REMITTANCES: DETERMINANTS, MOTIVATIONS AND EFFECTS

A Dissertation

by

GEORGES SAMI NAUFAL

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2007

Major Subject: Economics

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Approved by:

Co-Chairs of Committee,	Manuelita Ureta
	Donald Deere
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ABSTRACT

Remittances: Determinants, Motivations and Effects. (December 2007)

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Co-Chairs of Advisory Committee: Dr. Manuelita Ureta
Dr. Donald Deere

This dissertation examines the determinants, motivations and effects of remittances. In that last two decades remittances have gained interest due to their large size. For several developing countries remittances constitute a large portion of their gross domestic product and sometimes exceed foreign direct investment. In the first essay, I use a unique data set from Nicaragua to asses the behavior of persons who send money back home. I estimate a heteroskedastic Tobit with a known form of variance to estimate the correlation of the remitting decisions of migrants. Working, residing in a developed country and belonging to the nuclear family positively affect remittances. The labor status and the level of education of the head of the household both affect remittances. The decision to participate in the remitting process appears to be positively related across migrants within the same receiving household.

The second essay presents a simple theoretical model of migrants' remitting behavior. I consider two general motivations for remitting: altruism and self-interest. From the same data set used in the first chapter, I estimate a heteroskedastic Tobit and a sample selection equation to empirically test the findings of the theoretical model.

Evidence suggests that migrants from Nicaragua remit for altruistic reasons. Moreover some gender heterogeneity exists in the remitting behavior.

In the last essay, I study the impact of remittances on a small open economy using a stochastic limited participation model with cash in advance constraints and costly adjustment of cash holdings. I examine the impact of remittances on the steady state of the economy and on the dynamic response of variables to money shocks, output shocks, and shocks to remittance flows. I also examine the impact on dynamic responses to shocks of alternative specifications regarding the initial impact of a monetary injection or a remittances shock on the economy. I find that a positive remittances shock forces the exchange rate to depreciate and lowers both output and consumption in the period of the shock, irrespective of adjustment costs on money balances. Also, the positive remittance shock lowers utility during the period of the shock but improves it thereafter.

DEDICATION

To my parents, Sami Naufal and Wafaa Naufal

for their inconceivable support

To my brothers, Ziad Naufal and Kamal Naufal

for always being there

To Lindsey Flasowski, my wife

for changing my life, forever.

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CHAPTER I

INTRODUCTION

This dissertation examines the determinants, motivations and effects of remittances. In that last two decades remittances have gained interest due to their continuous increase and their large size. For several developing countries remittances constitute a large portion of their gross domestic product and sometimes exceed foreign direct investment. Official estimates show that remittances averaged around 60 billion U.S. dollars per year in the 1990s (World Bank) and reached 167 billion U.S. dollars in 2005 (World Bank's Global Economic Prospects). In some countries remittances constitute a significant share of gross domestic product (GDP) (Connell and Brown, 2004; De Haas, 2006; Heilmann, 2006; Chami et al., 2006). For instance, in Nicaragua, the poorest country in the Western Hemisphere (www.worldbank.org/ni), remittances constitute around 16% of its GDP, the fifth highest percentage among the developing country recipients of workers' remittances in 2001.

The growing importance of these transfers of money has produced a number of studies to explore their dimensions, determinants, effects and the government policies designed to influence them. Remittances gain their significance not just from their size but from the potential and actual effects of these money flows on both the society and the individual. Remittances affect labor market decisions; school retention levels, export sector competitiveness, and can create moral hazard problems (Funkhouser, 1992;

This dissertation follows the style of Journal of Development Economics.

Glytsos, 2002; Edwards and Ureta, 2003; Amuedo-Dorantes and Pozo, 2004; Chami et al., 2005).

All these studies stress on better understanding the remittance behavior in order to develop economic policies that take full advantage of these flows.

In the next chapter, I use a unique data set from Nicaragua to asses the characteristics of the individuals who remit. Unlike all previous studies I have information on the sender and the receiver from the same source. I estimate a heteroskedastic Tobit with a known form of heteroskedasticity which allows me to examine the correlation of the remitting decisions of migrants in the same original receiving household.[1] The main contribution of this paper is the ability to quantify the correlation of the remitting decisions between migrants who belong to the same receiving household. The ability to measure this relationship is crucial since it allows further understanding of how intra-family decisions are made regarding the allocation of resources across households that are separated by migration. The knowledge of the mechanism of intra-family remitting decisions shed light on the indirect outcomes of remittance policies. I believe this is the first paper to address this issue. This paper also adds to the remittance literature in computing changes in both the likelihood of remitting and the amount remitted.

Gender, labor force status, and destination of the migrant all have significant effects on remittances. The relationship of the migrant to the head of the household also affects the remitting behavior. The labor status and the level of education of the head of

[1] The receiving household is the original household in Nicaragua which reported at least one migrant living abroad.

the receiving household influence the migrant's decision to participate in the remitting behavior. Evidence suggests that there is a positive correlation between migrants' remitting decisions among migrants belonging to the same receiving household.

In Chapter III, I investigate the motivation behind remittances. Remittances differ from other types of capital flows. Capital flows such as FDIs are in general profit driven and therefore are positively related to GDP growth. However, this is not always the case for remittances. Remittances are not always profit driven and can be altruistically motivated. Also, FDIs tend to be less stable relative to remittances (Orozco, 2002).

Uncovering the reasons for remitting is crucial for policy implication for several reasons. From the original household perspective, the forces behind remittances can shed some light on households' migration strategies (De La Brière et al., 2002). In fact Hoddinott (1994) stresses that remittances should be incorporated in the model of household migration decisions. From a macroeconomic look, remittances are thought to be intended to ease the burden of poor economic performance on local recipients (Chami et al., 2005). Therefore altruistically motivated remittances are expected to be countercyclical with income growth and consequently can decrease the scope of the government intervention in recession times. In this particular case, policies built on predictions that remittances behave in the same manner as other types of capital flows might have unanticipated consequences.

I present a simple theoretical model of remittance behavior. I consider remittances as unidirectional flows from the migrant in a host country to the original

household in the home country which I refer to in this paper as the receiving household. This allows me to consider the reaction of remittances to a bad state outcome on the receiving household. This is the first paper that looks at the response of remittances to shocks that pertain to the receiving household. This is crucial in terms of investigating the remittance behavior since most remittances consider the migrant as a source and the receiving household as the end destination and therefore, they are expected to react to any income shocks at the receiving end. This setup gives two broad motivations for remitting: altruism where migrants simply care about the receiving household members' welfare and self-interest where migrants remit for investment opportunities that are expected to yield a certain payoff in the future. I test the theoretical predictions of this model using survey data from Nicaragua. I quantify the results of the heteroskedastic Tobit for policy purposes.

Altruism seems to be the main motivation behind the remitting behavior to Nicaragua. Moreover the remitting behavior is not identical across gender. Female migrants seem to behave more altruistically toward the receiving household.

The literature on the macroeconomic impact of remittances on the recipient country is sparse. Chapter IV explores the impact of remittances flows on output, consumption, interest and exchange rates in the recipient country. In particular, I explicitly model remittances in a small open economy and analyze the impact of shocks to money, remittances and output. I expand a limited participation model that requires that money balances be held to finance certain types of purchases and agents incur adjustment costs on money holdings. These two requirements generate a large and

persistent liquidity effect consistent with the stylized facts (Hairault et al., 2004). The impact of the adjustment costs on the predetermined allocation of money cash available for consumption is then analyzed to see how the main real variables of the economy respond to a remittances shock.

One of the contributions of this Chapter is the ability to examine the dynamic response of major macroeconomic variables to remittances shock. Another important contribution is the capacity to observe the impact on the main economic variables when I allow for different end uses of remittances, and monetary injections. In fact, many domestic governments are interested in developing policy tools to direct a portion of remittances towards investment (The New York Times Magazines April 22, 2007). I distinguish between the direct effect of remittances on output through investment and the indirect effect through consumption and its multiplier effect. Being able to distinguish the end use of remittances is crucial in looking at the final effect on output in the economy (Burgess and Haksar, 2005; Heilmann, 2006; Sayan, 2006). This Chapter also presents a welfare analysis of remittances shock and investigates how remittances affect the utility of the representative agent.

Positive remittances shock forces the exchange rate to depreciate and lowers both output and consumption in the period of the shock, irrespective of adjustment costs on money balances. Also, the positive remittance shock lowers utility during the period of the shock but improves it thereafter.

Finally, Chapter V summarizes and concludes.

CHAPTER II

WHO REMITS? THE CASE OF NICARAGUA

2.1. Introduction and Motivation

International estimates of official remittances flows suggest that total remittances averaged around US$ 59 billion per year during the 1990s[2] (World Bank). Fig. 2.1 ranks the first 20 developing country recipients of workers' remittances by size of remittances received in 2001.

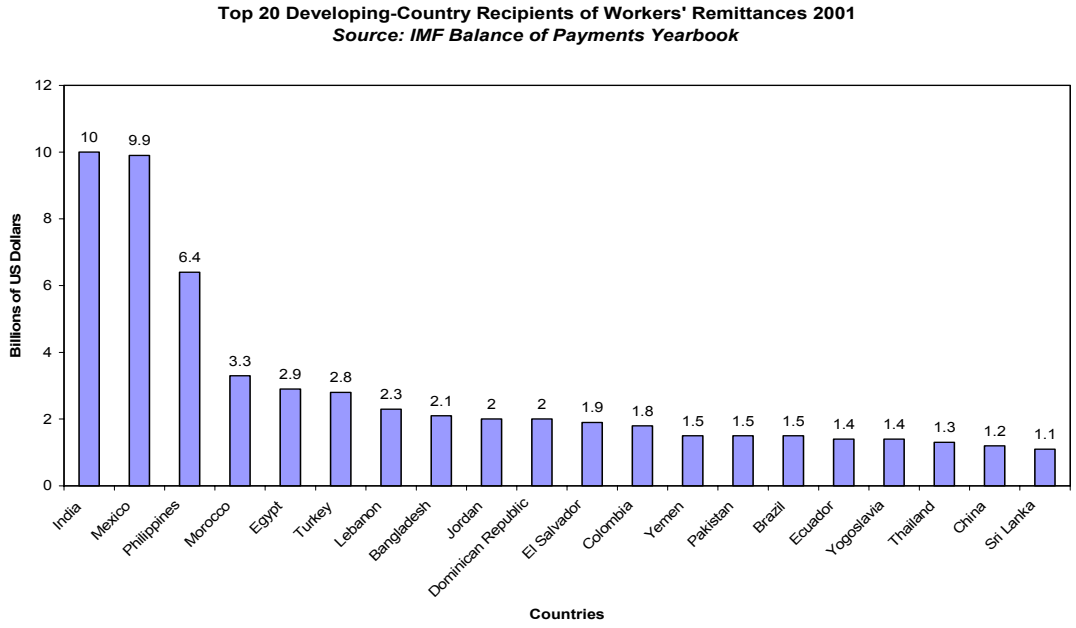

Fig. 2.1 Top 20 Developing-Country Recipients of Workers' Remittances by Size of Remittances

[2] Most estimates of remittances are based on the balance of payments statistics reported to the International Monetary Fund (IMF). Note that these numbers are generally an underestimate of the actual remittances since they only include the official flows of this money into the receiving countries.

Out of the first 20 developing countries receiving remittances six are from Central and South America with a total of 18.5 billion U.S. dollars. In some countries remittances constitute a significant share of gross domestic product (GDP). Fig. 2.2 ranks the first 20 developing country recipients of workers' remittances by percentage of their GDP.

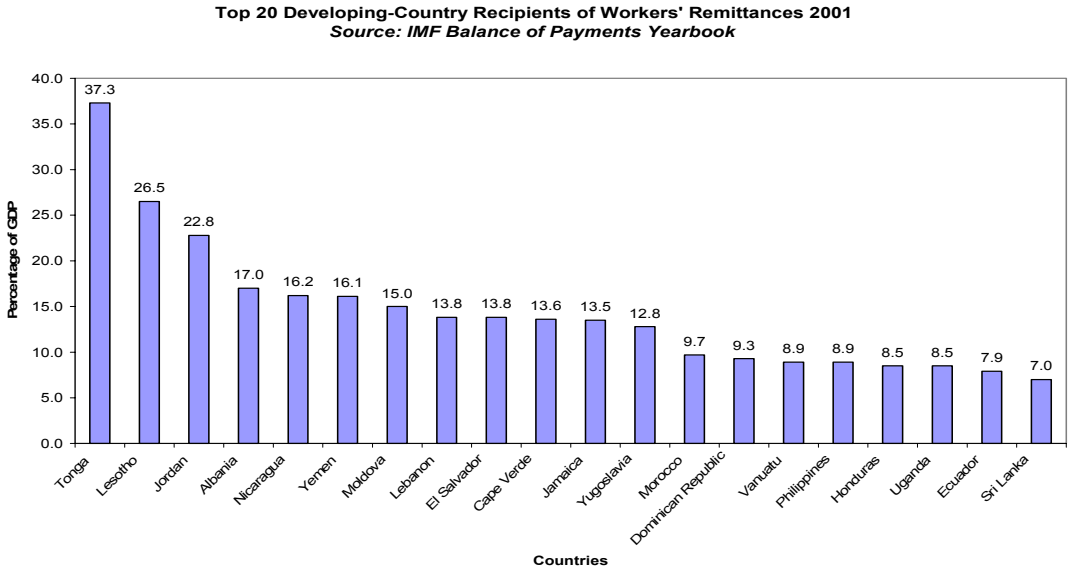

Fig. 2.2. Top 20 Developing-Country Recipients of Workers' Remittances by Percentage of GDP

Remittances constitute more than 10% of the GDP in twelve developing countries. In Nicaragua, the poorest country in the Western Hemisphere (World Bank Website www.worldbank.org), remittances constitute around 16% of its GDP, the fifth highest percentage among the developing country recipients of workers' remittances in 2001. The growing importance of these transfers of money has produced a number of

studies to explore their dimensions, determinants, effects and the government policies designed to influence them. Migrant remittances affect the performance of the economy. Glytsos (2002) shows that remittances have the potential to substitute for foreign aid. Chami et al. (2003) find that remitting takes place under asymmetric information and imply that remittances have a negative impact on economic growth. Amuedo-Dorantes and Pozo (2004) find that workers' remittances can reduce the international competitiveness of the receiving countries' export sector by appreciating the real exchange rate in the receiving economies. Remittances also impact the behavior at the household level. Funkhouser (1992) finds opposite effects of remittances inflows on the Nicaraguan and Salvadorian labor markets. Edwards and Ureta (2003) find that remittances have a large effect on school retention. All these studies stress on better understanding the remittance behavior in order to develop economic policies that take full advantage of these flows.

In this study I use a unique data set from Nicaragua to asses the characteristics of the individuals who remit. Unlike all previous studies I have information on the sender and the receiver from the same source. I estimate a heteroskedastic Tobit with a known form of heteroskedasticity which allows me to examine the correlation of the remitting decisions of migrants in the same original receiving household.[3] The main contribution of this paper is the ability to quantify the correlation of the remitting decisions between migrants who belong to the same receiving household. The ability to measure this relationship is crucial since it allows further understanding of how intra-family decisions

[3] In this paper the receiving household is the original household in Nicaragua which reported at least one migrant living abroad.

are made regarding the allocation of resources across households that are separated by migration. The knowledge of the mechanism of intra-family remitting decisions shed light on the indirect outcomes of remittance policies. I believe this is the first paper to address this issue. This paper also adds to the remittance literature in computing changes in both the likelihood of remitting and the amount remitted.

Gender, labor force status, and destination of the migrant all have significant effects on remittances. The relationship of the migrant to the head of the household also affects the remitting behavior. The labor status and the level of education of the head of the receiving household influence the migrant's decision to participate in the remitting behavior. Evidence suggests that there is a positive correlation between migrants' remitting decisions among migrants belonging to the same receiving household.

Section 2.2 below provides an overview of the existing literature. Section 2.3 consists of a theoretical model. Section 2.4 describes the data and the methodology. Section 2.5 contains the results and section 2.6 summarizes and concludes.

2.2. Literature Review

Lucas and Stark (1985) discuss several hypotheses for motivations to remit. The authors present three reasons for remitting ranging from pure altruism to pure self-interest spanning a more tempered point of view combining these two extremes. Lucas and Stark explore these concepts using data from the National Migration Study of Botswana. