in the host country, proxied by world or U.S. output, has a statistically significant, positive impact on remittances. IMF(2005) finds that multiple exchange rates and restrictions on foreign exchange deposits have a statistically significant, negative impact on remittances while financial development and broad measures of political risk and law and order did not have a significant effect. Finally, these studies found that interest rate differentials, a proxy for relative investment opportunities and the portfolio motive, did not have a significant effect on remittance activity.

[7] To verify these findings, we constructed a panel dataset on workers' remittances and estimated a remittance determination equation relating workers' remittances to domestic income, world income, and relative investment opportunities. The dataset includes observations from 1980-2004 for a sample of emerging market countries from the Penn World Tables (Heston, Summers, and Aten, 2006), International Financial Statistics (IMF, 2006), and World Development Indicators (World Bank, 2006b). The results indicate that domestic income has a statistically significant, negative impact on remittances while world income, proxied by U.S. income, has a significant positive impact. Both variables are significant at the 1 percent level. Relative investment opportunities measured through interest rate differentials, however, is not significant.

The literature to date, however, has largely been silent on the impact of countercyclical remittance flows on government policy and the macro economy, especially in the context of a fully specified general equilibrium framework. We proceed in the next section by developing a stochastic dynamic general equilibrium model with distortionary government policy in order to investigate the implication of countercyclical remittance flows on economic decision making and the conduct of monetary and fiscal policy in a business cycle setting.

3. Stochastic Monetary Economies with Remittances

The economy contains a representative household, a representative firm, a government, and remitters. Given the preponderance of evidence on the altruistic motive for remitting, the household in this economy receives remittances which are exogenously specified as countercyclical real income transfers. Thus, we are not solving for optimal remittance behavior but are instead specifying an exogenous remittance function that captures optimal behavior of senders of remittances as characterized in the microeconomic literature. These transfers enter the household budget constraint directly, augmenting the income the household receives from production.[8]

The government raises revenue with distortionary effects to finance its exogenous stochastic spending through taxation, printing money, or debt issuance through one-period real bonds. Since tax structures vary across countries (Gordon and Li, 2006), we model two stochastic monetary economies with remittances: one where the government uses a tax on labor income and a second where the government raises revenue through a consumption tax. In both economies, however, we assume that the government is unable to levy a direct tax on remittance income flows, an assumption which accords with evidence from various studies (e.g., World Bank, 2006a, p. 93) which report that remittances are not typically taxed directly by governments. Finally, as in Lucas

[8] In contrast, foreign aid, official development assistance, and private capital flows may be modeled as entering the investment function or government budget constraint.

and Stokey (1983), Alvarez, Kehoe, and Neumeyer (2004), and others, this framework does not include a tax on capital and therefore avoids the well understood problems arising from capital taxation in representative agent models.[9]

Aggregate output, Y_t, is produced from a constant returns-to-scale production function,

$$Y_t = \exp(\theta_t) H_t^{\alpha} K_t^{1-\alpha}, \quad 0 < \alpha < 1, \tag{3.1}$$

where K_t and H_t are the aggregate capital stock and labor supply, respectively, and θ_t represents the available technology. Technology is assumed to be the realization of an exogenous stochastic process and evolves according to, $\theta_t = \rho_\theta \theta_{t-1} + \epsilon_{\theta,t}$, where $0 < \rho_\theta < 1$, the random variable, $\epsilon_{\theta,t}$, is normally distributed with mean zero and standard deviation $\sigma_{\theta,t}$ and the realization of $\epsilon_{\theta,t}$ is known to all agents at the beginning of period t. The restriction on labor's share of income below unity means labor supply is nonlinear and marginal product of labor is endogenous.[10] Preserving the nonlinearity of the labor supply function and associated Jensen's inequality effects more accurately capture the cost of government policy and its interaction with remittances through the endogeneity of the marginal product of labor.

Investment in physical capital in period t produces capital in period $t+1$ according to,

$$K_{t+1} = (1-\delta) K_t + X_t, \quad 0 < \delta < 1, \tag{3.2}$$

[9] In addition to ruling out taxation of the pre-existing stock of capital, an assumed zero capital tax is also justified by the well established result that tax rates on capital should be close to zero on average in the context of representative agent models. For other work on optimal capital taxation in this setting, see Atkinson (1971), Diamond (1973), Pestieau (1974), Atkinson and Sandmo (1980), Judd (1985), Chamley (1986), and Chari, Christiano, and Kehoe (1991, 1994). In the context of heterogeneous agents, however, a positive tax rate on capital has been found to be optimal. Auerbach and Kotlikoff (1987), for example, detail capital taxation in an overlapping generations setting, while Aiyagari (1995) shows how idiosyncratic risk and borrowing constraints lead to positive capital taxes.

[10] The production function in equation (3.1) has meaningful implications which differ from similar recent work by Aiyagari et al. (2002), Alvarez, Kehoe, and Neumeyer (2004), and Schmitt-Grohé and Uribe (2004). These authors set $\alpha = 1$ in which results in an exogenous marginal product of labor.

where X_t is the level of investment in period t and δ is the rate of depreciation. The capital stock is assumed to be fixed so that $X_t = X = \delta K$. We believe this is a reasonable assumption to make in order to streamline the model given that the empirical evidence suggests that remittances are altruistic in nature and insensitive to interest rate and exchange rate changes. As discussed more fully in the following sections and in Appendix I, assumptions of a fixed capital stock will enable computation of closed-form equilibrium solutions for the private sector. The representative firm seeks to maximize profit by choosing labor supply resulting in the standard first-order conditions for the wage rate and rental rate on capital, adjusted for constant capital.

Preferences of the representative household are summarized by,

$$E_t \sum_{t=0}^{\infty} \beta^t \left[a \log C_{1t} + (1-a) \log C_{2t} - \gamma H_t \right], \tag{3.3}$$

where C_1 is the cash good, C_2 is the credit good, γ is a positive constant and $0 < \beta, a < 1$. The specification of linear disutility of labor is derived from the assumptions that labor is indivisible and allocation of labor is determined by employment lotteries (Hansen, 1985; and Rogerson, 1988).

Following the results of existing studies on the optimal behavior of remitters, the household receives remittances in the form of a compensatory income transfer equal to,

$$Rem_t = r_0 \left(\frac{\overline{Y}}{Y_t} \right)^{r_1}, \tag{3.4}$$

where $\overline{Y}$ is the steady-state level of output and r_0 and r_1 are positive constants. The responsiveness of remittances to the domestic business cycle is determined by the parameter r_1 and the steady-state level of remittances is equal to r_0. The remittance determination equation implicitly assumes income abroad is held constant at its full employment, steady-state level, with any level effects captured in the parameter, r_0, in the calibration process.

3.1. Labor Income Taxation

The household enters period t with previously accumulated assets equal to the stock of money holdings, M_t, and gross returns from government bonds, $B_t R_{t-1}$, where B_t is the stock of bonds and R_{t-1} is the gross real interest rate. The timing of the shocks is such that households know the past and current realization of technology and government spending and form expectations over future possible values. After the shocks are revealed and expectations are formed, the household then decides labor supply, receives remittances, chooses consumption of the cash and credit goods, government bonds, and the amount of money to be carried into the next period. Household allocations must satisfy the following budget constraint,

$$C_{1t} + C_{2t} + \frac{M_{t+1}^d}{P_t} + B_{t+1} \leq \left(1 - \alpha\tau_t^h\right)(Y_t - X) + Rem_t + \frac{M_t}{P_t} + B_t R_{t-1}, \tag{3.5}$$

where P_t is the price level and τ_t^h is the tax applied to labor income.[11] The term M_{t+1}^d is the demand for money balances by the representative household to be used in the next period and is aggregated across households in relation to money supply in equilibrium. Previously accumulated money balances are used to purchase the cash good in the current period and must also satisfy the cash-in-advance constraint,

$$P_t C_{1t} \leq M_t. \tag{3.6}$$

Real government consumption, G_t, is assumed to follow an exogenous stochastic process. Government policy includes sequences of labor taxes and supplies of money and bonds which must

[11] Under labor taxation firms are assumed to take depreciation charges before taxes are applied at the household level. If firms were not allowed to take depreciation charges before taxes were applied, the government would find it optimal to tax inelastically supplied investment and use the proceeds to retire money balances. This assumption is not necessary under consumption based taxation.

satisfy the following budget constraint,

$$\frac{M_t}{P_t} + B_t R_{t-1} = \tau_t^h \alpha \left(Y_t - X\right) - G_t + B_{t+1} + \frac{M_{t+1}}{P_t}, \tag{3.7}$$

where the initial stocks of money, M_0, and bonds, B_0, are given. The money supply and government spending in period t are assumed to grow at the rate $\exp(g_t) - 1$ and $\exp(\mu_{t+1}) - 1$, respectively. The random variable g_t is assumed to evolve according to the following autoregressive process, $g_t = \rho_g g_{t-1} + \epsilon_{g,t}$, where $\epsilon_{g,t}$ is normally distributed with mean zero and standard deviation $\sigma_{g,t}$. Like the shock to technology, the realization of $\epsilon_{g,t}$ is known to all at the beginning of period t. The economy-wide resource constraint is,

$$C_{1t} + C_{2t} + X + G_t = Y_t + Rem_t. \tag{3.8}$$

3.2. Consumption Taxation

Under consumption taxation, household allocations must satisfy the following modified budget constraint,

$$\left(C_{1t} + C_{2t}\right)\left(1 + \tau_t^c\right) + \frac{M_{t+1}^d}{P_t} + B_{t+1} + X \leq Y_t + Rem_t + \frac{M_t}{P_t} + B_t R_{t-1}, \tag{3.9}$$

where τ_t^c is the tax on household consumption and is applied at the same rate to both the credit and cash good. The household pays the tax on credit good consumption with credit and cash good consumption. Previously accumulated money balances must satisfy,

$$P_t C_{1t}\left(1 + \tau_t^c\right) \leq M_t. \tag{3.10}$$

Government policy includes sequences of consumption taxes and supplies of money and bonds which must satisfy the following budget constraint,

$$\frac{M_t}{P_t} + B_t R_{t-1} = \tau_t^c \left(C_{1t} + C_{2t}\right) - G_t + B_{t+1} + \frac{M_{t+1}}{P_t}. \tag{3.11}$$

The remaining components of the model are identical to those under labor based taxation.

3.3. Solution to the Household Problem

Assumptions of a fixed capital stock and logarithmic preferences enable computation of closed-form equilibrium solutions for the private sector and price system given a particular government policy.[12] The closed-form solution for consumption of the credit good can be used to solve for optimal labor supply, defining an implicit function,

$$H_t = h\left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right). \tag{3.12}$$

It is clear from equations (3.12), (3.1), and (3.4) that the realization of exogenous shocks and government policy determines labor supply, aggregate output, and aggregate remittances, respectively. Thus, while remittances are not directly subject to government taxation, government policy indirectly influences the level of remittances through changes in the marginal product of labor.

3.4. The Ramsey Equilibrium with Remittances

Under the assumption that an institution or commitment technology exists through which the government can bind itself to a particular sequence of policies, the government attempts to maximize

[12] See Appendix I for solutions to the household problem under labor and consumption based taxation. The equilibrium solution for the private sector indicates that the specification of consumption taxation in equations (3.9) - (3.11) minimizes the distortion from the consumption tax. Forcing the household to pay all taxes with money balances would change the relationship between cash and credit good consumption and the interest rate.

household utility in (3.3) subject to the government budget constraint in (3.7) or (3.11) while taking into account the equilibrium specification for the price system and optimal responses by households and firms.[13] The Euler conditions from the Ramsey problem and the household's problem yield a set of nonlinear operator equations that define the Ramsey equilibrium with remittances. The computational solution procedure used in this analysis is based on the projection approach as described in Judd (1992, 1998) as applied to Ramsey problems in Cosimano and Gapen (2005). The procedure solves for the optimal set of policies (H_t, μ_{t+1}, $\tau_t^{h,c}$, λ_{gt}) as functions of the exogenous shocks and state variables that satisfy the Ramsey equilibrium.[14] Here, λ_{gt} is the Lagrange multiplier on the government budget constraint, or the value that households place on the ability of the government to raise revenue from a source "outside" the economy (Bohn, 1988). In this setting the multiplier is equal to the shadow price of debt and reveals the cost of distortionary government revenue policies.

The Ramsey equilibrium is characterized quantitatively by assigning values to the parameters of technology, spending, preferences, and policy variables. Since credible calibrations of the economies in Figure 1 are unavailable, the model is instead calibrated to match the features of the Chilean economy using the results from Bergoeing and Soto (2002).[15] Chile should serve as a reasonable comparator for the countries in Figure 1 since it is a cash-based developing economy with a historical pattern of higher economic volatility and real interest rates relative to developed markets. It is also useful in the baseline calibration exercise for economies without remittances since remittance flows into Chile amounted to only $13 million in 2004 (World Bank, 2006a), or 0.1 percent of GDP. The parameter values from this exercise are summarized in Table 1. The parameter describing the

[13] See Appendix II for the solution to the Ramsey problem.

[14] If the private sector is made more complex, these four conditions would need to be augmented with equilibrium conditions for interest rates and prices. These additional conditions would limit the accuracy of the projection method since additional equations would limit the number of nodes the computer can solve.

[15] For comparison purposes the case of the calibrated U.S. economy is also considered in Appendix II. Results are broadly similar to the calibrated Chile economy presented in the text, with any differences largely driven by the cash-credit intensiveness of each country.

sensitivity of remittances to the business cycle is calibrated based on a remittance determination equation relating workers' remittances to domestic income, world income, and relative investment opportunities.[16] The coefficient on domestic income is the elasticity of workers' remittances with respect to changes in domestic income, implying a value of $r_1 = 0.3$. Studies of optimal bequest behavior (Wilhelm 1996) imply a slightly higher value.[17] Taken together, the sensitivity of remittances to the business cycle is set at $r_1 = 0.5$. Small variations in this calibrated value were evaluated and found to have little effect.

The steady-state level of remittances, r_0, is varied from 5 to 25 percent of income during the solution and simulation procedure. This range was chosen to match data on mean worker remittances in percent of GDP for remittance-dependent economies as presented in Figure 1. In total eight economies were calibrated and, once properly specified, each economy was solved using a nonlinear equation optimizer in Matlab. Then using the optimal coefficients of the polynomial approximations that describe the Ramsey plan, each economy was simulated under the effects of technology and government spending shocks.[18]

4. Remittances and Labor Taxation

We first discuss the steady-state values, policy decision rules, and standard deviation of the model economies before proceeding to the business cycle moments.

[16] The following cross-country fixed effects linear regression was estimated,

$$wr_{it} = \alpha_i + \beta_1 y_{it} + \beta_2 y_{it}^{US} + \beta_3 \left(r_{it} - r_{it}^{US} \right) + \varepsilon_{it},$$

where wr is the ratio of workers' remittances to GDP in the recipient economy, y is real per capita income in the recipient economy, y^{US} is real per capita income of the United States as a proxy for changes in world income, and r is a real deposit or money market interest rate. The dataset includes observations from 1980-2004 for a sample of emerging market countries, classified according to IMF definition. Data sorces include World Development Indicators, the Penn World Tables, and International Financial Statistics database.

