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

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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.

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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. 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.[1] On the motivation to remit, the literature has examined whether remittances are altruistically motivated or behave more like investment-related capital flows. Chami, Fullenkamp, and Jahjah (2003, 2005) show that the characteristics of remittances as person-to-person private income flows differ from other private capital flows.[2] Using a microfoundations approach and panel techniques, they show that remittances, unlike other capital flows, are countercyclical and may have unintended consequences for economic growth. Subsequent econometric studies such as World Bank (2006a), IMF (2005), and Mishra (2005) have confirmed the countercyclicality result and suggest, therefore, that remittance behavior appears to be altruistically motivated, compensating for poor economic performance in the home country.

To date, 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. 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 a current emphasis among policy makers to highlight remittances as a potential cure to the many economic challenges facing developing countries that depend on such transfers. Without careful analysis of the macroeconomic implications of such transfers, policies aimed at encouraging remittances may create unintended consequences for the recipient economies.

The purpose of this paper is two-fold. First, to shed light on how the behavior of real and nominal variables differ in remittance-dependent economies, where the ratio of remittances to gross domestic product (GDP) is significant, from the same variables in economies that

[1] See Taylor (1999) for an extensive review of the literature on remittances.

[2] Despite having the same title, the Chami, Fullenkamp, and Jahjah (2003, 2005) differ in exposition and treatment of remittances. Chami, Fullenkamp, and Jahjah (2003) includes discussion on the impact of remittances on growth while Chami, Fullenkamp, and Jahjah (2005) focuses on the countercyclical properties of remittances. Both papers use different model frameworks to generate their results. Due to these differences, we choose to cite both studies simultaneously throughout this paper.

receive little or no remittances. Second, to examine to what degree these remittances influence the conduct of optimal monetary and fiscal policy and whether a preferred policy structure exists to allow policy makers to best achieve their objectives in economies which receive such flows. The paper generates these results by combining the traditional general equilibrium framework of macroeconomics with the public finance approach from Ramsey (1927) to calibrate and simulate a stochastic monetary model under various remittance-to-income ratios. We calibrate the model to match the features of one cash-based developing economy, Chile, and one credit-based developed economy, the United States. Since tax structures vary between developed and developing countries with developed countries relying more on income taxes and developing countries preferring consumption-based taxes (Gordon and Li, 2006), we investigate the results under both systems. Finally, to remain consistent with the findings from the recent econometric studies mentioned above, remittances are exogenously specified as countercyclical real income transfers to households. We believe that this is the first such exercise in a fully specified general equilibrium setting.

Despite having a negative impact on household labor supply, remittances lead to increases in consumption. When the household receives remittances in addition to income from production, the household seeks to spread these additional resources across consumption and leisure according to their respective marginal utility. The reduction in steady-state labor supply leads to reduced domestic output, but the drop in income from production is not enough to offset the additional resources from remittances. Consequently, total household resources rise despite the choice by the household to increase leisure, leading to an increase in household consumption and confirming the widespread belief that remittances can play an important role in poverty reduction and improved standards of living. These results hold in both country cases, regardless of the tax system employed.

The influence of remittances on optimal monetary and fiscal policy is dependent on the tax structure in place. In the baseline economies without remittances, optimal government policy follows the Friedman rule, which is consistent with the finding by 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 taxation results in higher steady-state rates of labor taxation, higher debt levels, and money growth as the government seeks to finance the same level of spending while raising revenue from a tax acting 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. Following the recent survey by Kocherlakota (2005), non-optimality of the Friedman rule in a representative agent model with flexible prices is unusual. In contrast, optimal policy maintains the Friedman rule in remittance-dependent economies when the government uses consumption taxation instead of labor income taxation. When remittances are introduced the use of a consumption tax leads to an increase in the tax base, derived from domestic production and exogenous remittances, instead of taxing income from declining domestic production alone. As the level of remittances is increased, the government finds that it can reduce the tax on consumption while still having enough resources to cover exogenous government expenditures, pay debt service costs, and run the Friedman rule.

Following the arguments found in Tinbergen (1956), the behavior of optimal policy under remittances and labor taxation indicate that the government in this case does not have a sufficient number of independent policy instruments to meet all of its objectives simultaneously. Consequently, governments that rely solely on labor income taxation find it optimal to violate the Friedman rule and use its remaining policy instrument, the inflation tax on nominal money balances, since the debt stock alone is not rich enough to adequately control the incentives of successive governments. The inflation tax acts as a tax on remittances since households are forced to accumulate cash prior to purchase units of the cash good, exposing the household to the risk of unexpected inflation. Since consumption taxes act on a different base, instrument independence is restored. One important conclusion that can be drawn from non-optimality of the Friedman rule in the presence of remittances, therefore, is that the government needs to have an appropriate set of policy instruments to carry out its policy plans.

Despite the fact that remittances are exogenously specified as countercyclical, their presence increases the correlation between labor and output, creating a procyclical effect on the business cycle. This result is present in both country cases and tax structures. In remittance-dependent economies, household decisions are based on the interaction between income from the domestic production process and income transfers from the remittance function. If the economy receives a positive productivity shock, for example, domestic output rises through the production function and remittance transfers decline since they are countercyclical. Simulation results indicate that the household responds to the reduction in remittances by increasing labor supply through standard consumption smoothing arguments, serving to further increase the level output and the correlation between labor and output. The finding of increased procyclicality means that remittances have the undesirable effect of raising business cycle volatility. In other words, the benefits to the household from higher consumption and leisure from remittances come at a cost, a cost 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 (2003, 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.

The countercyclical nature of remittances leads to an insurance effect on consumption of the credit good since the household can contemporaneously transfer remittances into credit good consumption during the period in which remittances are received. In contrast, the cash-in-advance constraint means the household has to transfer remittance resources across time and the more volatile inflation and output processes leads to increased volatility of cash good consumption. In the two country cases, Chile and the U.S., volatility of the credit good declines while that of the cash good increases under labor taxation. Volatilities of both the cash and credit good decline under consumption taxation. The conclusion that remittances provide consumption insurance against income shocks, therefore, is conditional on the relative importance of the cash and credit good in household consumption and the type of tax system in place.

In regard to the relationship between remittances and government debt, we find that remittances reduce the burden of servicing existing debt or, equivalently, allow the government to sustain a higher level of debt. Remittances increase total household resources and the potential revenue base for the government, even though the distortionary inflation tax must be used to tax 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.

In addition, the government finds it optimal to use 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 is most pronounced in the U.S. model economies under labor taxation since the inflation tax base is smaller than in Chile due to the higher prevalence of credit good consumption in the U.S. economy. This is consistent with optimal policy in a Ramsey setting whereby adjusting debt to satisfy the government budget constraint imposes fewer distortions in the presence of remittances than varying the inflation tax or labor income taxes. Put differently, remittances alter the set of optimal Ramsey policies in favor of additional debt usage in order to minimizes the total distortionary cost of generating revenue. 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.

Overall, 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. 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.

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. The model is a combination cash-in-advance model and stochastic growth model with a fixed capital stock, similar to models employed in Cooley and Hansen (1995), Chari, Christiano, and Kehoe (1991), and Lucas and Stokey (1983). Sections IV and V describe the main results under labor income taxation and consumption taxation, respectively, while Section VI discusses remittances, macroeconomic risk, and welfare implications. Finally, concluding remarks are contained in Section VII.

2. On 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. The decision by the remitter to use official or unofficial channels, such as the family and friends network, for remittance purposes depends on a number of factors. These include 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). The cost to remit is a significant determinant of the choice to remit through formal or informal channels as costs can vary substantially. Analysis by Köksal (2006) and Köksal and Liebig (2005) suggest that fees generally range from 1 to 2 percent of the amount remitted in larger transactions, and up to as much as 20 percent on smaller transactions. A recent survey of 480 immigrant workers confirmed these results, finding that those who send money home twice a month paid between $22 and $39 dollars to send a median total monthly remittance of $263 (Fine, Leimach, and Jacob, 2006). Despite these costs, remittance flows to developing countries have grown substantially, increasing from $31 billion in 1990 to $167 billion in 2005.[3] Remittances typically flow from developed to developing economies, though estimates of south-south remittances are also considerable.

As shown in Figure 1, developing countries now receive remittances in significant amounts, with the top 20 remittance-dependent countries recording 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. The recipients of the largest remittance flows were India, Mexico, and the Philippines, each of whom received between $7 and $22 billion in remittances during 2003. As reported by IMF (2005) and World Bank (2006a), the largest source of remittances is the United States and the two largest destination regions of remittance flows are Latin America and developing Asia. These studies both indicate that remittance flows are beginning to outpace official transfers, private equity flows, and FDI. Across the Caribbean, for example, Mishra (2005) reports that remittances increased from 3 to 13 percent of GDP from 1990 to 2002, while FDI fell from 11 to 7 percent and ODA fell from 4 to 1 percent. Across all developing countries, IMF (2005) reports that remittances are now the second largest inflow behind FDI, but ahead of ODA and non-FDI private capital inflows.[4]

On the motivation to remit, the literature has examined whether remittances are altruistically motivated, providing resources and insurance for family members left behind, or behave more like capital flows, driven by expected profits and the remitter's desire to invest in the home country. This latter approach, referred to as the portfolio motive, has been advanced in a variety of studies including Straubhaar (1986), Elbadawi and Rocha (1992), El-Sakka and McNabb (1999), and Buch, Kuckulenz, and Le Manchec (2002) to suggest that remittances promote development and enhance growth opportunities. The theory of altruistically motivated remittance flows is consistent with optimal bequest behavior, where utility of the parents includes lifetime resources of their children. Altruism, therefore, has its roots in Becker's (1974) analysis on economics of the family and has been discussed more recently in Lucas and Stark (1985), Chami, Fullenkamp, and Jahjah (2003, 2005), Gupta (2005), and World Bank (2006a).

[3] World Bank (2006a). Remittances are defined in the broadest possible terms to include workers' remittances, compensation of employees, and migrant transfers. Total worldwide remittances, which include remittances to both developed and developing economies, were estimated at $232 billion in 2005. Remittances to developing countries, therefore, constitute over 70 percent of total remittance flows.

[4] 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.

Establishing the primary motivation behind remittance behavior is important since the altruistic and portfolio 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 primarily portfolio motivated, then remittances, like investment, should be procyclical relative to output in the receiving country. However, if remittances are primarily motivated by altruism on the part of the remitter, then remittances as compensatory income transfers would be countercyclical relative to output in the receiving country. In other words, the remitter would remit more when economic conditions were worsening in the home country.

An examination of the existing econometric studies on remittance behavior suggests that remittances are primarily motivated by altruism. Chami, Fullenkamp, and Jahjah (2003, 2005) develop a model for examining the causes of remittances and, using cross-country data from 1970-98, find that remittances tend to be negatively correlated with GDP growth while capital flows such as FDI have a positive correlation. More recently, IMF (2005) uses annual data on a panel of 87 countries from 1980 to 2003, Mishra (2005) investigates data for 13 Caribbean countries from 1980 to 2002, and World Bank (2006a) examines cross-country data from 1995 to 2003. Like Chami, Fullenkamp, and Jahjah (2003, 2005), these studies find that remittances are countercyclical. Though these studies cite other factors as important determinants of remittances in addition to home country income, we focus only on the income of remittance recipients in the home country since it is instructive in the model specification that follows.[5] Inclusion of the remaining factors does not change the thrust of the present exercise.

To verify these findings, we constructed a panel dataset on remittances from various sources over the period 1970-2005. The majority of countries in the sample, however, do not begin reporting data until the l990s. To examine the relationship between remittances and output, we computed standard panel growth regressions and found a robust negative correlation between the growth rate of worker remittances and per capita GDP growth. Over the entire sample period, for example, regressing the growth rate of real per capita GDP on the growth rate of worker remittances, the rate of investment, and the initial value of per capita GDP results in a coefficient on remittances of -0.33.[6]

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. Studies examining the macroeconomic implications of remittances have instead relied on surveys of households in different coun-

[5] Chami, Fullenkamp, and Jahjah. (2003, 2005), World Bank (2006a), IMF (2005), and Bougha-Hagbe (2004), among others, indicate that other important determinants of remittances include the income of the remitter in the host country (proxied by the host country output), the degree of attachment to the family and home country, and other demographic factors, including the number of years in host country.

[6] Data sources: Penn World Tables (Heston, Summers, and Aten, 2006), International Financial Statistics (IMF, 2006), and World Development Indicators (World Bank, 2006b). Additional explanatory variables included initial real GDP per capita, the ratio of investment to GDP, the ratio of trade to GDP, and educational attainment in years of schooling. The equation was estimated using fixed effects, random effects, and maximum likelihood estimation, and also estimated over several sub-periods. Changing the sample to 1985-2005 results in a larger negative relationship (-0.44) and a higher level of significance (1 percent level), indicating a globalization effect may be present from the widespread balance of payments liberalization beginning in the mid 1980s.

tries. Recently, Adams (2004) uses household surveys to look at the role of remittances in alleviating poverty in Guatemala while Amuedo-Dorantes, Bansak, and Pozo (2005) examine remittance patterns from Mexico survey data. Finally, McKenzie (2005) investigates the impact of these flows on Mexican household decisions and allocation of resources.[7] In contrast to the micro-based literature, the existing macroeconomic studies do not utilize an optimizing framework when examining the impact of remittances, which hinders a systematic analysis of these flows. Thus, one of the main contributions of this paper is to provide such a optimizing 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 properties of remittances and their relation to optimal policies and allocations are examined in a stochastic monetary economy. The model is a combination of a cash-in-advance model and a stochastic growth model, similar to those employed in Cooley and Hansen (1995), Chari, Christiano, and Kehoe (1991), and Lucas and Stokey (1983). The economy has a representative household, a representative firm, a government, and remitters. The household derives utility from leisure and two consumption goods, a cash good and a credit good, and previously accumulated cash balances are needed to purchase units of the cash good. Output is produced according to a production function that combines capital, labor, and technology, where the process governing technology is assumed to be exogenous and stochastic. 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 remitters as characterized in the microeconomic literature. These transfers augment the income the household receives from production.

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 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.[8]

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

[8] In addition to ruling out taxation of the pre-existing stock of capital, an assumed zero capital tax is

Aggregate output, Y_t, is produced according to the following 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 the following law of motion,

$$\theta_t = \rho_\theta \theta_{t-1} + \epsilon_{\theta,t}, \quad 0 < \rho_\theta < 1. \tag{3.2}$$

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 in this paper on labor's share of income below unity means labor supply is nonlinear and marginal product of labor is endogenous.[9] As discussed in the proceeding section, the solution procedure used in this analysis preserves the nonlinearity of the labor supply function and associated Jensen's inequality effects, thereby capturing 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,

$$K_{t+1} = (1-\delta) K_t + X_t, \quad 0 < \delta < 1, \tag{3.3}$$

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 $X_t = X = \delta K$. 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.

The representative household obtains utility from consumption and leisure. Preferences are summarized by the following utility function,

$$E_t \sum_{t=0}^{\infty} \beta^t \left[a \log C_{1t} + (1-a) \log C_{2t} - \gamma H_t \right], \tag{3.4}$$

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). The household enters period t with previously accumulated assets equal

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.

[9] 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 equal to $\partial Y / \partial H = \exp(\theta)$. Setting $0 < \alpha < 1$ results in an endogenous marginal product of labor of $\partial Y / \partial H = f(\alpha, \exp(\theta), H, K)$.

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.

Following the results of the empirical studies that show remittances to be countercyclical, the household receives remittances in the form of a compensatory income transfer equal to,

$$Rem_t = r_0 \left(\frac{\overline{Y}}{Y_t} \right)^{r_1}, \tag{3.5}$$

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 business cycle is determined by the parameter r_1 and the steady-state level of remittances is equal to r_0. Since remittances are additional household income outside the production process and the capital stock is assumed to be fixed, the function above models remittances as a pure income transfer.

3.1. Labor Income Taxation

Previously accumulated assets, income from production, and remittance income are all used to finance household expenditures during the period. Entering the period, the current shocks to the economy are revealed. As a result, 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. Overall, household allocations must satisfy the following budget constraint,

$$C_{1t} + C_{2t} + \frac{M_{t+1}^d}{P_t} + B_{t+1} \leq \left(1 - \alpha \tau_t^h\right) (Y_t - X) + Rem_t + \frac{M_t}{P_t} + B_t R_{t-1}, \tag{3.6}$$

where P_t is the price level and τ_t^h is the tax applied to labor income.[10] Remittances are not subject to taxation like labor income. 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,

$$P_t C_{1t} \leq M_t. \tag{3.7}$$

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 satisfy the following budget constraint,

$$\frac{M_t}{P_t} + B_t R_{t-1} = \tau_t^h \alpha (Y_t - X) - G_t + B_{t+1} + \frac{M_{t+1}}{P_t}, \tag{3.8}$$

[10] 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.

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. Thus, the level of government spending and money stock are defined as,

$$G_t = \exp(g_t)G_{t-1}, \tag{3.9}$$

$$M_{t+1} = \exp(\mu_{t+1})M_t. \tag{3.10}$$

The random variable g_t is assumed to evolve according to the following autoregressive process,

$$g_t = \rho_g g_{t-1} + \epsilon_{g,t}, \tag{3.11}$$

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,

$$C_{1t} + C_{2t} + X + G_t = Y_t + Rem_t, \tag{3.12}$$

which states that output from production plus remittances can be consumed by either households or the government, or used to replace depreciated capital.

3.2. Consumption Taxation

If the government is able to implement a consumption tax in place of the labor income tax, equations (3.6) - (3.8) must be altered to account for the change in tax structure. The remaining equations describing production, household utility, and remittances remain unchanged. Under consumption taxation, household allocations must satisfy the following modified budget constraint,

$$(C_{1t} + C_{2t})(1 + \tau_t^c) + \frac{M_{t+1}^d}{P_t} + B_{t+1} + X \leq Y_t + Rem_t + \frac{M_t}{P_t} + B_t R_{t-1}, \tag{3.13}$$

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 with previously accumulated money balances according to,

$$P_t C_{1t}(1 + \tau_t^c) \leq M_t. \tag{3.14}$$

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

$$\frac{M_t}{P_t} + B_t R_{t-1} = \tau_t^c (C_{1t} + C_{2t}) - G_t + B_{t+1} + \frac{M_{t+1}}{P_t}. \tag{3.15}$$

The remaining processes describing the growth of money, government spending, the shocks to technology and spending, and the economy-wide resource constraint in (3.9) - (3.12) 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 given a particular government policy.[11] The functional form for the closed-form solutions for household consumption and the price level are,

$$C_{1t} = c_1 \left(H_t, g_t, \theta_t, \mu_{t+1} \right), \tag{3.16}$$

$$C_{2t} = c_2 \left(H_t, g_t, \theta_t, \mu_{t+1} \right), \tag{3.17}$$

$$P_t = p \left(H_t, g_t, \theta_t, \mu_{t+1}, M_t, \tau_t^c \right). \tag{3.18}$$

The closed-form solution for the interest rate is found by inserting the solution for credit good consumption at time t and $t+1$ into,

$$R_t = \frac{1}{\beta C_{2t}} \left[\frac{1}{E_t \left[\frac{1}{C_{2t+1}} \right]} \right], \tag{3.19}$$

which is derived from the Euler condition on government bonds. The equilibrium solution for the private sector indicates that the specification of consumption taxation in equations (3.13) - (3.15) 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.

The solution for the credit good in (3.17) can also be used to solve for optimal labor supply, defining an implicit function,

$$H_t = h \left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c} \right). \tag{3.20}$$

It is clear from equations (3.20), (3.1), and (3.5) 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

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. The

[11] See the Appendix for solutions to the household problem under labor and consumption based taxation.

Ramsey problem is to choose a competitive equilibrium that maximizes household utility. The competitive equilibrium that solves the Ramsey problem is called the Ramsey plan or Ramsey equilibrium.

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 (3.4) subject to the government budget constraint in (3.8) or (3.15) while taking into account the equilibrium specification for the price system and optimal responses by households and firms.[12] After the shocks to spending and technology are realized, optimal policy is a mapping of state variables to taxes, money supply, and the amount of debt so that the government's budget constraint is satisfied.

Like the household maximization problem, the government's problem can be set up as a dynamic programming problem. For example, under labor taxation the government seeks to maximize,

$$V(s_t) = \underset{\Delta_t}{Max} \left\{ \begin{array}{c} a \log C_{1t} + (1-a) C_{2t} - \gamma H_t + \\ \lambda_{gt} \left(\tau_t^h \alpha (Y_t - X) - G_t + B_{t+1} + \frac{M_{t+1}}{P_t} - \frac{M_t}{P_t} - B_t R_{t-1} \right) + \beta E_t V(s_{t+1}) \end{array} \right\} \tag{3.21}$$

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,[13]

$$\tau_t \ : \ \left\{ \begin{array}{c} \frac{a}{C_{1t}} \frac{\partial C_{1t}}{\partial \tau_t} + \frac{1-a}{C_{2t}} \frac{\partial C_{2t}}{\partial \tau_t} - \gamma \frac{\partial H_t}{\partial \tau_t} + \\ \lambda_{gt} \left[\alpha \tau_t \frac{\partial Y_t}{\partial \tau_t} + \alpha (Y_t - X) - B_t \frac{\partial R_{t-1}}{\partial \tau_t} - \left(\exp(\mu_{t+1}) - 1 \right) \frac{M_t}{P_t} \frac{1}{P_t} \frac{\partial P_t}{\partial \tau_t} \right] \end{array} \right\} = \beta E_t \left\{ \lambda_{gt+1} B_{t+1} \frac{\partial R_t}{\partial \tau_t} \right\}, \tag{3.22}$$

$$\mu_{t+1} \ : \ \left\{ \begin{array}{c} \frac{a}{C_{1t}} \frac{\partial C_{1t}}{\partial \mu_{t+1}} + \frac{1-a}{C_{2t}} \frac{\partial C_{2t}}{\partial \mu_{t+1}} - \gamma \frac{\partial H_t}{\partial \mu_{t+1}} + \\ \lambda_{gt} \left[\alpha \tau_t \frac{Y_t}{\partial \mu_{t+1}} - \frac{M_{t+1}}{P_t} \exp(\mu_{t+1}) - B_t \frac{\partial R_{t-1}}{\partial \mu_{t+1}} - \left(\exp(\mu_{t+1}) - 1 \right) \frac{M_t}{P_t} \frac{1}{P_t} \frac{\partial P_t}{\partial \mu_{t+1}} \right] \end{array} \right\} = \beta E_t \left\{ \lambda_{gt+1} B_{t+1} \frac{\partial R_t}{\partial \mu_{t+1}} \right\}, \tag{3.23}$$

$$B_{t+1} : \lambda_{gt} = \beta E_t \left\{ \lambda_{gt+1} R_t \right\}, \tag{3.24}$$

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

[12] 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.

[13] 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.

would be equivalent to collection of a lump-sum tax, making the multiplier equal to the shadow price of debt or the cost 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, the labor equation from the household's problem, and the government budget constraint yield a set of operator equations that define the Ramsey equilibrium with remittances.

The system of equations that characterize the optimal policies in the Ramsey equilibrium theoretically is nonlinear. 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), which 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.

Using the nonlinear projection approach has several advantages. First, preserving the endogenous properties of the marginal product of labor is important in the determination of the variances and covariances of the model economies during simulation. The degree to which changes in remittances, government policy, or exogenous shocks offset or magnify distortionary effects on equilibrium allocations depends on the degree of countercyclicality of remittances and the amount of nonlinearity present within the system, and within the labor supply function in particular. Second, preserving nonlinearities in the labor supply function yields an endogenous loss function, allowing for a complete analysis of the value of remittances and the cost of distortionary government policy. Third, the multiplier from the Ramsey problem, λ_g, is optimally solved for as an endogenous policy variable, revealing how the shadow price of debt behaves relative to marginal taxation and money growth. Finally, use of a nonlinear solution procedure eliminates the need for an exogenously specified quadratic loss function to capture the excess burden of taxes and allocative distortions of inflation (e.g. Barro, 1979; Barro and Gordon, 1981; Bohn, 1988; and Schmitt-Grohé and Uribe, 2004), avoids the use of linear production with resulting exogenous marginal product of labor (e.g. Aiyagari et al., 2002; Alvarez, Kehoe, and Neumeyer, 2004; and Schmitt-Grohé and Urí be, 2004), and differs from the traditional primal approach (Chari, Christiano, and Kehoe, 1994; and Chari and Kehoe, 1999).[14]

3.5. Calibration

The Ramsey equilibrium is characterized quantitatively by assigning values to the parameters of technology, spending, preferences, and policy variables. We calibrate the model to match the features of two non-remittance dependent economies, Chile and the United States, to serve as the baseline case. Though the United States is the largest source country of remittance flows, with \$39 billion in outward remittances in 2004 (World Bank, 2006a),

[14] The primal approach recasts the problem of choosing optimal policy as a problem of choosing allocations subject to constraints which capture restrictions on those allocations.

this total amounts to only 0.3 percent of GDP. Remittance flows into Chile amounted to $13 million in 2004, or 0.1 percent of GDP. The two cases are useful for this exercise since Chile is a cash-based economy while the U.S. is a credit-based economy. Chile has also had a historical pattern of higher economic volatility and real interest rates relative to the United States experience. Examining both developed and developing country business cycles and alternative cash-credit characteristics should improve understanding of the main results.

The U.S. model is calibrated to match the general features of the post-Korean War economy as reported in the U.S. National Income and Product Accounts (NIPA).[15] 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.[16] 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.[17] The fraction of time spent working was set at 0.31 according to Juster and Stafford (1991).

In the case of Chile, we follow the calibration procedure in Bergoeing and Soto (2002), who use quarterly Chilean data from 1986-2000 to calibrate several real business cycle models. Using data from 1996-2000, the ratio of government spending to GDP in Chile was 12 percent and total government debt to GDP was 13 percent. According to Bergoeing and Soto (2002) the fraction of time spent working was 0.43, markedly higher than that found in developed country analysis. The authors attribute the difference to practices in the formal labor market that discourage part time work. The remaining variables, γ and δ, for each country are derived from first-order conditions and the non-stochastic steady-state government budget constraint.[18] The parameter values for the U.S. and Chile under

[15] This was done 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).

[16] 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.

[17] 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.

[18] The calibrated values for depreciation and the marginal disutility of leisure vary slightly between the labor tax and consumption tax cases in each economy due to the manner in which taxation enters the first order conditions in each setting. The differences across models are not problematic since our goal is to understand how each particular economy behaves once remittances are added to the system.

Furthermore, the non-stochastic steady-state values for taxes used to calibrate depreciation and the disutility of labor are estimated in economies without remittances. Re-calibration of the model under various levels of remittances would result in different non-stochastic steady-state values for taxes and, in turn, the rate of depreciation and disutility of labor. In order to simulate each economy using constant household preferences, the calibrated levels of γ and δ are held constant at their baseline levels in Table 1 when remittances labor and consumption taxes are summarized in Table 1. The higher economic volatility experienced by the Chilean economy is captured in the calibrated values for the exogenous processes for government spending and technology while high real interest rates are reflected in the the rate of time preference. The process governing technology in Chile is more volatile and persistent than in the U.S., 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 parameter describing the sensitivity of remittances to the business cycle is calibrated based on the literature on bequest behavior found in the United States. Like remittances, bequests are private income transfers and altruism is a key motive that explains bequest behavior (see Barro, 1974; and Becker, 1974).[19] Altruism implies that parents bequeath in a compensatory fashion since they receive utility from the lifetime resources of their children. A second implication of altruism is that parents will bequeath unequally, transferring more to children with fewer resources. Consequently, compensatory bequest behavior mirrors the countercyclical remittance function in this paper and the empirical findings from the bequest literature can inform the calibration procedure. In this regard, 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.[20] Based on the results of this study, the sensitivity of remittances to the business cycle is set at $r_1 = 0.5$ for both the U.S. and Chile, meaning that remittances, like bequests, are compensatory on less than a one-to-one basis relative to output. This calibrated value is less than that suggested from the regression-based estimates of of the correlation between the growth rate of worker remittances and per capita GDP growth in the macro literature. The calibrated value for the sensitivity of remittances to the business cycle is therefore conservative, and increasing this parameter would generally magnify the business cycle results found herein.

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 we calibrate sixteen economies, eight each for Chile and the United States under labor and consumption taxation. Once properly specified, each economy is 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.[21] The next section presents the results under labor taxation followed by the results under consumption taxation and

are added.

[19]For arguments in favor of exchange-motivated bequests see Bernheim, Shleifer and Summers (1985). See Perozek (1998) for a critique of the evidence on exchange motivation.

[20]The Estate-Income Tax Match data set is especially useful since it contains reliable information on both parents and heirs. The data set contains complete family information, matched by taxpayer identification numbers, and includes a variety of information in addition to income which is useful in controlling for non-income related factors. See Wilhelm (1996) for additional information.

[21]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).

discussion of any differences.

4. Remittances and Labor Taxation

If the government is able to implement a tax on labor income, the calibrated and simulated economies are based on the set of equations (3.1) - (3.12). We first discuss the steady-state values, policy decision rules, and standard deviation of the model economies before proceeding to the business cycle moments.

4.1. Steady-State Values and Standard Deviations

The upper panel in Table 2 represents the steady-state Ramsey equilibrium in levels or 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.[22] 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 other words, the government equates the real gross rate of return on money balances and government debt in expectation, satisfying Euler conditions. Due to the higher real interest rates found historically in Chile (9.3 percent annually according to Bergoeing and Soto, 2002), the Friedman rule requires that money be withdrawn at a higher rate in Chile than the U.S. in order to equate the rates of return on money and debt. 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). 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.

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. Consequently, as remittances are added to the model economies, steady-state consumption of the cash and credit goods increases while steady-state labor supply decreases. For example, Table 2 reports a decline in steady-state labor supply in Chile from 0.44 to 0.41, a decline of 7 percent, when moving from the baseline economy without remittances to the economy with a 5 percent remittance-to-income ratio. As the remittance-to-income ratio rises to 25 percent in Chile, steady-state labor supply declines by 23 percent and output falls by nearly 16 percent. The pattern is repeated in the U.S., where labor supply falls from 0.31 to 0.29 at the 5 percent remittance-to-income level, and by nearly 26 percent overall when remittances climb to 25 percent of income. However, despite the decline in domestic output in Chile and the U.S., the household in both cases is able to increase overall consumption since disposable income – income from production plus remittances – has risen.

[22] According to Friedman (1969), optimal monetary policy satiates the economy with real balances to the extent that it is possible to do so.

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. Since it must still finance the same level of government spending, the Ramsey government must find the least obtrusive policy mix to rase the additional revenue required to close its budget constraint. In the U.S. optimal government policy responds by increasing both steady-state labor taxes and money growth. The steady-state tax rate on labor income increases from 31.4 percent in the baseline economy without remittances to 34.1 percent under a remittance-to-income ratio of 25 percent. Over the same interval, the steady-state money growth rate increases to nearly 6 percent per quarter. In Chile, optimal government policy also 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.[23] The steady-state growth rate in money rises to 4.5 percent quarterly at a remittance-to-income level of 25 percent while the tax on labor income falls from 25.0 percent to 21.9 percent.[24] One by-product of the increase in steady-state money growth in Chile and the U.S. is a commensurate increase in inflation. In the presence of remittances and labor taxation, optimal monetary policy deviates from the Friedman rule.

The violation of the Friedman rule through use of the inflation tax, 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 steady-state inflation rate in Chile rises to 4.5 percent at the 15 percent remittance-to-income ratio, or nearly the same value as the 4.2 percent in the U.S. Yet, while the quarterly steady-state rate of inflation in the U.S. rises further to 5.9 percent at the 25 percent remittance-to-income ratio, it only increases to 4.6 percent in Chile. 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., however, the inflation tax base is smaller and a larger inflation rate is needed in order to generate sufficient resources from the inflation tax.

Following the recent survey by Kocherlakota (2005), non-optimality of the Friedman rule in a representative agent model with flexible prices is unusual. In this case remittances provide incentives for the household to reduce labor supply, shrinking the labor tax base from which the government draws revenue. If the government were to respond by increasing the labor tax rate further in order to finance its spending, this would induce further declines in labor supply through equation (3.20). Thus, the Ramsey government elects to use additional money growth, causing a violation in the Friedman rule. As will be discussed in more detail in the following sections, the violation of the Friedman rule and resulting inflation tax is a means by which the government can tax remittances indirectly through the cash-in-advance constraint.

Increases in money growth and labor taxation, as seen in the case of the U.S. and in Chile at higher levels of remittances, 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, the reduction in the value of the multiplier in the

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

[24] 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 policy in the two country cases begins to look more similar.

steady-state in Table 2 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-in-advance constraint. Consequently, the economies with remittances report a lower value of the multiplier on the government budget constraint, not a higher value.[25] One important implication of remittances, therefore, is that the cost of servicing existing debt or increases in the stock of government debt have fallen. In the context of the model, this implies that the government can service the existing amount of debt without imposing the same level of distortions as before or, if the macroeconomy was made more realistic, the government could raise the level of debt while imposing no additional distortionary costs than present in the baseline economy without remittances. Under either scenario the government is able to sustain a higher level of debt as the remittance-to-income ratio increases, allowing for the conclusion that remittances reduce the level of country or credit risk and improve debt sustainability.

4.2. Business Cycle Moments

The bottom panel in Table 2 reports summary statistics on the moments of the business cycle for each model economy. 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 Chile and the U.S. economy.[26] However, the model economies without remittances generate volatility of consumption, prices, and inflation that more closely match features of U.S. data as reported in Stock and Watson (1999), Cooley and Prescott (1995), and Bergoeing and Soto (2002). Although money supply has very little volatility in either of the baseline economies 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 the interest rates is lower than that found in other studies since the values reported here are based on the filtered value of the gross interest rate series as opposed to a series of net interest rates.

The responses of government policy, household allocations, and price system to shocks to technology and government spending for Chile and the U.S. are contained in Tables 3 and 4, respectively. The main difference between the economies with remittances and the economy without remittances is the changing relationship between labor and domestic output in the presence of remittances. As remittances are added, the correlation between labor supply and output increases, or labor supply becomes more procyclical. As seen in Table 4, the correlation between labor and output in the U.S. moves from -1 to -0.92 at the 5 percent level of remittances to income. At the 15 percent level of remittances to income, the correlation between labor supply and output changes sign with the correlation

[25] 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.

[26] For the U.S., Stock and Watson (1999) report standard deviation of real GDP of 1.66 (from 1953–1996) and Cooley and Prescott (1995) report standard deviation of real GNP of 1.72 percent (from 1954:1–1991:2). Bergoeing and Soto (2002) report standard deviation of real GDP in Chile of 2.20 percent (from 1986-2000). The reduced model volatility is due to the assumption of a fixed capital stock since standard deviation of investment is much higher than output and consumption.

registering 0.70. Finally, at a remittances-to-income ratio of 25 percent, the correlation between labor is 0.91, a near complete reversal from the economy without remittances. A similar pattern can be seen in the data for Chile.

The simulation results indicate that, for the economy without remittances, a positive technology shock will lead to higher output, but will induce households to lower their labor supply.[27] 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 merely 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 around 8 percent in the U.S. and 3 percent in Chile. Thus, a relatively low 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.

Since the correlation between labor and output has increased in the presence of remittances, the correlation between labor and government policy has decreased. As can be seen from the simulation results in Table 4 for the U.S., the correlation between labor supply and labor taxes and money growth has changed from 0.35 and 0.35, respectively, under no remittances to -0.99 and -0.95, respectively, under a 15 percent remittances-to-income ratio. The result is similar for Chile in Table 3, where the correlation between labor supply and labor taxes and money growth changes from 0.79 and 0.80, respectively, under the baseline to -0.99 and -0.95 at the 15 percent level of remittances. In both cases, fiscal and monetary policy have a stronger negative correlation with output in the economies with remittances relative to the baseline economy without remittances. Therefore, while their impact on output is procyclical, remittances serve to increase the countercyclicality of government policy.

With government policy becoming more countercyclical, the government finds it optimal to use debt since its marginal cost has fallen in the presence of remittances. Allowing the debt to fluctuate, as opposed to labor taxes or money growth, helps to insure the household against economy wide shocks. This effect is clearly seen in both Chile and the U.S., where the addition of remittances under labor taxation produces increased volatility in both money growth rates and the multiplier. The increased use of debt is more pronounced in the U.S.,

[27] See the Appendix for details on the impulse response functions. 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, which report a positive correlation. However, 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 other words, the household uses labor supply to smooth shocks under the baseline case. The household will decrease 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, remittances are used to smooth consumption, restoring the traditional positive correlation between labor and output.

with volatility on the multiplier increasing from 5 percent in the baseline to 8.5 percent at the 25 percent level of remittances, since the inflation tax base is smaller than in Chile due to the higher prevalence of credit good consumption. This 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 shifting correlations between (i) labor supply and output and (ii) labor supply and labor taxes 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. By enacting the Friedman rule, the 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, and 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. Consequently, the government finds it optimal to use its remaining policy instrument, the inflation tax, since the debt stock alone is not rich enough to adequately 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 counter the procyclical relationship between labor and output in the presence of remittances, providing 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 (3.13) - (3.15) to account for the change in tax structure. As in the previous case, 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 5 represents the steady-state Ramsey equilibrium in levels or 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.[28] 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 now finds that it can reduce the tax on consumption while still having enough resources to cover exogenous government expenditures, pay debt service costs, and run the Friedman rule. In the case of Chile, the tax on consumption expressed as a percent of total consumption of the cash and credit goods falls from 18.8 percent under the baseline economy without remittances to 17.1 percent at the 25 percent level of remittances to income. For the U.S., the consumption tax declines from 23.0 percent to 20.3 percent, respectively.

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 case of Chile under labor taxation, the value of the multiplier in Table 5 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 the choice between cash and credit goods. With a lower shadow price of debt the distortionary

[28] The differences between the steady-state values in Tables 2 and 5 are a result of the small differences in calibrated values due to the change in tax structure.

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.[29]

5.2. Business Cycle Moments

The bottom panel in Table 5 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 for Chile and the U.S. are contained in Tables 6 and 7, respectively. The simulations for both the U.S. and Chile 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 Chile, for example, the standard deviation of cash and credit good consumption declines from 1.66 percent under the baseline economy without remittances to 1.43 percent at the 25 percent remittances-to-income level. In the U.S., the numbers are 1.43 and 1.23, respectively. This result stands in contrast to the U.S. economies under labor taxation where volatility of cash good consumption rises in line with volatility of the price level, inflation, and money growth. In the case of Chile under 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, especially in the case of Chile where the use of debt is relatively more pronounced than it is in the U.S. model economy.[30] The standard deviation of debt in Chile reported in Table 5 falls from 0.26 percent in the baseline economy without remittances to 0.17 percent at a remittance-to-income ratio of 25 percent while volatility of consumption taxes fall from 1.90 percent to 1.73 percent, respectively. In the U.S., volatility of debt remains constant as remittances flows increase, likely due to the smaller calibrated government spending shocks and higher initial steady-state debt, while volatility of consumption taxes falls from 3.41 percent to 3.33 percent.

Despite the decline in volatility of consumption taxes, their volatility in absolute terms is higher than volatility of labor income taxes, even at the highest level of remittances. For example, volatility of labor taxes in Chile vary from 1.56 percent to 1.13 percent while the

[29] We are, of course, ignoring the fact that governments may use the additional resources to increase its spending. However, we are not attempting to evaluate the optimal level of government spending, but rather the optimal mix of distortionary policy to finance a given level of exogenously defined expenditures.

[30] The role of debt is also more pronounced in Chile from a business cycle perspective since Chile is calibrated with a lower stock of debt and larger exogenous shocks to government spending. Consequently, the use of debt in defecit financing in Chile results in larger variation of debt in relation to its base. In contrast, the U.S. is calibrated to a much higher level of debt and smaller shocks to government spending, reducing the role of debt when viewed relative to the higher base.

volatility of consumption taxes ranges from 1.90 percent to 1.73 percent. The difference is likely due to level effects since the steady-state labor tax is higher than the steady state consumption tax, and variation in terms of shocks to technology and productivity are of equal size.

As was the case under labor taxation, the presence of remittances does allow for an increase in debt usage. In both country cases the volatility of the multiplier increases, from 3.4 percent in Chile under the baseline to 8.8 percent at the 25 percent level of remittances, and from 4.3 to 11.6 percent in the U.S. over the same interval. 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.

If the two case studies here are indeed representative of business cycles in remittance dependent economies, then the optimal mix of government policy under a regime of consumption taxes appears to be 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, something we consider in a later section.

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.

6. Remittances, Macroeconomic Risk, and Welfare Implications

The results of the previous sections indicate that remittances have both positive and negative effects. The presence of remittances leads to increased levels of consumption and leisure, both of which contribute positively to household utility. However, these gains are offset by increased volatility. The surprising procyclical finding has the unsavory effect of increasing output risk, as seen by the increased volatility of output under model simulation.

Under higher levels of remittances, household labor supply is responding to the combined effects of economic shocks on output and remittance flows, with the household reacting more forcefully to remittance-channel effects as the remittances-to-income ratio increases. The result is that remittances, while countercyclical, produce higher business cycle volatility.

A by-product of increased output risk in an increase in labor supply risk. Labor supply volatility in Tables 2 and 5 follow a u-shaped pattern, first declining and then increasing as the initial 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 (2003, 2005) find that such private income flows increase labor market risk in the context of asymmetric information.[31]

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. As such, both country cases with labor taxation exhibit declines in volatility of credit good consumption. 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. Furthermore, Ramsey policies indicate that the inflation tax is used more heavily in the context of the U.S., where the credit good is relatively more important than the cash good, since the government is forced to raise the revenue from a smaller base of cash-good consumption.

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 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. Fig-

[31] Chami, Fullenkamp, and Jahjah (2003, 2005) introduce asymmetric information between the household and the firms and between the household and the remitter. They show that profit maximization by risk-neutral firms, in this case, 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.

ure 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 that recorded higher levels of remittances also experienced higher rates of output volatility and average inflation, with the relationship between remittances and business cycle volatility appearing particularly strong.[32] 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. Utility equivalence measures are constructed for both the U.S. and Chile under labor income and consumption taxation. The optimal tax system is found by computing the difference in utility gains under each tax system. Results are displayed in Table 8.

The top two panels in Table 8 display the gain in household utility from remittances. The utility equivalence measure is derived from two components: the steady-state increases in consumption and leisure which increase utility, versus the increase in business cycle and consumption volatility, if any, which will tend to decrease utility. The resulting gain or loss will depend on the net impact of the steady-state versus business cycle effects. 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 for Chile and 4.7 percent in the U.S. The increase in per period utility rises to 21.2 percent and 19.8 percent, respectively at the 25 percent level of remittances.

The overall gains in per-period utility under consumption and labor taxation are relatively similar, but differ in composition. Gains from leisure under labor taxation are similar across Chile and the U.S., but contributions from consumption of the cash good are more important in Chile while contributions from the credit good are more important in the U.S., reflecting the heavier use of the inflation tax in the U.S. under labor taxation for reasons discussed above. For example, under a 15 percent level of remittances in Chile, per period utility from consumption of the cash good rises by 18.4 percent versus only 2.2 percent in the U.S., whereas gains from credit good consumption in the U.S. are 14.1 percent versus 7.5 in Chile. Gains from the cash and credit good are more evenly distributed under consumption taxation in the U.S. since use of the inflation tax is eliminated. Remaining distortions from the cash-in-advance constraint are minimized and reflected in per period

[32] 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.

increases in cash good utility. Gains from the cash good are even more pronounced in Chile under consumption taxation, where cash good consumption remains dominant over credit good consumption.

The welfare measure in the bottom panel of Table 8 indicates that consumption taxation is preferable to labor taxation. The numbers in the panel show the difference in utility gains between the two tax systems, measured as the utility gains under consumption taxation minus utility gains under labor taxation. The gains in total utility under consumption taxation are slightly higher in all cases than under labor taxation. Per period increases in utility in the U.S. start at 0.05 percent per period at the 5 percent level of remittances to income and top out at 0.66 percent per period at the 25 percent level of remittances. The equivalent measures for Chile are 0.05 percent and 0.51 percent, respectively. 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.[33]

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). Using the Lucas (1987) framework and some of the calibrated values in this paper would yield a gain in per period utility of 0.9 percent through elimination of the business cycle.[34] Employing a similar stochastic monetary economy as is used in this paper, Cooley and Hansen (1991) report that transitioning from 5 percent and 10 percent inflation to zero inflation results in gains in lifetime utility of 0.4 and 0.6 percent, respectively. Aiyagari et al. (1998) examine the relationship between the size of the banking sector and inflation and estimate that the welfare cost of inflation is 0.5 percent of consumption after accounting for transitional dynamics.

[33] 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.

[34] Using logarithmic preferences and post World War II data series, Lucas (1987) reports that completely removing consumption variability entails a lifetime increase in utility equal to 0.2 percent of consumption. However, Lucas uses a time preference parameter of $\beta = 0.95$ and using a calibrated value equal to $\beta = 0.991$ as in the U.S. economy in this paper would result in a lifetime increase in utility equal to 0.9 percent.

7. Conclusion

This paper provides a unifying framework that assesses how remittances influence the incentives and decisions of economic agents, while also investigating how these decisions impact the recipient economy at large. The model is well grounded in the public finance and business cycle literature and relies on optimizing behavior by various agents in the economy. In this unifying framework we find that remittances, like private capital flows, have both positive and negative economic effects. While remittances increase consumption and have the ability to 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.

The presence of remittances also changes the cost and functioning of government 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 private income transfers such as remittances. We further encourage continued research into the macroeconomic effects of remittances, with particular emphasis on whether remittances entail additional economic and policy risk and, if so, to what degree. We believe that our framework is general enough to allow for the addition of other features that reflect particular institutional or country-specific factors. 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.

8. Appendix: Household optimization problem

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

8.1. 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 (3.4) subject to the budget constraint in (3.6) and the cash-in-advance constraint in (3.7). 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,

$$M_{t+1}^d \ : \ \frac{1-a}{C_{2t}} = \beta E_t \left\{ \frac{a}{C_{1t+1}} \frac{P_t}{P_{t+1}} \right\}, \tag{8.1}$$

$$B_{t+1} \ : \ \frac{1}{C_{2t}} = \beta E_t \left\{ \frac{1}{C_{2t+1}} R_t \right\}, \tag{8.2}$$

$$H_t \ : \ \gamma C_{2t} = (1-a) \left(1 - \alpha \tau_t^h \right) \alpha \frac{Y_t}{H_t}. \tag{8.3}$$

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

$$R_t = \frac{1}{\beta C_{2t}} \left[\frac{1}{E_t \left[\frac{1}{C_{2t+1}} \right]} \right]. \tag{8.4}$$

Maximization of expression (3.4) 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,

$$C_{1t}+C_{2t}+\frac{1}{R_t}\left(C_{1t+1}+C_{2t+1}\right)+\frac{M_{t+1}^d}{P_t}\left(1-\frac{1}{R_t}\frac{P_t}{P_{t+1}}\right) \tag{8.5}$$

$$\leq \left(1-\alpha\tau_t^h\right)\left(Y_t-X\right)+Rem_t+\frac{M_t^d}{P_t}+B_tR_t+$$

$$\frac{1}{R_t}\left[\left(1-\alpha\tau_{t+1}\right)\left(Y_{t+1}-X\right)+Rem_{t+1}-\frac{M_{t+2}^d}{P_{t+1}}-B_{t+2}\right]. \tag{8.6}$$

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,

$$1-\frac{1}{R_t}\frac{P_t}{P_{t+1}}=1-\frac{R_t^M}{R_t}\geq 0, \tag{8.7}$$

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,

$$\sum_{i=0}^{\infty}q_i\left[\begin{array}{c}C_{1t+i}+C_{2t+i}+\frac{M_{t+i+1}^d}{P_{t+i}}\left(1-\frac{1}{R_{t+i}}\frac{P_{t+i}}{P_{t+i+1}}\right)- \\ \left(1-\alpha\tau_{t+i}^h\right)\left(Y_{t+i}-X\right)-Rem_{t+i}\end{array}\right] \tag{8.8}$$

$$\leq \frac{M_t^d}{P_t}+B_tR_{t-1},$$

where,

$$q_0=1 \text{ and } q_i=\prod_{n=1}^{i}\frac{1}{R_{t+n-1}}, \tag{8.9}$$

and where the following transversality conditions have been imposed,

$$\lim_{I\to\infty}\left(q_IB_{t+I+1}\right) = 0, \tag{8.10}$$

$$\lim_{I\to\infty}\left(q_I\frac{M_{t+I+1}^d}{P_{t+I}}\right) = 0. \tag{8.11}$$

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 (3.7) and (3.10) into the Euler condition for money balances in (8.1) to solve for the ratio of consumption of the cash good to consumption of the credit good. Assuming that $M_{t+1} = M^d_{t+1}$ in equilibrium,

$$\frac{C_{1t}}{C_{2t}} = \beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1}). \tag{8.12}$$

The resource constraint in (3.12) can then be used with the above to calculate the closed-form solutions for consumption,

$$C_{1t} = \frac{(Y_t + Rem_t - X - G_t)\,\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}, \tag{8.13}$$

$$C_{2t} = \frac{(Y_t + Rem_t - X - G_t)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}. \tag{8.14}$$

Inserting (8.13) into the cash-in-advance constraint in (3.7), which holds with equality in equilibrium as long as the real interest rate is positive, produces the closed-form equation for the price level,

$$P_t = \frac{M_t}{(Y_t + Rem_t - X - G_t)}\left[\frac{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}{\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}\right], \tag{8.15}$$

while the closed-form solution for the real interest rate is found by inserting (8.14) at time t and $t+1$ into (8.4).

Finally, the solution in (8.14) can be substituted into the Euler condition for labor in (8.3) to solve for optimal labor supply. Doing so, and noting the specification for output and remittances in (3.1) and (3.5), respectively, defines an implicit function,

$$F\left(H_t, g_t, \theta_t, \mu_{t+1}, \tau^h_t\right) = 0. \tag{8.16}$$

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

The implicit function theorem states that given $F\left(H_t,\, g_t,\, \theta_t,\, \mu_{t+1},\, \tau^h_t\right) = 0$, 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 $\left(H_0,\, g_0,\, \theta_0,\, \mu_0,\, \tau^h_0\right)$ satisfying $F\left(H_t,\, g_t,\, \theta_t,\, \mu_{t+1},\, \tau^h_t\right) = 0$, F_H is non-zero except when $H = 0$, then there exists a 4-dimensional neighborhood of $\left(g_0,\, \theta_0,\, \mu_0,\, \tau^h_0\right)$, N, in which h is an implicitly defined function of the variables g, θ, μ, and τ^h in the form of $h(g_t,\, \theta_t,\, \mu_{t+1},$

τ_t^h).[35]

The continuous partial derivatives of (8.16) are[36]

$$F_H \;:\; \frac{\gamma\left[\alpha\frac{Y_t}{H_t} - r_1 Rem_t \frac{\alpha}{H_t}\right]}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - \frac{(1-a)\left(1-\alpha\tau_t^h\right)(\alpha-1)\,\alpha}{H_t}\frac{Y_t}{H_t}, \tag{8.17}$$

$$F_g \;:\; \frac{-\gamma G_t}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}, \tag{8.18}$$

$$F_\theta \;:\; \frac{\gamma\left(Y_t - r_1 Rem_t\right)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - (1-a)\left(1-\alpha\tau_t^h\right)\alpha\frac{Y_t}{H_t}, \tag{8.19}$$

$$F_\mu \;:\; \frac{-\gamma\left(Y_t + Rem_t - X - G_t\right)\beta\left(\frac{a}{1-a}\right)}{\left[1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})\right]^2}, \tag{8.20}$$

$$F_\tau \;:\; (1-\alpha)\,\alpha^2\frac{Y_t}{H_t}. \tag{8.21}$$

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 (8.16) acts as the difference function between the left and right-hand sides of equation (8.3). The left-hand side of equation (8.3) 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.

[35] See Sydsaeter (1981, 81)

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

8.2. Consumption Taxes

Under consumption taxation the process is identical to the one described above, but with the budget constraint in (3.13) and the cash-in-advance constraint in (3.14) used in the dynamic programming problem. The first-order conditions can be combined to form the following Euler conditions,

$$M_{t+1}^d \quad : \quad \frac{1-a}{C_{2t}\left(1+\tau_t^c\right)} = \beta E_t \left\{ \frac{a}{C_{1t+1}\left(1+\tau_{t+1}^c\right)} \frac{P_t}{P_{t+1}} \right\}, \tag{8.22}$$

$$B_{t+1} \quad : \quad \frac{1}{C_{2t}\left(1+\tau_t^c\right)} = \beta E_t \left\{ \frac{1}{C_{2t+1}\left(1+\tau_{t+1}^c\right)} R_t \right\}, \tag{8.23}$$

$$H_t \quad : \quad \gamma C_{2t}\left(1+\tau_t^c\right) = (1-a)\,\alpha \frac{Y_t}{H_t}. \tag{8.24}$$

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

$$R_t = \frac{1}{\beta C_{2t}\left(1+\tau_t^c\right)} \left[\frac{1}{E_t\left[\frac{1}{C_{2t+1}\left(1+\tau_{t+1}^c\right)}\right]} \right]. \tag{8.25}$$

Despite the presence of the consumption tax in the Euler conditions above, the closed form solutions for consumption are identical to those in equations (8.13) and (8.14), while the closed-form equation for the price level is,

$$P_t = \frac{M_t}{\left(Y_t + Rem_t - X - G_t\right)\left(1+\tau_t^c\right)} \left[\frac{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}{\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} \right]. \tag{8.26}$$

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 (8.3) and (8.24),

$$F\left(H_t, g_t, \theta_t, \mu_{t+1}, \tau_t^c\right) = 0. \tag{8.27}$$

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

$$F_H \;:\; \frac{\gamma\left[\alpha\frac{Y_t}{H_t} - r_1 Rem_t \frac{\alpha}{H_t}\right](1+\tau_t^c)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - \frac{(1-a)(\alpha-1)\alpha}{H_t}\frac{Y_t}{H_t}, \tag{8.28}$$

$$F_g \;:\; \frac{-\gamma G_t(1+\tau_t^c)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})}, \tag{8.29}$$

$$F_\theta \;:\; \frac{\gamma(Y_t - r_1 Rem_t)(1+\tau_t^c)}{1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})} - (1-a)\alpha\frac{Y_t}{H_t}, \tag{8.30}$$

$$F_\mu \;:\; \frac{-\gamma(Y_t + Rem_t - X - G_t)\beta\left(\frac{a}{1-a}\right)(1+\tau_t^c)}{\left[1+\beta\left(\frac{a}{1-a}\right)\exp(-\mu_{t+1})\right]^2}, \tag{8.31}$$

$$F_\tau \;:\; \gamma C_{2t}. \tag{8.32}$$

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

8.3. 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,

$$C_{1t} = c_1\left(H_t, g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right), \tag{8.33}$$

$$C_{2t} = c_2\left(H_t, g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right), \tag{8.34}$$

$$H_t = h\left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right), \tag{8.35}$$

$$w_t = \varpi\left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}\right). \tag{8.36}$$

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

$$P_t = p\left(H_t, g_t, \theta_t, \mu_{t+1}, M_t, \tau_t^{h,c}\right), \tag{8.37}$$

$$R_t = r\left(g_t, \theta_t, \mu_{t+1}, \tau_t^{h,c}, E_t\left[H_{t+1}, g_{t+1}, \theta_{t+1}, \mu_{t+2}, \tau_{t+1}^{h,c}\right]\right). \tag{8.38}$$

9. Appendix: 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 U.S. economy without remittances and in the U.S. 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 3 and Figure 4 shows the case with remittances.[37] The impulse response functions for Chile are not markedly different from those presented here for the U.S. and are omitted for reasons of space.

9.1. The Baseline U.S. 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 in Tables 3 and 4. 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.[38] 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, all of which are reported in Tables 3 and 4.

[37] 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.

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

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 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 3. 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 baseline panels of Tables 3 and 4. 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. The resulting lack of correlation between shocks to government spending and both labor supply and output in the baseline economy without remittances are reflected in Tables 3 and 4.

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 slight 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 U.S., increases 3 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, though the effect is stronger in the U.S. than in Chile. 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. In contrast to the positive technology shock, inflation remains above its steady-state level while the government spending shock persists. From period $t+1$ onward, $C_{1t+i+1} > C_{1t+i}$ which otherwise reduces inflation, but this effect is offset by higher money growth leaving inflation above steady-state inflation for the duration of the shock. 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.

9.2. The U.S. Economy with Remittances

Figure 4 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 0.74 percent with remittances in Figure 4 versus 0.61 percent without remittances in Figure 3. Remittances, however, fall due to their countercyclical nature, leaving the response of household consumption at similar levels as the economy without remittances. Consumption in the economy with remittances increases by 0.91 percent versus an increase of 0.93 percent in the baseline 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 now clearly negative, producing a stronger decline in output relative to the baseline economy without remittances. Labor and output decline by -0.09 percent and -0.05 percent, respectively, in the economy with 15 percent remittances to income in Figure 4, versus the flat response shown in Figure 3. 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 and debt relative to 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 much stronger in the presence of remittances, increasing by 0.67 percent under 15 percent remittances to income versus 0.50 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.

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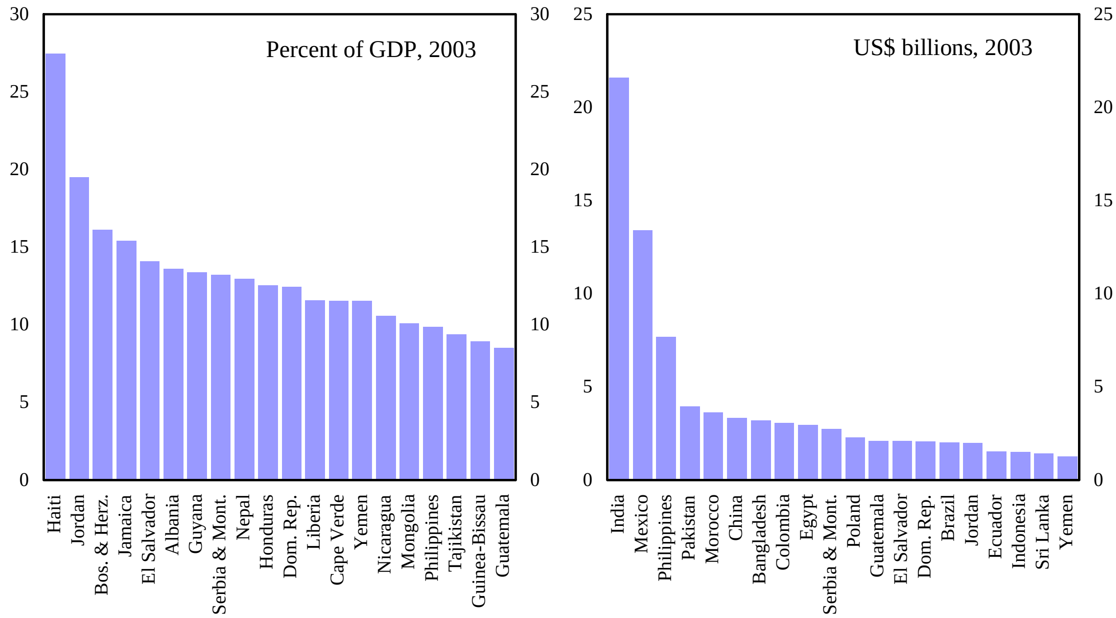
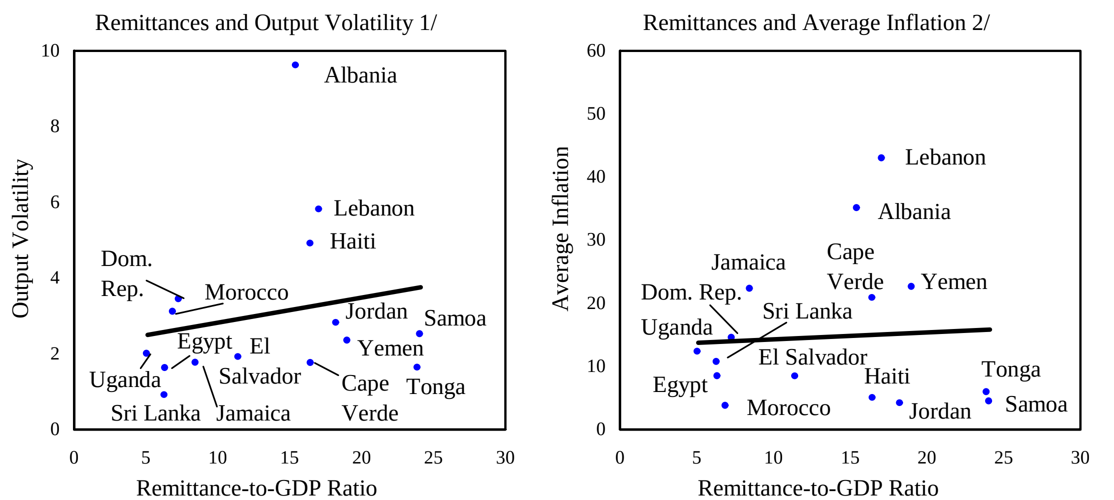
Figure 1: Developing Countries: 20 Largest Recipients of Remittances in 2003



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.

Figure 3: Impulse Response Functions: U.S. Baseline Economy With Labor Taxation

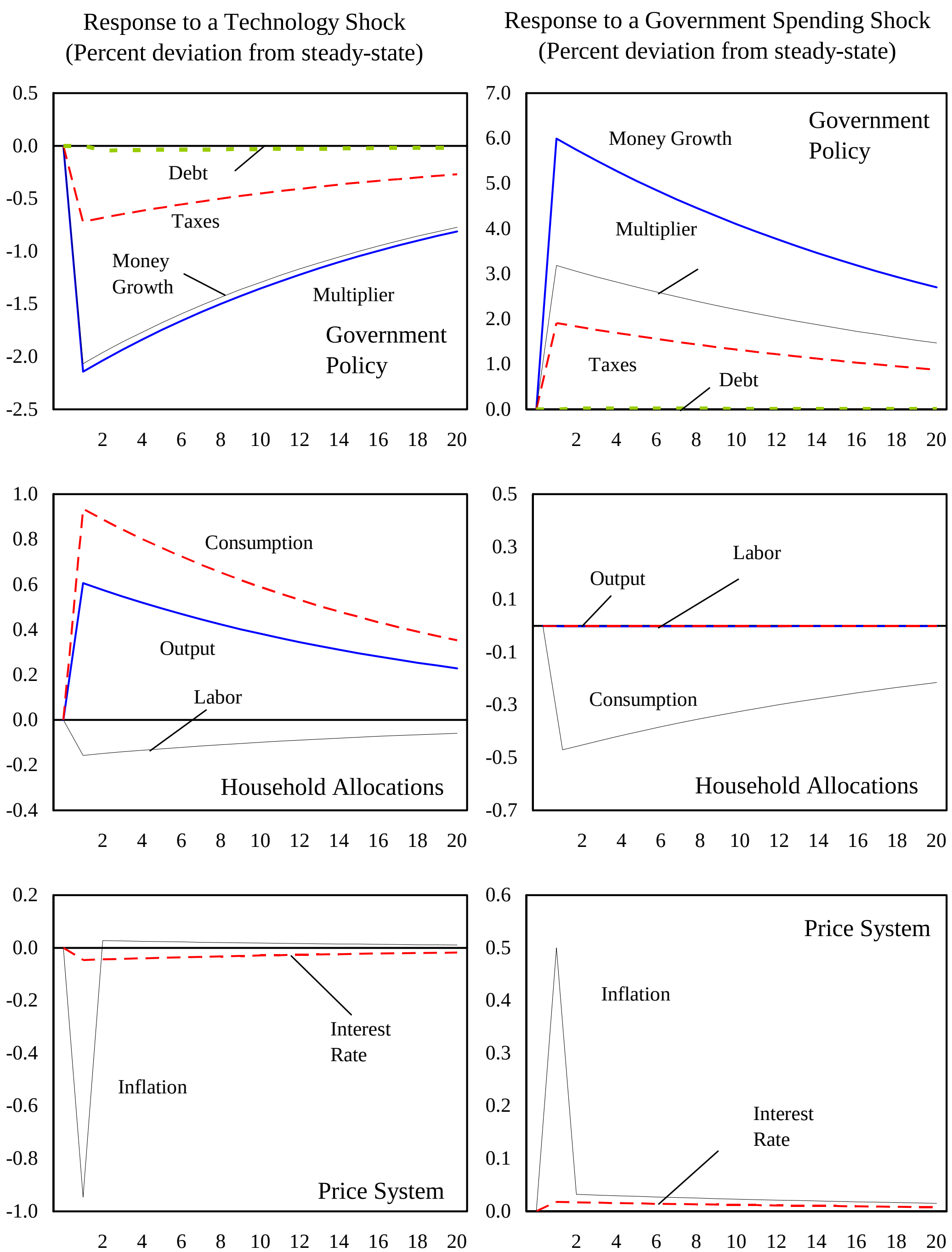


Figure 4: Impulse Response Functions: U.S. Economy with 15 Percent Remittances to Income

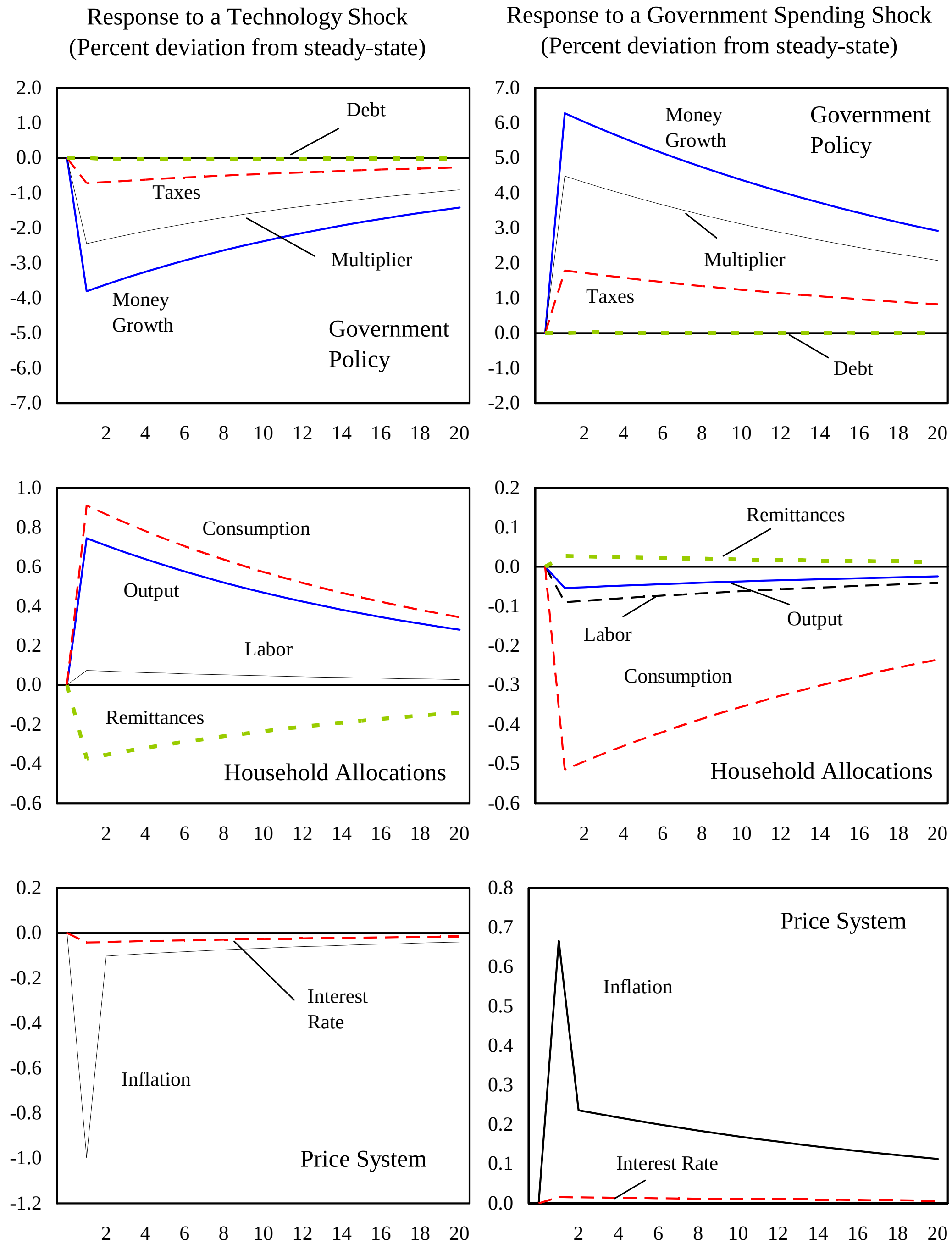


Table 1: Parameter Values for U.S. and Chile Calibration Exercises.

Parameter Values		α	β	a	γ	δ	ρ_θ	σ_θ	ρ_g	σ_g
U. S.	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
Chile	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: Labor Taxation.

Steady State Values [1/]

	Chile				U.S.			
	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	1.73	1.67	1.55	1.45
Remittances	-	0.08	0.22	0.34	-	0.08	0.23	0.36
Cash Good	0.85	0.86	0.88	0.90	0.49	0.50	0.50	0.51
Credit Good	0.28	0.29	0.31	0.32	0.63	0.64	0.67	0.69
Labor	0.44	0.41	0.37	0.34	0.31	0.29	0.26	0.23
Multiplier	0.11	0.10	0.08	0.05	0.14	0.13	0.12	0.11
	(in percent)				(in percent)			
Inflation Rate	-2.2%	1.0%	4.5%	4.6%	-0.9%	1.1%	4.2%	5.9%
Real Interest Rate	2.2%	2.2%	2.2%	2.2%	0.9%	0.9%	0.9%	0.9%
Money Growth Rate	-2.2%	0.9%	4.4%	4.5%	-0.9%	1.1%	4.1%	5.7%
Tax Rate	25.0%	22.8%	20.4%	21.9%	31.4%	31.7%	32.5%	34.1%

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 labor income.

Standard Deviation (in percent) [2/]

	Chile				U.S.			
	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	0.81	0.88	1.00	1.14
Remittances	-	0.62	0.70	0.78	-	0.44	0.50	0.57
Cash Good	1.67	1.68	1.65	1.59	1.43	1.49	1.60	1.68
Credit Good	1.66	1.54	1.39	1.36	1.38	1.34	1.25	1.17
Labor	0.26	0.13	0.10	0.37	0.21	0.12	0.15	0.37
Multiplier	3.78	3.90	3.86	3.87	5.02	5.58	6.82	8.51
Price Level	1.67	1.70	1.82	1.76	1.42	1.55	2.00	2.55
Inflation	1.21	1.18	1.13	1.10	1.04	1.06	1.12	1.19
Interest Rate	0.05	0.05	0.03	0.03	0.07	0.06	0.06	0.06
Debt	0.20	0.23	0.24	0.29	0.07	0.07	0.07	0.07
Money Growth Rate	0.02	0.15	0.29	0.29	0.07	0.18	0.40	0.61
Tax Rate	1.56	1.33	0.90	1.13	2.67	2.65	2.52	2.29

2/ 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 labor income.

Table 3: Simulated Chile 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 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 5: Steady-State Values and Standard Deviations: Consumption Taxation.

Steady State Values: [1/]								
	Chile				U.S.			
	Remittances-to-Income Ratio				Remittances-to-Income Ratio			
Variable	0%	5%	15%	25%	0%	5%	15%	25%
	(in levels)				(in levels)			
Output	1.56	1.51	1.42	1.34	1.74	1.68	1.58	1.50
Remittances	0.00	0.08	0.21	0.34	-	0.08	0.24	0.37
Cash Good	0.84	0.86	0.90	0.93	0.45	0.46	0.49	0.51
Credit Good	0.28	0.28	0.29	0.31	0.58	0.59	0.62	0.65
Labor	0.42	0.40	0.36	0.33	0.31	0.29	0.27	0.24
Multiplier	0.09	0.08	0.04	0.01	0.12	0.10	0.06	0.03
	(in percent)				(in percent)			
Inflation Rate	-2.2%	-2.2%	-2.2%	-2.2%	-0.9%	-0.9%	-0.9%	-0.9%
Real Interest Rate	2.2%	2.2%	2.2%	2.2%	0.9%	0.9%	0.9%	0.9%
Money Growth Rate	-2.3%	-2.3%	-2.2%	-2.2%	-0.9%	-0.9%	-0.9%	-0.9%
Tax Rate	18.8%	18.4%	17.7%	17.1%	23.0%	22.4%	21.3%	20.3%

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): [2/]								
	Chile				U.S.			
	Remittances-to-Income Ratio				Remittances-to-Income Ratio			
Variable	0%	5%	15%	25%	0%	5%	15%	25%
Output	1.18	1.24	1.37	1.49	0.76	0.81	0.89	0.97
Remittances	-	0.62	0.68	0.75	-	0.40	0.45	0.49
Cash Good	1.66	1.61	1.52	1.43	1.44	1.39	1.31	1.23
Credit Good	1.66	1.61	1.52	1.43	1.42	1.38	1.30	1.22
Labor	0.23	0.13	0.07	0.26	0.29	0.22	0.08	0.06
Multiplier	3.41	3.26	2.87	8.83	4.25	4.50	5.68	11.55
Price Level	1.41	1.38	1.30	1.23	1.06	1.03	0.97	0.92
Inflation	1.03	1.00	0.94	0.89	0.78	0.76	0.72	0.67
Interest Rate	0.03	0.03	0.02	0.02	0.05	0.05	0.05	0.05
Debt	0.26	0.24	0.21	0.17	0.07	0.07	0.07	0.06
Money Growth Rate	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.00
Tax Rate	1.90	1.87	1.80	1.73	3.41	3.39	3.36	3.33

2/ 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 6: Simulated Chile 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 7: 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.	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.	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.	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.	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 8: Utility Equivalence Measures

Labor Taxation: Utility Gains Over No-Remittance Economy						
	Chile			U.S.		
	Remittances-to-Income			Remittances-to-Income		
	5%	15%	25%	5%	15%	25%
	(Per period increase, in percent)					
Total Utility	5.0	13.8	21.2	4.7	12.9	19.8
Consumption	3.4	10.6	16.7	2.6	7.6	12.1
Cash Good	4.4	18.4	34.9	0.6	2.2	4.6
Credit Good	3.0	7.5	9.7	5.1	14.1	21.2
Labor	5.9	15.6	23.8	6.3	16.9	25.6

1/ The numbers reflect the per period increase in the relevant category to make the household indifferent between the baseline economy without remittances and the selected economy with remittances.

Consumption Taxation: Utility Gains Over No-Remittance Economy						
	Chile			U.S.		
	Remittances-to-Income			Remittances-to-Income		
	5%	15%	25%	5%	15%	25%
	(Per period increase, in percent)					
Total Utility	5.0	14.0	21.7	4.8	13.2	20.5
Consumption	5.0	14.3	22.8	4.1	11.6	18.4
Cash Good	13.1	37.3	59.4	3.4	9.6	15.3
Credit Good	1.8	5.0	7.9	4.9	13.9	22.0
Labor	5.0	13.8	21.1	5.3	14.5	22.1

1/ The numbers reflect the per period increase in the relevant category to make the household indifferent between the baseline economy without remittances and the selected economy with remittances.

Utility Gains from Consumption Taxation Versus Labor Taxation 1/						
	Chile			U.S.		
	Remittances-to-Income			Remittances-to-Income		
	5%	15%	25%	5%	15%	25%
	(Difference in per period increase, in percent)					
Total Utility	0.05	0.22	0.51	0.05	0.29	0.66
Consumption	1.60	3.77	6.12	1.45	3.98	6.32
Cash Good	8.66	18.89	24.52	2.82	7.41	10.73
Credit Good	-1.30	-2.54	-1.73	-0.23	-0.24	0.84
Labor	-0.83	-1.80	-2.70	-0.98	-2.44	-3.55

1/ The numbers reflect the difference in utility gains between the economies with remittances under consumption taxation and labor taxation.