[17] Wilhelm (1996) uses data from the Estate-Income Tax Match data set to test several altruistic models of optimal bequest behavior and finds that a \$1 increase in earnings of the dependent results in a reduction in bequests of between \$0.12 and \$0.19, depending on the bequest function tested, implying a slightly higher value for r_1.

[18] Statistics were computed by running simulations of 10,000 periods in length, taking logarithms, and filtering each simulated time series using the H-P filter as described in Hodrick and Prescott (1997).

4.1. Steady-State Values and Standard Deviations

The upper panel in Table 2 represents the steady-state Ramsey equilibrium in levels or quarterly growth rates under labor taxation. In the baseline economies without remittances, optimal government policy follows the Friedman rule by setting money growth equal to the rate of time preference.[19] Enacting the Friedman rule results in an expected gross nominal interest rate equal to 1.0 and the expected real return on money balances equals the inverse of time preference in the steady state. In this process, the government equates the real gross rate of return on money balances and government debt in expectation, satisfying Euler conditions. As discussed in Alvarez, Kehoe, and Neumeyer (2004) and Chari, Christiano, and Kehoe (1991, 1996), the Friedman rule is optimal in a variety of monetary economies with distortionary taxes. That the government should avoid taxation of intermediate goods, in this case money balances, is also a well established result from public finance (e.g., Diamond and Mirrlees, 1971).

The addition of remittances provides the household with two sources of disposable income: income from the domestic production process and remittances from abroad. Remittances create additional disposable income which the household seeks to spread across each of the goods in the household utility function, including leisure. The increase in steady-state leisure has the effect of decreasing domestic output, which reduces income to the household from the domestic production process. However, the household balances these sources of disposable income by choosing a level of leisure such that the decline in domestic output is not enough to offset the inflow of remittances, leading to an increase in disposable income. Consequently, as remittances are added to the model economies, steady-state consumption of the cash and credit goods increases while steady-state labor supply and domestic output decrease.

[19] According to Friedman (1969), optimal monetary policy satiates the economy with real balances to the extent that it is possible to do so. Enacting the Friedman rule requires the government to run a gross-of-interest surplus by setting equilibrium labor income taxes high enough to cover government spending, interest on the debt, and the withdrawal of money balances from the economy.

As a result of the negative incentive effect that remittances have on labor supply and domestic output, the government finds itself with a smaller tax base through which it can raise revenue using a labor income tax. Since it must still finance the same level of government spending, the Ramsey government seeks the least obtrusive policy mix to rase the additional needed revenue to close its budget constraint. Optimal government policy initially responds by increasing money growth relative to the baseline, financing the government's obligations as well as allowing for a slight reduction in the tax rate on labor income.[20] A by-product of the increase in steady-state money growth is a commensurate increase in inflation and a deviation from the Friedman rule. Based on the results of the recent survey by Kocherlakota (2005), non-optimality of the Friedman rule in a representative agent model with flexible prices is unusual. The government finds it optimal to rely more on money growth than labor taxation for two reasons. First, the cash-based nature of the calibrated economy, a common feature of many developing countries with under developed financial systems, provides a larger inflation tax base. Second, additional use of labor income taxation in the presence of remittances exacerbates the negative incentive effect that remittances have on labor supply, thereby shrinking the tax base further through equation (3.12). However, the use of the inflation tax has limits in a Ramsey setting. Increases in remittances beyond the 15% remittances-to-income level results in higher money growth and higher labor taxes, though the labor tax remains below its initial baseline calibrated value.

Increases in steady-state money growth and labor taxation raise the cost of distortionary government policy at the margin, which under normal conditions would increase the value of the multiplier on the government budget constraint. However, a reduction in the steady-state value of the multiplier occurs since the presence of remittances increases the overall tax base even though the distortionary inflation tax must be used to tax these resources indirectly through the cash-

[20] The government also makes more frequent use of debt, which is discussed more fully in the discussion on business cycle moments.

in-advance constraint. Consequently, the economies with remittances report a lower value of the multiplier on the government budget constraint, not a higher value. One important implication of remittances, therefore, is that they decrease cost of servicing government debt. Introducing remittances to the baseline economy implies that the government can service the existing amount of debt with fewer distortions, or the government could raise the level of debt while maintaining the same level of distortionary costs. Under either scenario the government is able to sustain a higher level of debt as the remittance-to-income ratio increases, suggesting that remittances reduce the level of country or credit risk and improve debt sustainability.[21]

4.2. Business Cycle Moments

The bottom panel in Table 2 reports summary statistics on the moments of the business cycle while the responses of government policy, household allocations, and price system to shocks to technology and government spending are contained in Table 3.[22] The difference between the economy without remittances and the economies with remittances is driven by the changing relationship between labor and domestic output in the presence of remittances. As mentioned in the previous section, the introduction of remittances from abroad means household labor supply now reacts to two variable sources of income. When remittances are low or nonexistant, household labor supply responds primarily to fluctuations in the domestic production process. As the remittances-to-income ratio is increased, the household will begin to react more strongly to fluctuations from the remittance

[21] Reductions in credit risk normally produce declines in real interest rates in financial markets. However, the model characteristics and calibration procedure link the rate of time preference with real interest rates derived from the data. As a result, increases in remittances-to-income ratios do not produce lower equilibrium real interest rates, but instead are reflected in a lower shadow price on debt.

[22] As is commonly found in most real business cycle models, the models without remittances generate about half of the standard deviation of output as found in the Chilean economy. Bergoeing and Soto (2002) report standard deviation of real GDP in Chile of 2.20 percent (from 1986-2000). The model economies with remittances generate volatility of consumption, prices, and inflation that more closely match features of the data. Although money supply has very little volatility in the baseline economy without remittances, volatility of the price level and rate of inflation in each period are also determined by volatility of the cash good due to the cash-in-advance specification. The volatility of interest rates is lower since the values reported here are based on gross as opposed to net interest rates.

channel of income. As seen in Table 3, the correlation between labor and output is -1.00 in the baseline economy without remittances and -0.99 at the 5 percent remittances-to-income level.[23] At the 15 percent level of remittances to income, however, the correlation between labor supply and output changes sign with the correlation registering 0.99.

These simulation results indicate that remittances cause labor supply to become more procyclical. In the economy without remittances, a positive technology shock will lead to higher output, but will induce households to lower their labor supply. When remittances are present, however, a positive technology shock that raises output will lead to lower remittances due to the countercyclical nature of these flows. Lower remittances induce the household to raise its labor supply, which will offset the household's tendency to lower its labor supply due to the positive technology shock. The changing correlation signals that the household is deciding optimal labor supply based on both domestic economic conditions and remittances, with household labor supply becoming more sensitive to remittances as the level of remittances to income is increased. Consequently, while remittances are explicitly modeled as countercyclical income transfers, their effect on output is procyclical. Simulations indicate that the sign change on the correlation between labor and output takes place at a remittances-to-income ratio of 8 percent. Thus, a moderate level of remittances to income can meaningfully alter the economic relationships in the economy, a level which is being seen with increasing frequency in many countries.

Not only does the Ramsey government find it optimal to increase the steady-state rate of money growth as remittances are added, but it also finds it optimal to allow money growth rates to fluctuate more substantially than in the baseline economy without remittances. Increased use

[23] See Appendix III for details on the impulse response functions. The negative correlation between labor and output, which stands in conflict with actual data, is a direct result of consumption smoothing and the assumption of a fixed capital stock, eliminating the complementary inputs characteristic of the production function. The household uses labor supply to smooth shocks, decreasing labor supply in the presence of a positive technology shock when capital is fixed, but not enough to fully offset the effect that the increase in technology has on output. Therefore, consumption and leisure increase. As remittances are added, they are used to smooth consumption, restoring the traditional positive correlation between labor and output.

of the money growth rate allows for a reduction in volatility of labor taxes, thereby reducing the negative effects of labor taxation on labor supply. The government also chooses to increase debt usage since its marginal cost has fallen in the presence of remittances. Allowing the debt to fluctuate helps to insure the household against economy wide shocks. This effect is clearly seen through the increased volatilities of the debt stock and the multiplier, which is consistent with optimal policy in a Ramsey setting whereby the cost of letting the shadow price of debt vary more freely imposes fewer distortions than varying the inflation tax or labor income taxes. The increased use of debt under these circumstances is also consistent with Barro's (1979) finding that minimizing distortions requires using debt to minimize variations in taxes across time.

The altered economic relationships in the presence of remittances are also behind the departure from optimality of the Friedman rule. As discussed in Alvarez, Kehoe, and Neumeyer (2004), the Friedman rule of setting net nominal interest rates to zero is optimal under commitment when the government has a sufficient number of independent policy instruments. In the baseline economy without remittances, the period $t-1$ government has a sufficient number of independent instruments to bind and control the choices of the period t government. The Friedman rule in period $t-1$ satiates consumers with real balances and equalizes expected rates of return across bonds and money. The period $t-1$ government is left with real bonds to induce the period t government to follow the same plan.

In contrast, the addition of remittances causes a reduction in labor supply and output, meaning the government has to raise additional resources. Following the Friedman rule in this case would require higher steady-state labor taxes to cover government spending, interest on the debt, and the withdrawal of money balances. Yet the changed correlations between (i) labor supply and output and (ii) labor supply and labor taxes means following the Friedman rule would induce successive declines in labor supply and output, further increasing remittance flows and creating further market

inefficiencies. In other words and in the spirit of Tinbergen (1956), the changing correlations of underlying economic variables in the presence of remittances means the government does not have a sufficient number of independent policy instruments to meet all of its objectives simultaneously. The government finds it optimal to use its remaining policy instrument, the inflation tax, since the debt stock alone is not rich enough to control the incentives of successive governments.

One important conclusion that can be drawn from non-optimality of the Friedman rule in the presence of remittances and labor income taxation, therefore, is that the government needs to have a sufficiently rich set of government policy instruments to carry out its policy plans. Remittances and the need for instrument independence may be one reason why developing countries place a greater reliance on consumption-based taxation or implement financial transactions taxes like those found in Colombia, Ecuador, and Brazil, among others. A consumption tax or value-added tax may be a more appropriate policy instrument since the tax could provide more instrument independence relative to the labor income tax. We examine this conjecture in the next sections, where we replace the labor income tax with a tax on household consumption.

5. Remittances and Consumption Taxation

If the government is able to implement a consumption tax in place of the labor income tax, the calibrated and simulated economies are based on the new set of equations (3.9) - (3.11) to account for the change in tax structure. We first discuss the steady-state values and standard deviations followed by analysis of the business cycle moments of the model economies.

5.1. Steady-State Values and Standard Deviations

The upper panel in Table 3 reports the steady-state Ramsey equilibrium in levels or quarterly growth rates under consumption taxation. As in the case of labor taxation, optimal government

policy with consumption taxes under the baseline case without remittances follows the Friedman rule by setting money growth equal to the rate of time preference.[24] In contrast to the economies with labor taxation, however, optimal government policy does not deviate from the Friedman rule in the presence of remittances if the government uses a consumption tax. At each level of remittances to income, the optimal policy of equating the ex-ante real returns on money and government bonds remains in place.

The presence of remittances under consumption taxation still leads to a reduction in steady-state labor supply as the household spreads the additional resources across consumption and leisure. However, as in the labor tax case, the overall level of household disposable income still increases since the drop in domestic output is not enough to fully offset the increase in remittance income. Therefore, the use of a consumption tax leads to an increase in the tax base as the government now taxes total consumption, derived from domestic production and exogenous remittances, instead of taxing income from declining domestic production under labor taxation. As the level of remittances is increased, the government finds that it can reduce the tax on consumption while having enough resources to cover expenditures, pay debt service costs, and enact the Friedman rule.

Because the tax base has increased, the sustainability of the government debt systematically improves. Since the consumption tax is imposed on both cash and credit goods, while the inflation tax under labor taxation effects only the cash good, remittances increase the tax revenue from both the cash good and the credit good so that the shadow price of government debt falls proportionately more in the steady-state with consumption taxes than labor taxes. In the labor tax case, the value of the multiplier declines from 0.11 under the baseline to 0.05 at the 25 percent remittance-to-income ratio, or a reduction of 55 percent. Under consumption taxation, the reduction in the value of the multiplier is nearly 90 percent. Furthermore, the consumption tax does not distort

[24] The differences between the steady-state values are a result of the small differences in calibrated values due to the change in tax structure.

the choice between cash and credit goods. With a lower shadow price of debt the distortionary impact of government taxation is lower so that the government could sustain a larger level of debt or reduce the amount of country risk for a given debt-to-income ratio.

5.2. Business Cycle Moments

The bottom panel in Table 3 reports summary statistics on the moments of the business cycle for each model economy under consumption taxation. The responses of government policy, household allocations, and price system to shocks to technology and government spending are contained in Tables 4. The simulations report almost no volatility of money growth as the government finds it optimal to enact the Friedman rule in all of the model economies. With the use of a consumption tax negating the need for the government to tax remittances indirectly through the inflation tax, volatility of cash and credit good consumption declines. Total consumption mirrors the behavior of disposable household income, which becomes less volatile due to the presence of countercyclical remittance flows. In the case of labor taxation, volatility of credit good consumption declines while volatility of cash good consumption remains relatively constant, only beginning to decline at high levels of remittances. With the Friedman rule followed consistently and volatility of the tax base declining as more remittances are added to the system, the government finds that it can reduce the volatility of remaining distortionary government policy. Both the volatility of debt and the tax on consumption decline in the presence of remittances.

As was the case under labor taxation, the presence of remittances does allow for an increase in debt usage. However, the availability of a consumption tax which does not distort the choice between cash and credit good consumption allows government policy to become less distortionary. Even though the marginal cost of debt has fallen in the presence of remittances, economic and policy volatility has declined, providing a smaller role for debt to insure the household against

economy wide shocks in comparison to the economies under labor taxation. The government finds that it does not have to trade one distortionary policy lever for another, but rather can optimally reduce the level and volatility of each policy instrument relative to the baseline.

Though the use of a consumption tax lowers the volatility of household consumption and distortionary government policy, it does not allow for a reduction in business cycle volatility. As was the case under labor income taxes, the presence of remittances alters the correlation between labor supply and output, increasing its procylicality. The increased correlation between labor and output in the presence of remittances results in higher output volatility. The volatility of output rises from 1.18 percent under the baseline without remittances to 1.49 percent at the 25 percent remittances-to-income level.

6. Remittances, Macroeconomic Risk, and Welfare Implications

The results of the previous sections indicate that remittances have both positive and negative effects. Remittances lead to increased levels of consumption and leisure, both of which contribute positively to household utility. However, these gains are offset by increased business cycle volatility. The surprising procyclical finding has the unsavory effect of increasing output risk, as seen by the increased volatility of output under model simulation. A by-product of increased output risk is an increase in labor supply risk. Labor supply volatility under both tax structures follow a u-shaped pattern, first declining and then increasing as the correlation between labor and output turns positive and reaches unity. At higher levels of remittances, the increased volatility of labor supply will result in a more volatile process for real wages and lead to increased labor market risk and, although not explicitly modeled in this paper, will increase the importance of efficient wage contracting and risk-sharing between firms and households. This result is likely to be more pronounced when other distortions are introduced into the framework. For example, Chami and

Fischer (2000) and Chami, Fullenkamp, and Jahjah (2005) find that such private income flows increase labor market risk in the context of asymmetric information.[25] Yet we are able to generate similar results under perfect information and flexible prices.

The household is unable to fully insulate itself from the increased business cycle volatility since the insurance effect of remittances on consumption is conditional on the cash-credit nature of the economy and the structure of taxation. The countercyclical nature of remittances does lead to an insurance effect on consumption of the credit good since remittances can be converted into the credit good in the same period the household receives the income transfer. In contrast, the cash-in-advance constraint means the household has to transfer remittance resources across time to consume the cash good, leaving the household exposed to the inflation tax. Under labor income taxation the government uses this channel with regularity, leading to a more volatile inflation and output process and increased volatility of cash good consumption. Ramsey policies suggest that the inflation tax would be used more heavily in credit-good intensive economies, since the government is forced to raise the revenue from a smaller base of cash-good consumption.[26]

Under consumption taxation, however, remittances smooth total consumption and provide the government with a countercyclical tax base. In this setting remittances restore the Friedman rule and reduce policy and inflation volatility over the no-remittance case, resulting in a reduction of both cash and credit good volatility under consumption taxation. The result holds regardless of the cash-credit specification since enacting the Friedman rule produces a cash good and credit good with similar features. Examination of the country cases allows us to conclude that the ability of remittances to provide consumption insurance against shocks to household income depends on two

[25] Chami, Fullenkamp, and Jahjah (2005) show that profit maximization by risk-neutral firms in the context of asymmetric information induces these firms to shift more risk to the households. They conclude that the optimal level of such transfers, which takes the firm's need to break even into consideration, would result in a lower level of transfers being chosen than in the decentralized case.

[26] See the U.S. calibrated case in Appendix II for such an example.

factors: the relative importance of the cash and credit good in household consumption and the type of tax system in place.

A preliminary examination of the data from the remittance-dependent economies in Figure 1, where available, generally confirms the model results that economies with higher reliance on remittance flows experience higher rates of output volatility and inflation. Figure 2 plots the standard deviation of output volatility and the average inflation rate in remittance-dependent economies, or countries with remittances to income of 5 percent or greater, during the period from 1990 to 2003. Both panels indicate that economies with higher levels of remittances tp GDP also experienced higher rates of output volatility and average inflation, with the relationship between remittances and business cycle volatility appearing particularly strong.[27] Any increase in household utility depends on the extent to which the marginal gain from remittances outweighs the marginal cost from additional volatility, and to what degree the household prefers one tax structure over another.

To measure the gain from remittances, we use a certainty equivalence framework where the utility equivalence is measured as the per-period increase in utility that makes the household indifferent between the economy without remittances and the selected economy with remittances. Results are displayed in Table 5. The utility equivalent measures were computed for each variable that enters the household's utility function, thereby highlighting the contribution that each plays in utility gains. For example, the per period gain in utility from moving from the economy without remittances to the economy with 5 percent remittances to income under labor taxation is 5.0 percent. The increase in per period utility rises to 21.2 percent at the 25 percent level of remittances.

[27] The relatively weaker observed correlation between remittances and inflation may be a result of the prevalance of consumption based taxation in developing countries relative to their developed counterparts. Gordon and Li (2006) report that developing countries collected 51 percent of their revenues from consumption and production taxes between 1996 and 2001, with the remainder coming in income taxes (31 percent), seignorage, and border taxes. The developed countries in their sample exhibited nearly the opposite distribution, with 54 percent of revenues coming from income taxation and 33 percent from consumption and production taxation. The extent to which countries plotted in Figure 2 use consumption taxes may account for the weaker relationship.

The welfare measures in Table 6 indicate that consumption taxation is preferable to labor taxation. The table reports the difference in utility gains between the two tax systems, measured as the utility gains under consumption taxation minus utility gains under labor taxation. In examining the contribution to overall utility gains, the relative gains from cash good consumption are sufficient to outweigh the relative decline in leisure and credit good consumption when switching from labor taxation to consumption taxation. While some of the differential between consumption and labor taxation is due to capturing second order effects from reductions in volatility under consumption taxation, marginal analysis can also help explain why the elimination of the inflation tax boosts the utility gains from the cash good more than the decline in utility of the credit good. Use of the inflation tax under labor taxation drives the household towards more credit good consumption, increasing its level of satisfaction, but eroding marginal utility of further credit good consumption. By eliminating the inflation tax, the household returns to a more optimal balance between cash-credit consumption, resulting in higher utility on the margin.[28]

While appearing small, the value of choosing the correct tax system is not negligible. The gains in moving from a system based on labor income taxes to one based on consumption taxes is roughly equivalent in magnitude to the cost of business cycle volatility as reported by Lucas (1987, pp. 20-31) and the gains from eliminating moderate inflation reported by Cooley and Hansen (1991) and Aiyagari et al. (1998).

[28] Some of the the loss in labor supply utility under consumption-based taxation is attributable to the calibration process. By changing the tax system, we slightly alter the first order conditions used in the calibration procedure. As a result, the calibrated value of the marginal disutility of supplying additional leisure in utility, γ, is lower under the consumption tax case than under the labor tax case. This means that utility gains are smaller from choosing more leisure when remittances are present under consumption taxation. However, the utility gains from consumption outweigh this effect, resulting in higher total utility under the consumption tax system. The results in the paper could therefore be viewed as a lower bound on the utility gains from implementing the correct tax system.

7. Conclusion

In a general equilibrium framework we find that remittances, like private capital flows, have both positive and negative economic effects. While remittances increase consumption and smooth household consumption against income shocks, they also increase the correlation between labor and output, contributing to increased macroeconomic risk through higher business cycle volatility, and influence the cost and functioning of policy instruments. In economies with labor taxation, remittances inhibit the ability of policy makers to enact the Friedman rule while, instead, increasing the incentive to use the inflation tax. The increased use of the inflation tax is likely to make the negative externality of remittances—increased business cycle volatility—more pronounced. However, the need to rely on the inflation tax is alleviated when the government has access to a consumption tax. Therefore, an important conclusion of this work is that policy makers need to use the correct set of policy instruments to achieve their objectives simultaneously, and the correct set of instruments may vary in the presence of remittances. Finally, remittances improve the ability of the government to service debt and the reduction in its shadow price leads to the increased usage of debt in a business cycle setting.

We believe that the suggestion by Calvo, Leiderman, and Reinhart (1996) that government should examine a wider variety of policy instruments when dealing with private capital flows, should also apply to remittance transfers. We encourage further research into the macroeconomic effects of remittances, with particular emphasis on whether remittances entail additional economic and policy risk. While it is unlikely that remittances entail the same level of risk as private capital flows since remittances are generally altruistically motivated, we nevertheless hope that these results form the basis for a set of policy instruments and operational guidance for governments and policy makers faced with such flows.

References

Acosta, P.A., E.K.K. Lartey, and F.S. Mandelman. 2007. "Remittances and the Dutch Disease." Federal Reserve Bank of Atlanta Working Paper No. 2007-8.

Adams, Jr., Richard H. 2004. "Remittances and Poverty in Guatemala." World Bank Policy Research Working Paper No. 3418.

Agarwal, Reena, and Andrew W. Horowitz. 2002. "Are International Remittances Altruism or Insurance? Evidence from Guyana Using Multiple-Migrant Households." *World Development*. Vol. 30, pp. 2033-44.

Agunias, D.R. 2006. *Remittances and Development: Trends, Impacts and Policy Options*. Washington: Migration Policy Institute.

Aiyagari, S. Rao. 1995. "Optimal Capital Income Taxation with Incomplete Markets, Borrowing Constraints and Constant Discounting." *Journal of Political Economy*. Vol. 106, pp. 1158-75.

Aiyagari, S. Rao, Albert Marcet, Thomas J. Sargent, and Juha Seppala. 2002. "Optimal Taxation without State-Contingent Debt." *Journal of Political Economy*. Vol. 110, pp. 1220-54.

Aiyagari, S. Rao, R. Anton Braun, and Zvi Eckstein. 1998. "Transaction Serices, Inflation, and Welfare." *Journal of Political Economy*. Vol. 106, pp. 1274-1301.

Alvarez, Fernando, Patrick J. Kehoe, and Pablo Andrés Neumeyer. 2004. "The Time Consistency of Optimal Monetary and Fiscal Policies." *Econometrica*. Vol. 72, pp. 541-67.

Amuedo-Dorantes, Catalina, Cynthia Bansak, and Susan Pozo. 2005. "On the Remitting Patterns of Immigrants: Evidence from Mexican Survey Data." *Economic Review*. Federal Reserve Bank of Atlanta, pp. 37-58.

Atkinson, A. B. 1971. "Capital Taxes, the Redistribution of Wealth and Individual Savings." *Review of Economic Studies*. Vo. 38, pp. 209-27.

Atkinson, A.B., and A. Sandmo. 1980. "Welfare Implications of the Taxation of Savings." *Economic Journal*. Vol. 90, pp. 529-49.

Auerbach, A., and L. Kotlikoff. 1987. *Dynamic Fiscal Policy*. Cambridge: Cambridge University Press.

Barro, Robert J. 1974. "Are Government Bonds Net Wealth?" *Journal of Political Economy*. Vol. 82, pp. 1095-117.

_____. 1979. "On the Determination of the Public Debt." *Journal of Political Economy*. Vol. 87, pp. 940-71.

Barro, Robert J., and David B. Gordon. 1981. "A Positive Theory of Monetary Policy in a Natural Rate Model." *Journal of Political Economy*. Vol. 91, 589-610.

Becker, Gary. 1974. "A Theory of Social Interaction." *Journal of Political Economy*. Vol. 82, pp. 1063-93.

Bergoeing, Raphael and Raimundo Soto. 2002. "Testing Real Business Cycles Models in an Emerging Economy." Central Bank of Chile Working Papers No. 159.

Bernheim, B. Douglas, Andrei Shleifer, and Lawrence H. Summers. 1985. "The Strategic Bequest Motive." *Journal of Political Economy*. Vol. 93, 1045-76.

Bohn, Henning. 1988. "Why Do We Have Nominal Government Debt?" *Journal of Monetary Economics*. Vol. 21, pp. 127-40.

Bouhga-Hagbe, Jacques. 2004. "A Theory of Workers' Remittances with an Application to Morocco." IMF Working Paper 04/194.

Buch, Claudia M., Anja Kuckulenz, and Marie-Helene Le Manchec. 2002. "Worker Remittances and Capital Flows." Kiel Institute for World Economics Working Paper 1130.

Calvo, Guillermo A., Leonardo Leiderman, and Carmen M. Reinhart. 1996. "Inflows of Capital to Developing Countries in the 1990s." *Journal of Economic Perspectives*. Vol. 10, pp. 123-39.

Chami, Ralph, and Jeffrey H. Fischer. 2000. "Do Private Income Transfers Increase Labor Market Risk?" *Economics Letters*. Vol. 69, pp. 143-51.

Chami, Ralph, Connell Fullenkamp, and Samir Jahjah. 2005. "Are Immigrant Remittance Flows a Source of Capital for Development?" *IMF Staff Papers*. Vol. 52, pp. 55-81.

Chamley, Christophe. 1986. "Optimal Taxation of Capital Income in General Equilibrium with Infinite Lives." *Econometrica*. Vol. 54, pp. 607-22.

Chari, V.V., and Patrick J. Kehoe. 1999. "Optimal Fiscal and Monetary Policy." In *Handbook of Macroeconomics,* Vol. 1C, edited by John B. Taylor and Michael Woodford. Amsterdam: North-Holland.

Chari, V.V., Lawrence J. Christiano, and Patrick J. Kehoe. 1991. "Optimal Fiscal and Monetary Policy: Some Recent Results." *Journal of Monetary Economics*. Vol. 37, pp. 203-23.

_____. 1994. "Optimal Fiscal Policy in a Business Cycle Model." *Journal of Political Economy*. Vol. 102, pp. 617-52.

_____. 1996. "Optimality of the Friedman Rule in Economies with Distorting Taxes." *Journal of Monetary Economics*. Vol. 23, pp. 519-39.

Christiano, Lawrence J., and Martin Eichenbaum. 1992. "Current Real Business Cycle Theories and Aggregate Labor-Market Fluctuations." *American Economic Review*. Vol. 82, pp. 430-50.

Cooley, Thomas F., and Gary D. Hansen. 1991. "The Welfare Costs of Moderate Inflation." *Journal of Money, Credit, and Banking*. Vol. 23, pp. 483-503.

_____. 1995. "Money and the Business Cycle." In *Frontiers of Business Cycle Research*, edited by Thomas. F. Cooley. Princeton, New Jersey: Princeton University Press.

Cooley, Thomas F., and Edward C. Prescott. 1995. "Economic Growth and Business Cycles." In *Frontiers of Business Cycle Research*, edited by Thomas F. Cooley. Princeton, New Jersey: Princeton University Press.

Cosimano, Thomas F. and Michael T. Gapen. 2005, "Solving Ramsey Problems with Nonlinear Projection Methods." *Studies in Nonlinear Dynamics and Econometrics*, 9: 1-36.

Diamond, Peter A. 1973. "Taxation and Public Production in a Growth Setting." In *Models of Economic Growth,* edited by James A. Mirrlees and N. H. Stern. New York: Wiley.

Diamond, Peter A., and James A. Mirrlees. 1971. "Optimal Taxation and Public Production I: Production Efficiency." *American Economic Review*. Vol. 61, pp. 8-27.

Durdu, C.B. and S. Sayan. 2008. "Emerging Market Business Cycles with Remittance Fluctuations" Paper presented at the Federal Reserve Bank of Atlanta Conference on "Remittances and the Macroeconomy." February 21–22.

El-Sakka, M. I. T., and Robert McNabb. 1999. "The Macroeconomic Determinants of Emigrant Remittances." *World Development*. Vol. 27, pp. 1493-502.

Elbadawi, Ibrahim A., and Robert de Rezende Rocha. 1992. "Determinants of Expatriate Workers' Remittances in North Africa and Europe." World Bank Policy Research Paper 1038.

Fine, Janice, Lauren Leimbach, and Katy Jacob. 2006. "Distributing Prepaid Cards through Worker Centers: A Gateway for Asset Building for Low-Income Households." The Center for Financial Services Innovation.

Friedman, Milton. 1969. "The Optimum Quantity of Money." In *The Optimum Quantity of Money and Other Essays*, edited by Milton Friedman. Chicago: Aldine.

Gordon, Roger and Wei Li. 2006. "Tax Structures in Developing Countries: Many Puzzles and a Possible Explanation." November.

Gupta, Poonam. 2005. "Macroeconomic Determinants of Remittances: Evidence From India." IMF Working Paper 05/224.

Hagen-Zanker, J. and M. Siegel. 2007. "The Determinants of Remittances: A Review of the Literature." Maastricht Graduate School of Governance Working Paper No. MGSoG/2007/WP003.

Hansen, Gary D. 1985. "Indivisible Labor and the Business Cycle." *Journal of Monetary Economics*. Vol. 16, pp. 309-27.

Hansen, Gary D., and Randall Wright. 1992. "The Labor Market in Real Business Cycle Theory." *Federal Reserve Bank of Minneapolis Quarterly Review*. Vol. 16.

Heston, Alan, Robert Summers, and Bettina Aten, 2006, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September. Available via the Internet: http://pwt.econ.upenn.edu/

Hodrick, Robert J., and Edward C. Prescott. 1997. "Postwar U.S. Business Cycles: An Empirical Investigation." *Journal of Money, Credit and Banking*. Vol. 29, pp. 1-16.

International Monetary Fund. 2005. *World Economic Outlook, April 2005: Globalization and External Imbalances*. Washington: International Monetary Fund.

_____. 2006. "International Financial Statistics." Availabe via the Internet http://imfstatistics.org/imf/

Judd, Kenneth L. 1985. "Redistributive Taxation in a Simple Perfect Foresight Model." *Journal of Public Economics*. Vol. 28, pp. 59-83.

_____. 1992. "Projection Methods for Solving Aggregate Growth Models." *Journal of Economic Theory*. Vol. 58, pp. 410–52.

_____. 1998. *Numerical Methods in Economics.* Cambridge, Massachusetts: MIT Press.

Juster, F. Thomas, and Frank P. Stafford. 1991. "The Allocation of Time: Empirical Findings, Behavioral Models, and Problems of Measurement." *Journal of Economic Literature*. Vol. 29, pp. 471-522.

Kocherlakota, Narayana. 2005. "Optimal Monetary Policy: What We Know and What We Don't Know." *Federal Reserve Bank of Minneapolis Quarterly Review*. Vol. 29, pp. 10-19.

Köksal, Nazli, 2006. "Determinants and Impact on the Turkish Economy of Remittances." Paper presented at the 2006 MEEA/ASSA Meetings. Boston, MA., January 6.

Köksal, Nazli, and Thomas Liebig. 2005. "Principal Channels and Costs of Remittances: The Case of Turkey." In *Migration, Remittances, and Development.* Paris: OECD.

Ljungqvist, Lars, and Thomas J. Sargent. 2000. *Recursive Macroeconomic Theory.* Cambridge, Massachusetts: The MIT Press.

Lucas, Robert E. 1987. *Models of Business Cycles.* Oxford: Basil Blackwell.

Lucas, Robert E., and Odel Stark. 1985. "Motivations to Remit: Evidence from Botswana." *Journal of Political Economy.* Vol. 93, pp. 901-18.

Lucas, Robert E., and Nancy L. Stokey, 1983. "Optimal Fiscal and Monetary Policy in an Economy without Capital." *Journal of Monetary Economics.* Vol. 12, pp. 59-93.

McKenzie, David J. 2005. "Beyond Remittances: The Effects of Migration on Mexican Households." In *International Migration, Remittances and the Brain Drain*, edited by Caglar Ozden and Maurice Schiff. Washington and New York: World Bank and Palgrave Macmillan.

Mishra, Prachi. 2005. "Macroeconomic Impact of Remittances in the Caribbean." Forthcoming IMF Working Paper. Washington: International Monetary Fund.

Perozek, Maria. 1998. "A Reexamination of the Strategic Bequest Motive." *Journal of Political Economy.* Vol. 106, pp. 423-45.

Pestieau, Pierre M. 1974. "Optimal Taxation and Discount Rate for Public Investment in a Growth Setting." *Journal of Public Economics.* Vol. 3, pp. 217-35.

Ramsey, F. P. 1927. "A Contribution to the Theory of Taxation." *Economic Journal.* Vol. 37, pp. 47-61.

Rogerson, R.. 1988. "Indivisible Labor, Lotteries, and Equilibrium." *Journal of Monetary Economics.* Vol. 21, pp. 3-16.

Schmitt-Grohé, Stephanie, and Martín Uribe, 2004, "Optimal Fiscal and Monetary Policy Under Sticky Prices," *Journal of Economic Theory*, Vol. 114, pp. 198-230.

Stock, James H., and Mark W. Watson. 1999. "Business Cycle Fluctuations in U.S. Macroeconomic Time Series." In *Handbook of Macroeconomics*, Vol. 1A, edited by John B. Taylor and Michael Woodford. Amsterdam: Elsevier Science.

Straubhaar, Thomas. 1986. "The Determinants of Workers' Remittances: Issues and Prospects." World Bank Staff Working Paper 481.

Sydsaeter, Knut. 1981. *Topics in Mathematical Analysis for Economists.* New York: Academic Press.

Taylor, J. Edward. 1999. "The New Economics of Labor Migration and the Role of Remittances in the Development Process." *International Migration.* Vol. 37, pp. 63-88.

Tinbergen, J. 1956. *Economic Policy: Principles and Design.* Amsterdam: North Holland.

Wilhelm, Mark O. 1996. "Bequest Behavior and the Effect of Heirs' Earnings: Testing the Altruistic Model of Bequests." *American Economic Review.* Vol. 86, pp. 874-92.

World Bank. 2006a. *Global Economic Prospects: Economic Implications of Remittances and Migration.* Washington: The World Bank.

_____. 2006b. *World Development Indicators.* Washington: The World Bank. Available via the Internet http://devdata.worldbank.org/data-query/

Table 1: Parameter Values for Chile Calibration Exercise.

Parameter Values	α	β	a	γ	δ	ρ_θ	σ_θ	ρ_g	σ_g
Labor Tax	0.63	0.978	0.75	1.72	0.020	0.98	0.010	0.76	0.010
Consumption Tax	0.63	0.978	0.75	1.76	0.018	0.98	0.010	0.76	0.010

Table 2: Steady-State Values and Standard Deviations: Chile Calibrated Economy.

Steady State Values (in levels)

	Labor Taxation				Consumption Taxation			
	Remittances-to-Income Ratio				Remittances-to-Income Ratio			
Variable	0%	5%	15%	25%	0%	5%	15%	25%
	(in levels)				(in levels)			
Output	1.61	1.55	1.44	1.35	1.56	1.51	1.42	1.34
Remittances	–	0.08	0.22	0.34	–	0.08	0.21	0.34
Cash Good	0.85	0.86	0.88	0.90	0.84	0.86	0.90	0.93
Credit Good	0.28	0.29	0.31	0.32	0.28	0.28	0.29	0.31
Labor	0.44	0.41	0.37	0.34	0.42	0.40	0.36	0.33
Multiplier	0.11	0.10	0.08	0.05	0.09	0.08	0.04	0.01
	(in percent)				(in percent)			
Inflation Rate	-2.2%	1.0%	4.5%	4.6%	-2.2%	-2.2%	-2.2%	-2.2%
Real Interest Rate	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Money Growth Rate	-2.2%	0.9%	4.4%	4.5%	-2.3%	-2.3%	-2.2%	-2.2%
Tax Rate	25.0%	22.8%	20.4%	21.9%	18.8%	18.4%	17.7%	17.1%

Output is output from production (excluding remittances). The inflation rate, real interest rate, and money growth rate are expressed in net terms. The tax rate is expressed as a percent of total household consumption.

Standard Deviation (in percent)

	Labor Taxation				Consumption Taxation			
	Remittances-to-Income Ratio				Remittances-to-Income Ratio			
Variable	0%	5%	15%	25%	0%	5%	15%	25%
Output	1.17	1.25	1.39	1.56	1.18	1.24	1.37	1.49
Remittances	–	0.62	0.70	0.78	–	0.62	0.68	0.75
Cash Good	1.67	1.68	1.65	1.59	1.66	1.61	1.52	1.43
Credit Good	1.66	1.54	1.39	1.36	1.66	1.61	1.52	1.43
Labor	0.26	0.13	0.10	0.37	0.23	0.13	0.07	0.26
Multiplier	3.78	3.90	3.86	3.87	3.41	3.26	2.87	8.83
Price Level	1.67	1.70	1.82	1.76	1.41	1.38	1.30	1.23
Inflation	1.21	1.18	1.13	1.10	1.03	1.00	0.94	0.89
Interest Rate	0.05	0.05	0.03	0.03	0.03	0.03	0.02	0.02
Debt	0.20	0.23	0.24	0.29	0.26	0.24	0.21	0.17
Money Growth Rate	0.02	0.15	0.29	0.29	0.00	0.00	0.00	0.00
Tax Rate	1.56	1.33	0.90	1.13	1.90	1.87	1.80	1.73

Output is standard deviation of output from production (excluding remittances). The standard deviation of the interest rate is based on the gross real interest rate while standard deviation of the tax rate is based on the tax on total household consumption.

Table 3: Simulated Economy Under Labor Taxation

Baseline Economy Without Remittances

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-	-0.79	-0.80	-0.91	1.00	0.00
Remittances	-	-	-	-	-	-	-
Cash Good	0.99	-	-0.85	-0.86	-0.94	0.99	-0.11
Credit Good	0.99	-	-0.85	-0.85	-0.94	0.99	-0.11
Labor	-1.00	-	0.79	0.80	0.92	-1.00	0.00
Multiplier	-0.91	-	0.94	0.96	1.00	-0.91	0.36
Gov. Spending	0.00	-	0.60	0.60	0.36	0.00	1.00
Price Level	-0.99	-	0.85	0.85	0.94	-0.99	0.11
Inflation	-0.37	-	0.33	0.33	0.36	-0.37	0.07
Real Int. Rate	-0.60	-	0.95	0.95	0.83	-0.60	0.80
Debt	0.02	-	0.02	-0.02	-0.15	0.02	0.14
Money Growth	-0.79	-	1.00	0.99	0.94	-0.79	0.60
Tax Rate	-0.80	-	0.99	1.00	0.96	-0.80	0.60

5% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.92	-0.74	-0.90	1.00	-0.01
Remittances	-1.00	1.00	0.92	0.74	0.90	-1.00	0.01
Cash Good	0.99	-0.99	-0.96	-0.81	-0.94	0.99	-0.12
Credit Good	1.00	-1.00	-0.95	-0.80	-0.93	1.00	-0.10
Labor	-0.99	0.99	0.89	0.69	0.88	-1.00	-0.07
Multiplier	-0.90	0.90	0.99	0.94	1.00	-0.90	0.39
Gov. Spending	-0.01	0.01	0.38	0.67	0.39	0.00	1.00
Price Level	-0.95	0.95	0.91	0.77	0.89	-0.95	0.11
Inflation	-0.46	0.46	0.46	0.40	0.45	-0.45	0.10
Real Int. Rate	-0.64	0.64	0.88	0.99	0.87	-0.64	0.77
Debt	0.05	-0.05	-0.05	-0.03	-0.18	0.05	0.10
Money Growth	-0.92	0.92	1.00	0.94	0.99	-0.92	0.38
Tax Rate	-0.74	0.74	0.94	1.00	0.94	-0.74	0.67

15% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.88	-0.72	-0.84	1.00	-0.01
Remittances	-1.00	1.00	0.88	0.72	0.84	-1.00	0.01
Cash Good	0.99	-0.99	-0.94	-0.80	-0.90	0.99	-0.14
Credit Good	1.00	-1.00	-0.91	-0.75	-0.87	1.00	-0.07
Labor	0.99	-0.99	-0.95	-0.82	-0.92	0.98	-0.17
Multiplier	-0.84	0.84	0.99	0.97	1.00	-0.84	0.52
Gov. Spending	-0.01	0.01	0.47	0.70	0.52	0.00	1.00
Price Level	-0.83	0.83	0.77	0.65	0.74	-0.83	0.09
Inflation	-0.54	0.54	0.55	0.49	0.53	-0.54	0.16
Real Int. Rate	-0.79	0.79	0.98	0.99	0.98	-0.78	0.62
Debt	0.07	-0.07	-0.07	-0.06	-0.19	0.07	0.06
Money Growth	-0.88	0.88	1.00	0.95	0.99	-0.88	0.47
Tax Rate	-0.72	0.72	0.95	1.00	0.97	-0.71	0.70

25% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.74	-0.97	-0.64	1.00	-0.01
Remittances	-1.00	1.00	0.74	0.97	0.64	-1.00	0.01
Cash Good	0.99	-0.99	-0.82	-0.99	-0.74	0.99	-0.14
Credit Good	1.00	-1.00	-0.75	-0.98	-0.66	1.00	-0.03
Labor	1.00	-1.00	-0.75	-0.98	-0.67	1.00	-0.03
Multiplier	-0.64	0.64	0.99	0.78	1.00	-0.64	0.76
Gov. Spending	-0.01	0.01	0.67	0.21	0.76	0.00	1.00
Price Level	-0.84	0.84	0.66	0.83	0.59	-0.84	0.08
Inflation	-0.52	0.52	0.51	0.54	0.48	-0.52	0.20
Real Int. Rate	-0.95	0.95	0.87	0.99	0.82	-0.95	0.28
Debt	0.11	-0.11	-0.10	-0.19	-0.15	0.10	0.01
Money Growth	-0.74	0.74	1.00	0.84	0.99	-0.73	0.67
Tax Rate	-0.97	0.97	0.84	1.00	0.78	-0.97	0.21

Table 4: Simulated Economy Under Consumption Taxation

Baseline Economy Without Remittances

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-	-0.72	-0.79	-0.92	1.00	0.00
Remittances	-	-	-	-	-	-	-
Cash Good	0.99	-	-0.79	-0.85	-0.95	0.99	-0.11
Credit Good	0.99	-	-0.79	-0.85	-0.95	0.99	-0.11
Labor	-1.00	-	0.72	0.80	0.93	-1.00	0.00
Multiplier	-0.92	-	0.90	0.96	1.00	-0.92	0.35
Gov. Spending	0.00	-	0.67	0.60	0.35	0.00	1.00
Price Level	-1.00	-	0.72	0.79	0.92	-1.00	0.00
Inflation	-0.37	-	0.27	0.29	0.33	-0.36	0.01
Real Int. Rate	-1.00	-	0.72	0.79	0.91	-1.00	0.01
Debt	0.06	-	-0.08	-0.13	-0.23	0.07	0.02
Money Growth	-0.72	-	1.00	0.98	0.90	-0.72	0.67
Tax Rate	-0.79	-	0.98	1.00	0.96	-0.80	0.60

5% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.73	-0.79	-0.90	1.00	0.00
Remittances	-1.00	1.00	0.73	0.79	0.90	-1.00	0.00
Cash Good	0.99	-0.99	-0.80	-0.85	-0.93	0.99	-0.11
Credit Good	0.99	-0.99	-0.80	-0.85	-0.93	0.99	-0.11
Labor	-1.00	1.00	0.73	0.79	0.90	-1.00	0.00
Multiplier	-0.90	0.90	0.93	0.97	1.00	-0.90	0.42
Gov. Spending	0.00	0.00	0.66	0.61	0.42	0.00	1.00
Price Level	-1.00	1.00	0.73	0.79	0.89	-1.00	0.00
Inflation	-0.36	0.36	0.27	0.29	0.33	-0.36	0.01
Real Int. Rate	-1.00	1.00	0.73	0.78	0.89	-1.00	0.01
Debt	0.07	-0.07	-0.08	-0.13	-0.21	0.07	0.02
Money Growth	-0.73	0.73	1.00	0.98	0.93	-0.73	0.66
Tax Rate	-0.79	0.79	0.98	1.00	0.97	-0.79	0.61

15% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.79	-0.77	-0.67	1.00	0.00
Remittances	-1.00	1.00	0.79	0.77	0.67	-1.00	0.00
Cash Good	0.99	-0.99	-0.85	-0.84	-0.75	0.99	-0.12
Credit Good	0.99	-0.99	-0.85	-0.84	-0.75	0.99	-0.12
Labor	1.00	-1.00	-0.79	-0.77	-0.67	1.00	0.00
Multiplier	-0.67	0.67	0.97	0.99	1.00	-0.67	0.74
Gov. Spending	0.00	0.00	0.59	0.63	0.74	0.00	1.00
Price Level	-1.00	1.00	0.79	0.77	0.67	-1.00	0.00
Inflation	-0.36	0.36	0.29	0.28	0.25	-0.36	0.01
Real Int. Rate	-1.00	1.00	0.79	0.77	0.67	-1.00	0.01
Debt	0.08	-0.08	-0.09	-0.13	-0.12	0.07	0.02
Money Growth	-0.79	0.79	1.00	0.99	0.97	-0.79	0.59
Tax Rate	-0.77	0.77	0.99	1.00	0.99	-0.77	0.63

25% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-1.00	-0.75	0.49	1.00	0.00
Remittances	-1.00	1.00	1.00	0.75	-0.49	-1.00	0.00
Cash Good	0.99	-0.99	-0.99	-0.82	0.39	0.99	-0.12
Credit Good	0.99	-0.99	-0.99	-0.82	0.39	0.99	-0.12
Labor	1.00	-1.00	-1.00	-0.75	0.49	1.00	0.00
Multiplier	0.49	-0.49	-0.45	0.18	1.00	0.49	0.83
Gov. Spending	0.00	0.00	0.03	0.66	0.83	0.00	1.00
Price Level	-1.00	1.00	1.00	0.75	-0.49	-1.00	0.00
Inflation	-0.36	0.36	0.36	0.28	-0.17	-0.36	0.01
Real Int. Rate	-1.00	1.00	1.00	0.76	-0.49	-1.00	0.01
Debt	0.08	-0.08	-0.13	-0.12	-0.01	0.08	0.02
Money Growth	-1.00	1.00	1.00	0.77	-0.45	-1.00	0.03
Tax Rate	-0.75	0.75	0.77	1.00	0.18	-0.75	0.66

Table 5: Utility Gains Over No-Remittance Economy.

	Labor Taxation Remittances-to-Income			Consumption Taxation Remittances-to-Income		
	5%	15%	25%	5%	15%	25%
	(Per period increase, in percent)					
Total Utility	5.0	13.8	21.2	5.0	14.0	21.7
Consumption	3.4	10.6	16.7	5.0	14.3	22.8
Cash Good	4.4	18.4	34.9	13.1	37.3	59.4
Credit Good	3.0	7.5	9.7	1.8	5.0	7.9
Labor	5.9	15.6	23.8	5.0	13.8	21.1

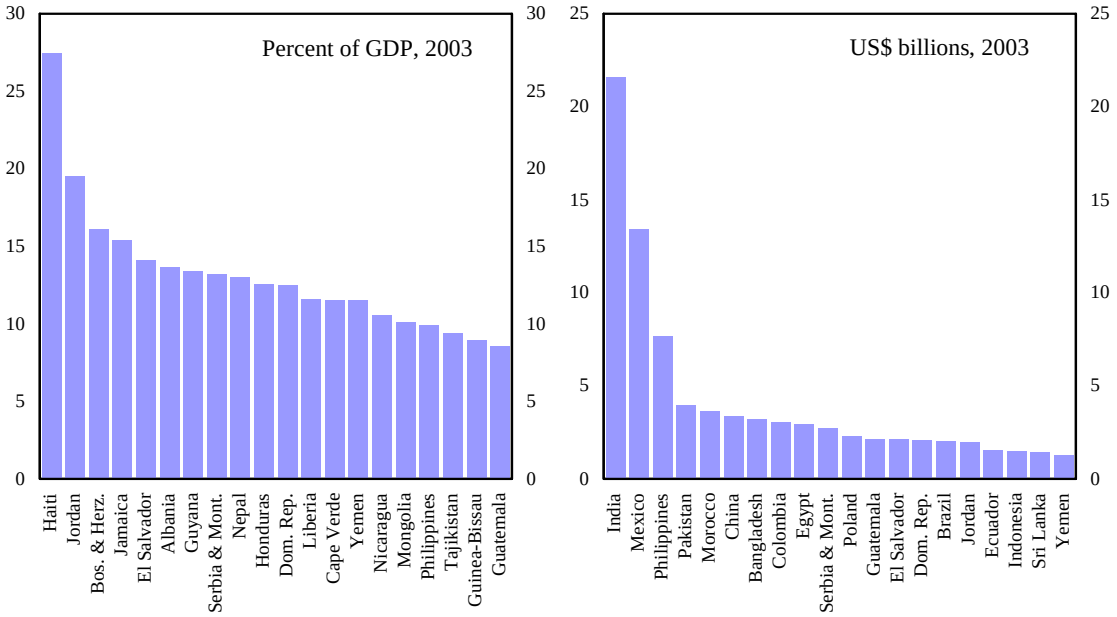
The numbers reflect the per period increase in each component of utility to make the household indifferent between the baseline economy without remittances and the selected economy with remittances.

Table 6: Utility Gains from Consumption Taxation Versus Labor Taxation.

	Remittances-to-Income		
	5%	15%	25%
(Difference in per period increase, in percent)			
Total Utility	0.05	0.22	0.51
Consumption	1.60	3.77	6.12
Cash Good	8.66	18.89	24.52
Credit Good	-1.30	-2.54	-1.73
Labor	-0.83	-1.80	-2.70

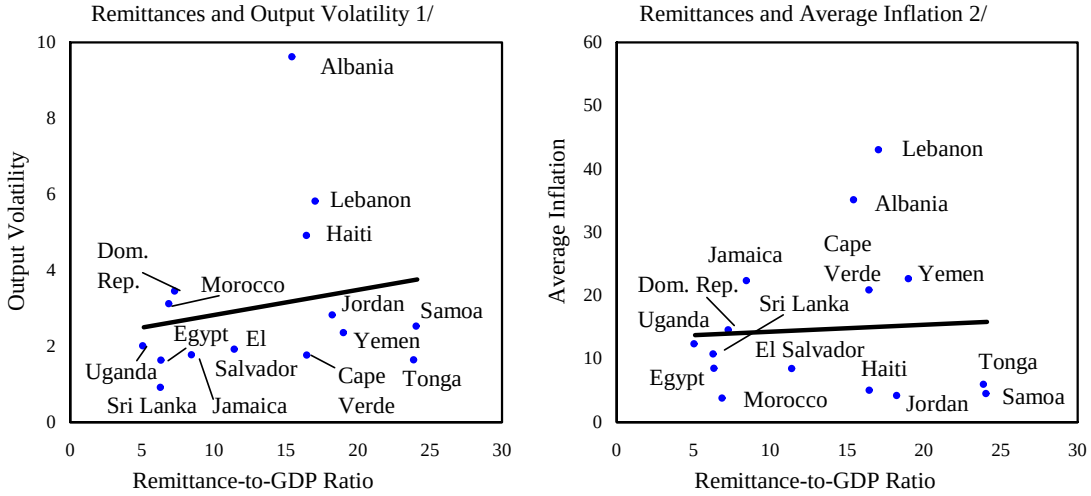
The numbers reflect the difference in utility gains between the economies with remittances under consumption taxation and labor taxation. A gain implies utility under consumption taxation is higher than under labor taxation.

Figure 1: Developing Countries: 20 Largest Recipients of Remittances in 2003



Source: World Development Indicators (World Bank, 2006). Reported data is workers' remittances and does not include migrant transfers or compensation of employees.

Figure 2: Top Remittance-Dependent Countries: Output Volatility and Inflation



1/ World Development Indicators (World Bank, 2006). Countries included registered average workers' remittances to GDP of 5 percent or greater from 1990-2003. Volatility of output calculated as the standard deviation of filtered logged real GDP per capita using the HP filter (Hodrick and Prescott, 1997).
2/ World Development Indicators (World Bank, 2006) and IFS database (IMF, 2006). Countries included registered average workers' remittances to GDP of 5 percent or greater from 1990-2003. Reported inflation figure is average annual CPI inflation from 1990-2003.

A. Referee Appendix I: Household optimization problem

This Appendix details the solution to the household optimization problem under labor and consumption taxation.

A.1. Labor Taxation

Under labor income taxation, the household chooses consumption of the cash and credit goods, the amount of money to be carried into the next period, and debt to maximize (3.3) subject to the budget constraint in (3.5) and the cash-in-advance constraint in (3.6). This can be set up as a dynamic programming problem,

$$V(s_t) = \underset{\Delta_t}{Max} \left\{ \begin{array}{c} a \ln C_{1t} + (1-a) \ln C_{2t} - \gamma H_t + \lambda_{1t} \left(\frac{M_t^d}{P_t} - C_{1t} \right) + \\ \lambda_{2t} \left(\begin{array}{c} \left(1 - \alpha \tau_t^h\right)(Y_t - X) + Rem_t + \frac{M_t^d}{P_t} \\ + B_t R_{t-1} - C_{1t} - C_{2t} - \frac{M_{t+1}^d}{P_t} - B_{t+1} \end{array} \right) + \beta E_t V(s_{t+1}) \end{array} \right\},$$

where $s_t = \left(B_t,\, \frac{M_t^d}{P_t},\, \theta_{t-1},\, g_{t-1},\, \tau_{t-1}^h,\, R_{t-1} \right)$ is the set of state variables and the vector of choice variables is $\Delta_t = \left(C_{1t},\, C_{2t},\, M_{t+1}^d,\, B_{t+1},\, H_t \right)$. Here, λ_{1t} and λ_{2t} are the Lagrange multipliers for the cash-in-advance constraint and household budget constraint, respectively.

The first-order conditions for this problem can be combined to form the following Euler conditions,

$$M_{t+1}^d \quad : \quad \frac{1-a}{C_{2t}} = \beta E_t \left\{ \frac{a}{C_{1t+1}} \frac{P_t}{P_{t+1}} \right\}, \tag{A.1}$$

$$B_{t+1} \quad : \quad \frac{1}{C_{2t}} = \beta E_t \left\{ \frac{1}{C_{2t+1}} R_t \right\}, \tag{A.2}$$

$$H_t \quad : \quad \gamma C_{2t} = (1-a) \left(1 - \alpha \tau_t^h\right) \alpha \frac{Y_t}{H_t}. \tag{A.3}$$

The Euler condition for bonds can be used to derive the condition on the real interest rate as,

$$R_t = \frac{1}{\beta C_{2t}} \left[\frac{1}{E_t \left[\frac{1}{C_{2t+1}} \right]} \right]. \tag{A.4}$$

Maximization of expression (3.3) is subject to $M^d \geq 0$ for all $t \geq 0$, given the initial stock of money, M_0. There is no similar restriction on debt since negative stocks of government bonds would indicate household indebtedness to the government, although transversality conditions will prevent debt from growing without bound in either direction. Transversality conditions can be derived by consolidating two consecutive household budget constraints yielding,

$$C_{1t} + C_{2t} + \frac{1}{R_t} \left(C_{1t+1} + C_{2t+1} \right) + \frac{M_{t+1}^d}{P_t} \left(1 - \frac{1}{R_t} \frac{P_t}{P_{t+1}} \right) \tag{A.5}$$

$$\leq \left(1 - \alpha \tau_t^h\right)(Y_t - X) + Rem_t + \frac{M_t^d}{P_t} + B_t R_t + \frac{1}{R_t} \left[(1 - \alpha \tau_{t+1})(Y_{t+1} - X) + Rem_{t+1} - \frac{M_{t+2}^d}{P_{t+1}} - B_{t+2} \right]. \tag{A.6}$$

To ensure a bounded budget set, the term multiplying M_{t+1}^d/P_t must be greater than or equal to zero. If this was not the case, households could make infinitely large profits by increasing money balances financed by issuing bonds. Since money balances earn no interest, the gross real return on money from t to $t+1$ is just the inverse of the inflation rate, or $R_t^M = P_t/P_{t+1}$. The result is that real return on money must be less than or equal to the return on bonds,

$$1 - \frac{1}{R_t}\frac{P_t}{P_{t+1}} = 1 - \frac{R_t^M}{R_t} \geq 0, \tag{A.7}$$

or the net nominal interest rate cannot be negative.

If the process of recursively using successive household budget constraints to eliminate successive bond terms is continued, the present-value budget constraint of the household can be derived as,

$$\begin{aligned} & \sum_{i=0}^{\infty} q_i \left[\begin{array}{c} C_{1t+i} + C_{2t+i} + \frac{M_{t+i+1}^d}{P_{t+i}} \left(1 - \frac{1}{R_{t+i}}\frac{P_{t+i}}{P_{t+i+1}}\right) - \\ \left(1 - \alpha\tau_{t+i}^h\right)\left(Y_{t+i} - X\right) - Rem_{t+i} \end{array} \right] \\ \leq \quad & \frac{M_t^d}{P_t} + B_t R_{t-1}, \end{aligned} \tag{A.8}$$

where,

$$q_0 = 1 \text{ and } q_i = \prod_{n=1}^{i} \frac{1}{R_{t+n-1}}, \tag{A.9}$$

and where the following transversality conditions have been imposed,

$$\lim_{I\to\infty} \left(q_I B_{t+I+1}\right) = 0, \tag{A.10}$$

$$\lim_{I\to\infty} \left(q_I \frac{M_{t+I+1}^d}{P_{t+I}}\right) = 0. \tag{A.11}$$

Households would not find it optimal to accumulate levels of money balances or bonds that violate these conditions because alternative allocations exist that would afford higher levels of consumption and higher lifetime utility.

The specification of log preferences allows for the derivation of closed-form solutions for consumption, prices, and interest rates since the income and substitution effects cancel. First, substitute the cash-in-advance constraint in (3.6) and (**??**) into the Euler condition for money balances in (A.1) to solve for the ratio of consumption of the cash good to consumption of the credit good. Assuming that $M_{t+1} = M_{t+1}^d$ in equilibrium,

$$\frac{C_{1t}}{C_{2t}} = \beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1}). \tag{A.12}$$

The resource constraint in (3.8) can then be used with the above to calculate the closed-form

solutions for consumption,

$$C_{1t} = \frac{(Y_t + Rem_t - X - G_t)\,\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}, \tag{A.13}$$

$$C_{2t} = \frac{(Y_t + Rem_t - X - G_t)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}. \tag{A.14}$$

Inserting (A.13) into the cash-in-advance constraint in (3.6), which holds with equality in equilibrium as long as the real interest rate is positive, produces the closed-form equation for the price level,

$$P_t = \frac{M_t}{(Y_t + Rem_t - X - G_t)}\left[\frac{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}{\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}\right], \tag{A.15}$$

while the closed-form solution for the real interest rate is found by inserting (A.14) at time t and $t+1$ into (A.4).

Finally, the solution in (A.14) can be substituted into the Euler condition for labor in (A.3) to solve for optimal labor supply. Doing so, and noting the specification for output and remittances in (3.1) and (3.4), respectively, defines an implicit function,

$$F\left(H_t, g_t, \theta_t, \mu_{t+1}, \tau_t^h\right) = 0. \tag{A.16}$$

This equation cannot be solved for H_t explicitly, but the implicit function theorem will allow for the construction of an implicit function which defines the explicit function. The defined derivatives can be obtained as long as an implicit function is known to exist under the implicit function theorem.

Proposition 1. *The function* $F\left(H_t,\, g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^h\right) = 0$ *defines an implicit function* $H_t = h(g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^h)$.

The implicit function theorem states that given $F\left(H_t,\, g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^h\right) = 0$, if (a) the function F has continuous partial derivatives F_H, F_g, F_θ, F_μ, and F_τ and, (b) at a point $\left(H_0,\, g_0,\, \theta_0,\, \mu_0,\, \tau_0^h\right)$ satisfying $F\left(H_t,\, g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^h\right) = 0$, F_H is non-zero except when $H = 0$, then there exists a 4-dimensional neighborhood of $\left(g_0,\, \theta_0,\, \mu_0,\, \tau_0^h\right)$, N, in which h is an implicitly defined function of the variables g, θ, μ, and τ^h in the form of $h(g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^h)$.[29]

[29] See Sydsaeter (1981, 81)

The continuous partial derivatives of (A.16) are[30]

$$F_H \;:\; \frac{\gamma\left[\alpha\frac{Y_t}{H_t} - r_1 Rem_t\frac{\alpha}{H_t}\right]}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - \frac{(1-a)\left(1-\alpha\tau_t^h\right)(\alpha-1)\,\alpha}{H_t}\frac{Y_t}{H_t}, \tag{A.17}$$

$$F_g \;:\; \frac{-\gamma G_t}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}, \tag{A.18}$$

$$F_\theta \;:\; \frac{\gamma\left(Y_t - r_1 Rem_t\right)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - (1-a)\left(1-\alpha\tau_t^h\right)\alpha\frac{Y_t}{H_t}, \tag{A.19}$$

$$F_\mu \;:\; \frac{-\gamma\left(Y_t + Rem_t - X - G_t\right)\beta\left(\frac{a}{1-a}\right)}{\left[1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})\right]^2}, \tag{A.20}$$

$$F_\tau \;:\; (1-\alpha)\,\alpha^2\frac{Y_t}{H_t}. \tag{A.21}$$

Given that $0 < \alpha, \beta < 1$, and γ is defined as a positive constant, F_H is non-zero except when $H = 0$, where F_H becomes undefined. Thus, around any point on the function, except $H = 0$, a neighborhood, N, can be constructed in which $F\left(H_t,\, g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^h\right) = 0$ defines an implicit function $H_t = h(g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^h)$.

Further examination of the labor supply function shows that optimal labor supply will be bounded away from zero and unique over the interval examined. Equation (A.16) acts as the difference function between the left and right-hand sides of equation (A.3). The left-hand side of equation (A.3) is upward sloping in labor supply while the right-hand side is downward sloping in labor supply. The left-hand side contains the term for overall consumption, $(Y_t + Rem_t - X_t - G_t)$ and when calibrated to match the features of the U.S. economy and examined over the interval $[0, 1]$ in labor supply, begins below zero and slowly increases. At low levels of labor supply, total output is less than government spending. As additional labor supply is added, output quickly outpaces government spending. The function is always upward sloping over the interval in question. The term on the right-hand side contains the marginal product of labor and is downward sloping in labor supply. The calibrated function begins at higher levels with low labor supply since marginal productivity of labor is high and slowly decreases as labor is increased. Consequently, the difference function begins negative at low levels of labor supply (low total consumption relative to high marginal product of labor) and turns positive as labor supply is increased (high total consumption relative to low marginal product of labor). Since the difference function is continuous and maintains a positive slope over the interval in question, the optimal labor supply which equates the two sides and satisfies the Euler condition is strictly greater than zero and is unique over the $[0, 1]$ interval.

A.2. Consumption Taxes

Under consumption taxation the process is identical to the one described above, but with the budget constraint in (3.9) and the cash-in-advance constraint in (3.10) used in the dynamic programming

[30] Recall that the partial derivative with respect to money growth is actually $\partial/\partial\exp(-\mu_{t+1})$.

problem. The first-order conditions can be combined to form the following Euler conditions,

$$M_{t+1}^{d} \quad : \quad \frac{1-a}{C_{2t}\left(1+\tau_{t}^{c}\right)} = \beta E_{t}\left\{\frac{a}{C_{1t+1}\left(1+\tau_{t+1}^{c}\right)}\frac{P_{t}}{P_{t+1}}\right\}, \tag{A.22}$$

$$B_{t+1} \quad : \quad \frac{1}{C_{2t}\left(1+\tau_{t}^{c}\right)} = \beta E_{t}\left\{\frac{1}{C_{2t+1}\left(1+\tau_{t+1}^{c}\right)}R_{t}\right\}, \tag{A.23}$$

$$H_{t} \quad : \quad \gamma C_{2t}\left(1+\tau_{t}^{c}\right) = \left(1-a\right)\alpha\frac{Y_{t}}{H_{t}}. \tag{A.24}$$

The Euler condition on bonds can be used to derive the condition on the real interest rate as,

$$R_{t} = \frac{1}{\beta C_{2t}\left(1+\tau_{t}^{c}\right)}\left[\frac{1}{E_{t}\left[\frac{1}{C_{2t+1}\left(1+\tau_{t+1}^{c}\right)}\right]}\right]. \tag{A.25}$$

Despite the presence of the consumption tax in the Euler conditions above, the closed form solutions for consumption are identical to those in equations (A.13) and (A.14), while the closed-form equation for the price level is,

$$P_{t} = \frac{M_{t}}{\left(Y_{t}+Rem_{t}-X-G_{t}\right)\left(1+\tau_{t}^{c}\right)}\left[\frac{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}{\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}\right]. \tag{A.26}$$

Consequently, the choice of consumption taxes affects the price system directly and indirectly through the household choice of labor supply.

Under consumption taxation, the implicit function is modified for the differences between the Euler condition for labor in (A.3) and (A.24),

$$F\left(H_{t}, g_{t}, \theta_{t}, \mu_{t+1}, \tau_{t}^{c}\right) = 0. \tag{A.27}$$

The corresponding continuous partial derivatives for application of the implicit function theorem under consumption taxation are,

$$F_{H} \quad : \quad \frac{\gamma\left[\alpha\frac{Y_{t}}{H_{t}} - r_{1}Rem_{t}\frac{\alpha}{H_{t}}\right]\left(1+\tau_{t}^{c}\right)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - \frac{\left(1-a\right)\left(\alpha-1\right)\alpha}{H_{t}}\frac{Y_{t}}{H_{t}}, \tag{A.28}$$

$$F_{g} \quad : \quad \frac{-\gamma G_{t}\left(1+\tau_{t}^{c}\right)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}, \tag{A.29}$$

$$F_{\theta} \quad : \quad \frac{\gamma\left(Y_{t}-r_{1}Rem_{t}\right)\left(1+\tau_{t}^{c}\right)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - \left(1-a\right)\alpha\frac{Y_{t}}{H_{t}}, \tag{A.30}$$

$$F_{\mu} \quad : \quad \frac{-\gamma\left(Y_{t}+Rem_{t}-X-G_{t}\right)\beta\left(\frac{a}{1-a}\right)\left(1+\tau_{t}^{c}\right)}{\left[1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})\right]^{2}}, \tag{A.31}$$

$$F_{\tau} \quad : \quad \gamma C_{2t}. \tag{A.32}$$

The term F_τ is very different than that found in the labor tax case. In this setting the effect is based on credit good consumption while the partial in the labor tax case is based on the marginal productivity of labor. Following the proposition in the previous section, the function $F\left(H_t,\, g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^c\right) = 0$ defines an implicit function $H_t = h(g_t,\, \theta_t,\, \mu_{t+1},\, \tau_t^c)$.

A.3. Household Policy Functions

Regardless of the choice of tax system, optimal labor supply is a function of government policy and the exogenous shocks to government spending and technology in equilibrium. Furthermore, since an implicit function for labor supply can be constructed in both cases, the optimal allocation of consumption and labor decisions by household, as well as the equilibrium wage rate, are all functions of government policy and the exogenous shocks to government spending and technology. In functional form,

$$C_{1t} = c_1\left(H_t, g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right), \tag{A.33}$$

$$C_{2t} = c_2\left(H_t, g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right), \tag{A.34}$$

$$H_t = h\left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right), \tag{A.35}$$

$$w_t = \varpi\left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right). \tag{A.36}$$

The remaining variables are functions of contemporaneous policy, past policy, or expectations over future outcomes,

$$P_t = p\left(H_t, g_t, \theta_t, \mu_{t+1}, M_t, \tau_t^{h,c}\right), \tag{A.37}$$

$$R_t = r\left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}, E_t\left[H_{t+1}, g_{t+1}, \theta_{t+1}, \mu_{t+2}, \tau_{t+1}^{h,c}\right]\right). \tag{A.38}$$

B. Referee Appendix II: The Ramsey Problem

The goal of the government is to maximize the welfare of the household subject to raising revenues through distortionary means. After the shocks to the system are revealed, the government selects a policy profile and households respond with a set of allocations that together satisfy budget and resource constraints and determine the equilibrium price system. The shocks to technology and government spending also cause changes in remittances and induce responses by both households and the government, thereby contributing to the overall volatility of the model economy. Therefore, the government must take into account the equilibrium reactions by households, remitters, and firms to the chosen policy mix.

Under the assumption that an institution or commitment technology exists through which the government can bind itself to a particular sequence of policies, the government attempts to maximize household utility in (3.3) subject to the government budget constraint in (3.7) or (3.11) while taking into account the equilibrium specification for the price system and optimal responses by households and firms.[31] Under labor taxation the government seeks to maximize,

$$V(s_t) = \underset{\Delta_t}{Max} \left\{ \begin{array}{c} a\log C_{1t} + (1-a)C_{2t} - \gamma H_t + \\ \lambda_{gt}\left(\tau_t^h \alpha\left(Y_t - X\right) - G_t + B_{t+1} + \frac{M_{t+1}}{P_t} - \frac{M_t}{P_t} - B_t R_{t-1}\right) + \beta E_t V\left(s_{t+1}\right) \end{array} \right\} \quad \text{(B.1)}$$

where $\Delta_t = (\tau_t,\ \mu_{t+1},\ B_{t+1})$ is the set of choice variables, s_t represents the set of state variables $\left(B_t,\ M_t^d/P_{t-1},\ \theta_{t-1},\ g_{t-1},\ \tau_{t-1}^h,\ R_{t-1}\right)$, and λ_{gt} is the Lagrange multiplier on the government budget constraint. The first-order conditions for this Ramsey problem are,[32]

$$\tau_t \ : \ \left\{ \begin{array}{c} \frac{a}{C_{1t}}\frac{\partial C_{1t}}{\partial \tau_t} + \frac{1-a}{C_{2t}}\frac{\partial C_{2t}}{\partial \tau_t} - \gamma\frac{\partial H_t}{\partial \tau_t} + \\ \lambda_{gt}\left[\alpha\tau_t\frac{\partial Y_t}{\partial \tau_t} + \alpha\left(Y_t - X\right) - B_t\frac{\partial R_{t-1}}{\partial \tau_t} - \left(\exp(\mu_{t+1}) - 1\right)\frac{M_t}{P_t}\frac{1}{P_t}\frac{\partial P_t}{\partial \tau_t}\right] \end{array} \right\} =$$
$$\beta E_t\left\{\lambda_{gt+1}B_{t+1}\frac{\partial R_t}{\partial \tau_t}\right\}, \quad \text{(B.2)}$$

$$\mu_{t+1} \ : \ \left\{ \begin{array}{c} \frac{a}{C_{1t}}\frac{\partial C_{1t}}{\partial \mu_{t+1}} + \frac{1-a}{C_{2t}}\frac{\partial C_{2t}}{\partial \mu_{t+1}} - \gamma\frac{\partial H_t}{\partial \mu_{t+1}} + \\ \lambda_{gt}\left[\alpha\tau_t\frac{Y_t}{\partial \mu_{t+1}} - \frac{M_{t+1}}{P_t}\exp(\mu_{t+1}) - B_t\frac{\partial R_{t-1}}{\partial \mu_{t+1}} - \left(\exp(\mu_{t+1}) - 1\right)\frac{M_t}{P_t}\frac{1}{P_t}\frac{\partial P_t}{\partial \mu_{t+1}}\right] \end{array} \right\} =$$
$$\beta E_t\left\{\lambda_{gt+1}B_{t+1}\frac{\partial R_t}{\partial \mu_{t+1}}\right\}, \quad \text{(B.3)}$$

$$B_{t+1} : \lambda_{gt} = \beta E_t\left\{\lambda_{gt+1}R_t\right\}, \quad \text{(B.4)}$$

where λ_{gt} represents the marginal utility of relaxing the government budget constraint by one unit or, as suggested by Bohn (1988), the value that households place on the ability of the government to raise revenue from a source "outside" the economy. Such an ability would be equivalent to collection of a lump-sum tax, making the multiplier equal to the shadow price of debt or the cost

[31] The Ramsey problem in the general equilibrium dynamic programming setting incorporates many of the reputational mechanisms for credible government policies as discussed in Ljungqvist and Sargent (2000). In general, the government would find it optimal to deviate from its original set of policies if allowed, and some mechanism, reputational or otherwise, is needed to ensure credibility of government policy.

[32] The first-order condition for money shown here is actually $\partial/\partial\left(\exp(-\mu_{t+1})\right)$. This was done for simplicity of computation. The optimal government policy for money balances can then be found by taking the $-\log(x)$ of the result.

of distortionary government revenue policies. A similar set of equations can be developed for the case of consumption based taxation.

The Euler conditions from the Ramsey problem and the household's problem yield a set of nonlinear operator equations that define the Ramsey equilibrium with remittances. An accurate assessment of the relationship between remittances, government policy, and household decisions requires a solution procedure that preserves these nonlinearities. The computational solution procedure used in this analysis is based on the projection approach as described in Judd (1992, 1998) as applied to Ramsey problems in Cosimano and Gapen (2005). The procedure solves for the optimal set of policies (H_t, μ_{t+1}, $\tau_t^{h,c}$, λ_{gt}) as functions of the exogenous shocks and state variables that satisfy the Ramsey equilibrium. If the private sector is made more complex, these four conditions would need to be augmented with equilibrium conditions for interest rates and prices. These additional conditions would limit the accuracy of the projection method since additional equations would limit the number of nodes the computer can solve.

C. Referee Appendix III: Calibrated U.S. Economy

For comparison purposes the Ramsey equilibrium was also calibrated to match the features of the post-Korean War U.S. economy as reported in the U.S. National Income and Product Accounts (NIPA) following the process in Stock and Watson (1999), Cooley and Prescott (1995), Cooley and Hansen (1991, 1995), Hansen and Wright (1992), Christiano and Eichenbaum (1992), Chari, Christiano, and Kehoe (1991, 1994), Juster and Stafford (1991), and Hansen (1985). The data is used to derive parameter values for the share of income attributable to capital and labor, the capital-output ratio, the fraction of time households spend working in the market, the relative importance of the cash good versus the credit good in the utility function, technology and spending shocks, and the ratio of government spending to output. The boundaries of the space defining the exogenous technology and government spending shocks are then calibrated from this data.[33] Using quarterly NIPA data from 1990:1–2002:4 the ratio of government spending to GDP in the United States was 14 percent and the ratio of federal government debt held by the public to GDP was 39 percent.[34] The fraction of time spent working was set at 0.31 according to Juster and Stafford (1991).

The parameter values for the U.S. are summarized in Table 1. The lower economic volatility experienced by the U.S. economy relative to Chile is captured in the calibrated values for the exogenous processes for government spending and technology while lower real interest rates are reflected in the rate of time preference. The process governing technology in the U.S. is less volatile with lower persistence than in Chile, but only slightly. The process for government spending, however, differs greatly as Chile experiences much larger spending shocks, but with significantly lower persistence than found in the U.S.

The upper panel in Table 2 represents the steady-state Ramsey equilibrium in levels or growth rates under labor and consumption taxation. As in the baseline Chilean calibrated economies without remittances, optimal government policy in the baseline U.S. calibration follows the Friedman rule by setting money growth equal to the rate of time preference under both tax structures. The existence of remittances provides the household with additional disposable income, and the household spreads these resources over each of the consumption goods as well as leisure. However, despite the decline in domestic output, the household under both tax systems is able to increase overall consumption since disposable income has risen.

As a result of the effect that remittances have on labor supply and domestic output, the government finds itself with a smaller tax base through which it can raise revenue using a labor income tax. In the U.S. case optimal government policy responds by increasing both steady-state labor taxes and money growth, whereas in Chile optimal policy makes increased use of money growth and debt financing while simultaneously pursuing a slight reduction in the tax rate on labor income. The optimal steady-state tax rate in Chile displays a u-shape, bottoming out at a 15% remittances-to-income level and then increasing. Therefore, as more remittances are added, optimal government

[33] The interval for each is taken as a multiple of the standard deviation of the error process. The system of equations in the Ramsey equilibrium also contain conditional expectations which must be evaluated. Since the processes that govern the shocks to technology and government spending are assumed to be distributed $N(0, \sigma^2_{\theta,g})$, expectations can be evaluated using Gauss-Hermite Quadrature. In this procedure, the form of the policy function is assumed to be independent of the realization of the shocks. Expectations are found by integrating over the possible realizations of θ and g while treating the policy function as a constant.

[34] A gross capital concept is assumed so that investment includes government investment. Government spending is defined as net real government spending on goods and services, or real total government spending less the sum of real defense investment, real non-defense investment, and real state and local investment. This amount is then taken as a ratio of real gross domestic product.

policy in the two country cases begins to look more similar under a system of labor taxation.

The violation of the Friedman rule under labor taxation, however, is more pronounced in the U.S. model economy than in Chile since the latter is cash-based while the U.S. is credit-based. The prevalence of the cash-based economy in Chile provides a larger inflation tax base, allowing for a lower equilibrium inflation rate given a level of government spending. In the U.S. case, however, the inflation tax base is smaller and a larger inflation rate is needed in order to generate sufficient resources from the inflation tax.

Under consumption taxation, the value of the multiplier in the U.S. case falls much further in the presence of remittances and displays similar behavior as in the case of Chile. With a lower shadow price of debt the distortionary impact of government taxation is lower so that the government could sustain a larger level of debt or reduce the amount of country risk for a given debt-to-income ratio.

The bottom panel in Table 2 reports summary statistics on the moments of the business cycle for the U.S. model economy under labor and consumption taxation. The responses of government policy, household allocations, and price system to shocks to technology and government spending for the U.S. are contained in Tables 3 and 4, respectively. The simulations for both the U.S. and Chile report almost no volatility of money growth under consumption taxation as the government finds it optimal to enact the Friedman rule in all of the model economies. Under labor taxation, volatility of cash good consumption rises in line with volatility of the price level, inflation, and money growth, a result similar to that for Chile reported in the main text.

The optimal mix of government policy for the U.S. case under a regime of consumption taxes is preferable to the mix of policy under labor taxation. When the government only has labor income taxes to choose from, increasing remittance flows result in marginally higher steady-state levels of money growth and taxes, and higher volatilities of money growth and debt balanced by lower volatility of labor income taxes. However, if the government has consumption taxes at its disposal, then remittances result in non-increasing money supply and declining marginal taxation, along with stable money growth rates and declining volatility of debt and consumption taxes. One measure of household preference for consumption taxes is the value of the multiplier on the government budget constraint, which nearly declines to zero at a 25 percent level of remittances to income—0.01 in Chile and 0.03 in the U.S.—indicating that nearly all the distortions from government policy have been removed. A second measure of household preferences involves utility welfare analysis which is contained in Tables 5 and 6. Like the Chile results presented in the main text, utility under a consumption tax system dominates that of the labor tax system.

Finally, though the use of a consumption tax lowers the volatility of household consumption and distortionary government policy, it does not allow for a reduction in business cycle volatility. As was the case under labor income taxes, the presence of remittances alters the correlation between labor supply and output, increasing its procylicality. The increased correlation between labor and output in the presence of remittances results in higher output volatility. In the simulated Chile economies, the volatility of output rises from 1.18 percent under the baseline without remittances to 1.49 percent at the 25 percent remittances-to-income level. For the U.S., the same numbers are 0.76 percent and 0.97 percent, respectively.

Table 1: Parameter Values for U.S. Calibration Exercise.

Parameter Values	α	β	a	γ	δ	ρ_θ	σ_θ	ρ_g	σ_g
Labor Tax	0.60	0.991	0.44	2.44	0.016	0.95	0.007	0.96	0.021
Consumption Tax	0.60	0.991	0.44	2.66	0.021	0.95	0.007	0.96	0.021

Table 2: Steady-State Values and Standard Deviations: U.S. Calibrated Economy.

Steady State Values: U.S. Calibrated Economy

	Labor Taxation				Consumption Taxation			
	Remittances-to-Income Ratio				Remittances-to-Income Ratio			
Variable	0%	5%	15%	25%	0%	5%	15%	25%
	(in levels)				(in levels)			
Output	1.73	1.67	1.55	1.45	1.74	1.68	1.58	1.50
Remittances	-	0.08	0.23	0.36	-	0.08	0.24	0.37
Cash Good	0.49	0.50	0.50	0.51	0.45	0.46	0.49	0.51
Credit Good	0.63	0.64	0.67	0.69	0.58	0.59	0.62	0.65
Labor	0.31	0.29	0.26	0.23	0.31	0.29	0.27	0.24
Multiplier	0.14	0.13	0.12	0.11	0.12	0.10	0.06	0.03
	(in percent)				(in percent)			
Inflation Rate	-0.9%	1.1%	4.2%	5.9%	-0.9%	-0.9%	-0.9%	-0.9%
Real Interest Rate	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Money Growth Rate	-0.9%	1.1%	4.1%	5.7%	-0.9%	-0.9%	-0.9%	-0.9%
Tax Rate	31.4%	31.7%	32.5%	34.1%	23.0%	22.4%	21.3%	20.3%

Output is output from production (excluding remittances). The inflation rate, real interest rate, and money growth rate are expressed in net terms. The tax rate is expressed as a percent of total household consumption.

Standard Deviation (in percent): Simulated U.S. Economy

	Labor Taxation				Consumption Taxation			
	Remittances-to-Income Ratio				Remittances-to-Income Ratio			
Variable	0%	5%	15%	25%	0%	5%	15%	25%
Output	0.81	0.88	1.00	1.14	0.76	0.81	0.89	0.97
Remittances	-	0.44	0.50	0.57	-	0.40	0.45	0.49
Cash Good	1.43	1.49	1.60	1.68	1.44	1.39	1.31	1.23
Credit Good	1.38	1.34	1.25	1.17	1.42	1.38	1.30	1.22
Labor	0.21	0.12	0.15	0.37	0.29	0.22	0.08	0.06
Multiplier	5.02	5.58	6.82	8.51	4.25	4.50	5.68	11.55
Price Level	1.42	1.55	2.00	2.55	1.06	1.03	0.97	0.92
Inflation	1.04	1.06	1.12	1.19	0.78	0.76	0.72	0.67
Interest Rate	0.07	0.06	0.06	0.06	0.05	0.05	0.05	0.05
Debt	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06
Money Growth Rate	0.07	0.18	0.40	0.61	0.02	0.02	0.01	0.00
Tax Rate	2.67	2.65	2.52	2.29	3.41	3.39	3.36	3.33

Output is standard deviation of output from production (excluding remittances). The standard deviation of the interest rate is based on the gross real interest rate while standard deviation of the tax rate is based on the tax on total household consumption.

Table 3: Simulated U.S. Economy Under Labor Taxation

Baseline Economy Without Remittances

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-	-0.37	-0.36	-0.56	1.00	0.00
Remittances	-	-	-	-	-	-	-
Cash Good	0.89	-	-0.74	-0.74	-0.87	0.89	-0.45
Credit Good	0.91	-	-0.72	-0.72	-0.85	0.91	-0.42
Labor	-1.00	-	0.35	0.35	0.54	-1.00	-0.01
Multiplier	-0.56	-	0.96	0.97	1.00	-0.55	0.83
Gov. Spending	0.00	-	0.91	0.93	0.83	0.00	1.00
Price Level	-0.88	-	0.72	0.72	0.85	-0.88	0.43
Inflation	-0.35	-	0.34	0.34	0.38	-0.35	0.23
Real Int. Rate	-0.94	-	0.67	0.66	0.80	-0.93	0.35
Debt	-0.63	-	0.46	0.45	0.53	-0.63	0.25
Money Growth	-0.37	-	1.00	0.98	0.96	-0.36	0.91
Tax Rate	-0.36	-	0.98	1.00	0.97	-0.36	0.93

5% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.53	-0.39	-0.56	1.00	-0.03
Remittances	-1.00	1.00	0.53	0.39	0.56	-1.00	0.03
Cash Good	0.89	-0.89	-0.86	-0.77	-0.87	0.87	-0.48
Credit Good	0.92	-0.92	-0.82	-0.73	-0.84	0.90	-0.42
Labor	-0.92	0.92	0.16	0.00	0.20	-0.93	-0.36
Multiplier	-0.56	0.56	0.99	0.98	1.00	-0.54	0.84
Gov. Spending	-0.03	0.03	0.85	0.93	0.84	0.00	1.00
Price Level	-0.82	0.82	0.77	0.69	0.78	-0.80	0.42
Inflation	-0.40	0.40	0.46	0.43	0.47	-0.39	0.31
Real Int. Rate	-0.94	0.94	0.78	0.67	0.79	-0.93	0.35
Debt	-0.61	0.61	0.52	0.45	0.51	-0.61	0.25
Money Growth	-0.53	0.53	1.00	0.97	0.99	-0.51	0.85
Tax Rate	-0.39	0.39	0.97	1.00	0.98	-0.36	0.93

15% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.57	-0.45	-0.54	1.00	-0.07
Remittances	-1.00	1.00	0.57	0.45	0.54	-1.00	0.07
Cash Good	0.88	-0.88	-0.90	-0.82	-0.87	0.84	-0.54
Credit Good	0.93	-0.93	-0.82	-0.73	-0.80	0.91	-0.42
Labor	0.70	-0.70	-0.99	-0.95	-0.97	0.65	-0.76
Multiplier	-0.54	0.54	0.98	0.99	1.00	-0.48	0.87
Gov. Spending	-0.07	0.07	0.84	0.92	0.87	0.00	1.00
Price Level	-0.63	0.63	0.61	0.56	0.60	-0.61	0.35
Inflation	-0.49	0.49	0.62	0.59	0.61	-0.46	0.45
Real Int. Rate	-0.96	0.96	0.78	0.68	0.75	-0.94	0.34
Debt	-0.57	0.57	0.51	0.44	0.45	-0.56	0.25
Money Growth	-0.57	0.57	1.00	0.98	0.98	-0.51	0.84
Tax Rate	-0.45	0.45	0.98	1.00	0.99	-0.38	0.92

25% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.54	-0.53	-0.50	1.00	-0.10
Remittances	-1.00	1.00	0.54	0.53	0.50	-1.00	0.10
Cash Good	0.86	-0.86	-0.90	-0.88	-0.86	0.81	-0.59
Credit Good	0.95	-0.95	-0.77	-0.76	-0.73	0.92	-0.39
Labor	0.91	-0.91	-0.84	-0.83	-0.80	0.87	-0.49
Multiplier	-0.50	0.50	0.97	0.99	1.00	-0.41	0.90
Gov. Spending	-0.10	0.10	0.87	0.89	0.90	0.00	1.00
Price Level	-0.49	0.49	0.47	0.47	0.45	-0.46	0.29
Inflation	-0.53	0.53	0.72	0.71	0.70	-0.48	0.56
Real Int. Rate	-0.97	0.97	0.72	0.71	0.68	-0.94	0.32
Debt	-0.52	0.52	0.45	0.42	0.36	-0.50	0.23
Money Growth	-0.54	0.54	1.00	0.98	0.97	-0.46	0.87
Tax Rate	-0.53	0.53	0.98	1.00	0.99	-0.45	0.89

Table 4: Simulated U.S. Economy Under Consumption Taxation

Baseline Economy Without Remittances

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-	0.14	-0.37	-0.60	1.00	0.00
Remittances	-	-	-	-	-	-	-
Cash Good	0.90	-	0.12	-0.73	-0.88	0.90	-0.43
Credit Good	0.91	-	0.12	-0.72	-0.88	0.91	-0.42
Labor	-1.00	-	-0.14	0.37	0.60	-1.00	0.00
Multiplier	-0.60	-	-0.08	0.96	1.00	-0.60	0.80
Gov. Spending	0.00	-	0.00	0.93	0.80	0.00	1.00
Price Level	-1.00	-	-0.15	0.38	0.61	-1.00	0.01
Inflation	-0.38	-	0.22	0.17	0.25	-0.38	0.04
Real Int. Rate	-1.00	-	-0.13	0.37	0.60	-1.00	0.00
Debt	-0.47	-	-0.19	0.24	0.32	-0.47	0.08
Money Growth	-0.36	-	-0.04	0.98	0.95	-0.36	0.92
Tax Rate	-0.37	-	-0.05	1.00	0.96	-0.37	0.93

5% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.35	-0.36	-0.54	1.00	0.00
Remittances	-1.00	1.00	0.35	0.36	0.54	-1.00	0.00
Cash Good	0.90	-0.90	-0.72	-0.73	-0.85	0.90	-0.43
Credit Good	0.91	-0.91	-0.71	-0.72	-0.84	0.91	-0.42
Labor	-1.00	1.00	0.35	0.36	0.54	-1.00	0.00
Multiplier	-0.54	0.54	0.96	0.98	1.00	-0.54	0.84
Gov. Spending	0.00	0.00	0.92	0.93	0.84	0.00	1.00
Price Level	-1.00	1.00	0.36	0.37	0.55	-1.00	0.01
Inflation	-0.37	0.37	0.16	0.16	0.23	-0.37	0.03
Real Int. Rate	-1.00	1.00	0.35	0.36	0.54	-1.00	0.00
Debt	-0.47	0.47	0.27	0.24	0.29	-0.47	0.09
Money Growth	-0.35	0.35	1.00	0.98	0.96	-0.35	0.92
Tax Rate	-0.36	0.36	0.98	1.00	0.98	-0.36	0.93

15% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.35	-0.34	-0.36	1.00	0.00
Remittances	-1.00	1.00	0.35	0.34	0.36	-1.00	0.00
Cash Good	0.90	-0.90	-0.71	-0.72	-0.72	0.90	-0.43
Credit Good	0.90	-0.90	-0.71	-0.71	-0.72	0.90	-0.43
Labor	-1.00	1.00	0.35	0.34	0.36	-1.00	0.00
Multiplier	-0.36	0.36	0.98	1.00	1.00	-0.36	0.93
Gov. Spending	0.00	0.00	0.92	0.94	0.93	0.00	1.00
Price Level	-1.00	1.00	0.35	0.35	0.36	-1.00	0.01
Inflation	-0.37	0.37	0.15	0.15	0.15	-0.37	0.02
Real Int. Rate	-1.00	1.00	0.35	0.34	0.36	-1.00	0.00
Debt	-0.47	0.47	0.28	0.23	0.21	-0.47	0.09
Money Growth	-0.35	0.35	1.00	0.98	0.98	-0.35	0.92
Tax Rate	-0.34	0.34	0.98	1.00	1.00	-0.34	0.94

25% Remittances to Income

Variable	Cross-Correlation of Output with:	Correlation with: Remit.	Money Growth	Tax Rate	Mult.	Shocks: Tech.	Shocks: Gov.
Output	1.00	-1.00	-0.38	-0.33	-0.05	1.00	0.00
Remittances	-1.00	1.00	0.38	0.33	0.05	-1.00	0.00
Cash Good	0.90	-0.90	-0.75	-0.71	-0.46	0.90	-0.44
Credit Good	0.90	-0.90	-0.74	-0.71	-0.46	0.90	-0.44
Labor	1.00	-1.00	-0.38	-0.33	-0.05	1.00	0.00
Multiplier	-0.05	0.05	0.89	0.94	1.00	-0.05	0.97
Gov. Spending	0.00	0.00	0.90	0.95	0.97	0.00	1.00
Price Level	-1.00	1.00	0.39	0.33	0.05	-1.00	0.00
Inflation	-0.37	0.37	0.15	0.13	0.03	-0.37	0.01
Real Int. Rate	-1.00	1.00	0.39	0.33	0.04	-1.00	0.00
Debt	-0.47	0.47	0.30	0.23	-0.01	-0.47	0.10
Money Growth	-0.38	0.38	1.00	0.98	0.89	-0.38	0.90
Tax Rate	-0.33	0.33	0.98	1.00	0.94	-0.33	0.95

Table 5: Utility Gains Over No-Remittance Economy: U.S. Calibrated Economy

	Labor Taxation Remittances-to-Income			Consumption Taxation Remittances-to-Income		
	5%	15%	25%	5%	15%	25%
	(Per period increase, in percent)					
Total Utility	4.7	12.9	19.8	4.8	13.2	20.5
Consumption	2.6	7.6	12.1	4.1	11.6	18.4
Cash Good	0.6	2.2	4.6	3.4	9.6	15.3
Credit Good	5.1	14.1	21.2	4.9	13.9	22.0
Labor	6.3	16.9	25.6	5.3	14.5	22.1

The numbers reflect the per period increase in each component of utility to make the household indifferent between the baseline economy without remittances and the selected economy with remittances.

Table 6: Utility Gains from Consumption Taxation Versus Labor Taxation: U.S. Calibrated Economy.

	Remittances-to-Income		
	5%	15%	25%
(Difference in per period increase, in percent)			
Total Utility	0.05	0.29	0.66
Consumption	1.45	3.98	6.32
Cash Good	2.82	7.41	10.73
Credit Good	-0.26	-0.24	0.84
Labor	-0.98	-2.44	-3.55

The numbers reflect the difference in utility gains between the economies with remittances under consumption taxation and labor taxation. A gain implies utility under consumption taxation is higher than under labor taxation.

D. Referee Appendix IV: Impulse Response Functions

This Appendix details the response of government policy, household allocations, and price system to a positive one-period shock to technology and government spending in the baseline Chile economy without remittances and in the Chile economy with a remittance-to-income ratio of 15 percent. Both cases use labor taxation. The impulse response functions for the baseline case are displayed in Figure 1 and Figure 2 shows the case with remittances.[35] The impulse response functions for the U.S. are not markedly different from those presented here for Chile and are omitted for reasons of space.

D.1. The Baseline Chile Economy

The equilibrium response of household labor supply to a productivity shock is determined by the combined effects of technology on the real wage, government policy, and the marginal utility of consumption. First, a positive shock to technology causes labor supply to increase through the direct effect higher technology has on labor supply through a higher real wage. The same increase in technology, however, also increases overall output. Since additional economy-wide resources are now available, government policy makers can reduce distortionary labor taxes and money growth and still finance the same level of government spending. This accounts for the negative correlation between technology shocks and fiscal and monetary policy in the baseline economies as reported in the text. The reduction in the labor tax rate and money supply have positive correlations with labor supply that reinforce the direct effect from a higher after-tax real wage since decreases in taxes and money growth increase labor supply. However, the increase in technology also decreases the marginal utility of consumption of the credit good, which otherwise causes a decrease in labor supply. Overall, these effects combine to produce a decline in labor supply. The result that the model economies without remittances produce a negative correlation between labor and output stands in conflict with actual Chilean and U.S. data.[36] The negative correlation is a direct result of consumption smoothing and the assumption of a fixed capital stock, eliminating the complementary inputs characteristic of the production function.

In the baseline economies without remittances, a positive technology shock that causes a decline in labor supply in the first period from its steady-state value produces a positive correlation between labor supply and government policy and a negative correlation between labor supply and technology shocks. The household is able to spread the additional economy-wide resources across both consumption goods and increased leisure since output rises even though labor supply falls. The government is also able to use the additional resources to pay down debt, although the percent deviation from the steady-state level of debt is small. The reduction in distortionary labor taxes and monetary policy, along with slight declines in outstanding debt, result in a lower value for

[35] Each set of vertical panels in the figure reports the percentage deviation from steady-state values for the relevant variables under a positive one-standard deviation shock to technology (left vertical panels) and government spending (right vertical panels). The percentage deviation of real and nominal interest rates are based on gross rates. Deviation of money growth is based on the net money growth rate. The cross-correlations from the simulations are based on filtered data as opposed to the impulse response functions which are based on raw data. The use of the H-P filter generally reduces the persistence of the various series (i.e., reduces the tendency for the variables to remain away from their steady-state values) and occasionally changes the sign of the initial response if the percentage deviation under raw data is very low. Nevertheless, this section proceeds with the standard use of raw data since the exercise remains illustrative of model relationships.

[36] Both Bergoeing and Soto (2002) and Cooley and Prescott (1995) report positive correlation between output and hours worked.

the multiplier on the government budget constraint. In a situation where additional resources are available, the marginal cost of financing government spending has been reduced.

The effect of the positive shock to technology on prices is dependent on the change in the level of consumption of the cash good since the price level is determined through the cash-in-advance constraint which holds with equality in equilibrium. In this case, a higher level of cash good consumption lowers the period t price level relative to its steady-state value since nominal money balances were chosen during period $t-1$ for use in period t. However, in periods $t+1$ onward the positive technology shock results in higher inflation relative to steady-state values since consumption of the cash good begins to return to its steady-state level, or $C_{1t+i+1} < C_{1t+i}$, and offsets the lower money growth rate. Consequently, the inflation dynamics in response to a positive technology shock first result in lower inflation in the initial period of the shock and then slightly higher inflation relative to steady-state inflation as the shock begins to expire. The real interest rate falls in period t since the expected marginal value of consumption of the credit good in period $t+1$ is less than the level that prevails in period t as a result of the technology shock. The path that consumption of the credit good takes in return to the steady state, combined with Jensen's inequality effects, results in a decline in real interest rates.

A positive shock to government spending is displayed in the right column of Figure 1. In this case, the shock causes labor supply to decrease through the direct effect of higher taxes on labor supply through a lower after-tax real wage. The increase in labor taxes, money growth, and debt occur since policy makers need to finance the additional government spending, resulting in a positive correlation between government spending and labor taxes, money growth, and debt in the baseline economy. The increase in the labor tax rate and money supply have a negative effect on labor supply that reinforces the direct effect from a lower after-tax real wage since increases in taxes and money growth decrease labor supply through the implicit function governing labor supply. However, the increase in government spending also increases the marginal utility of consumption of the credit good, which otherwise induces an increase in labor supply. In the baseline economy without remittances, these effects are largely offsetting, causing negligible declines in labor supply and output.

Since output remains essentially flat, the increased government spending pulls economy-wide resources away from the household, resulting in reduced consumption of both cash and credit goods while leisure remains relatively unchanged. The increase in distortionary labor taxes and money growth, along with increases in outstanding debt, result in a higher value for the multiplier on the government budget constraint. In a situation where additional government spending makes claims on an unchanged amount of economy-wide resources, the marginal cost of financing government spending has increased. This is reflected in a higher value of the multiplier on the government budget constraint which, in the case of the Chile, increases 1.2 percent from its steady-state level in the same period as the positive shock to government spending is revealed.

The positive shock to government spending displays the expected positive relationship on prices. A lower level of consumption of the cash good increases the period t price level since nominal money balances have already been chosen during the previous period. From period $t+1$ onward, $C_{1t+i+1} > C_{1t+i}$ which otherwise reduces inflation. The interest rate increases in period t since the expected value of consumption of the credit good in period $t+1$ is more than the level that prevails in period t as consumption begins to return to steady-state levels.

D.2. The Chile Economy with Remittances

Figure 2 details the impulse response functions from a one-period shock to technology and government spending under 15 percent remittances to income. Relative to the baseline economy without

remittances, the response of labor supply to a one-period positive technology shock is now positive, producing a stronger output response. In particular, output rises by 1.04 percent with remittances in Figure 2 versus 0.87 percent without remittances in Figure 1. Remittances, however, fall due to their countercyclical nature, leaving the response of household consumption at similar levels as the economy without remittances. The effect of remittances on government policy is somewhat mixed, as the positive technology shock results in a more pronounced drop in money growth and a smaller reduction in labor taxes. Finally, in contrast to the baseline economy without remittances, the inflation rate remains below the steady-state level while the positive technology shock persists. This is due to the strong negative response of money growth in the presence of remittances, which in this case is nearly twice as strong as found in the baseline case.

In response to a positive one-period shock to government spending, the labor supply response is more clearly negative, producing a stronger decline in output relative to the baseline economy without remittances. The stronger decline in labor supply and output means the government has a smaller base of resources to finance the same positive government spending shock as in the baseline case, and so it chooses slightly more money growth relative to debt and labor taxes to finance this additional spending. As a result, consumption falls by more in the economy with remittances relative to the baseline economy without remittances. Finally, the response of inflation to the positive government spending shock is somewhat stronger in the presence of remittances, increasing by 0.19 percent under 15 percent remittances to income versus 0.16 percent in the baseline economy without remittances. The inflation rate remains well above the steady-state rate of inflation as the positive government spending shock persists.

Figure 1: Impulse Response Functions: Chile Baseline Economy With Labor Taxation

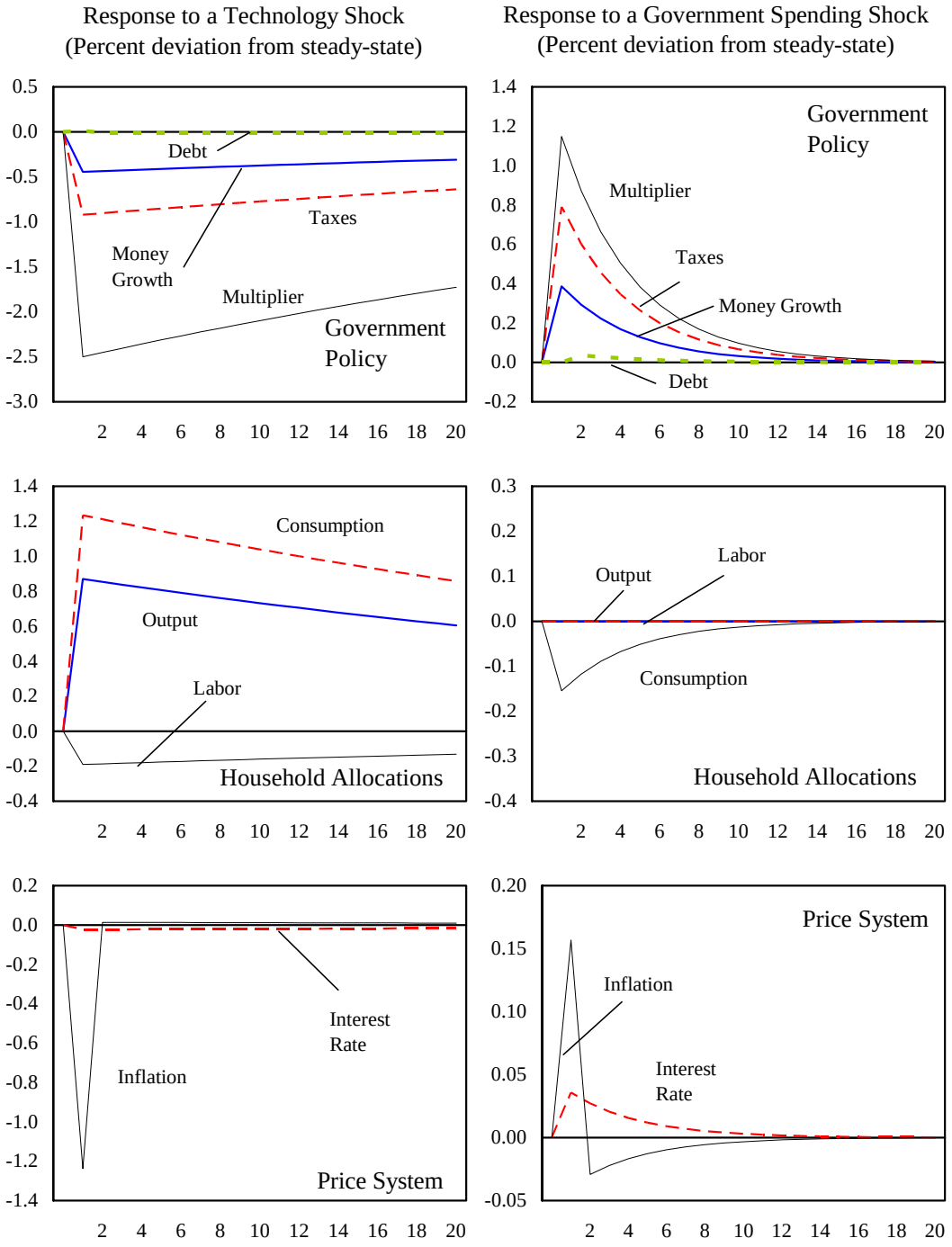


Figure 2: Impulse Response Functions: Chile Economy with 15 Percent Remittances to Income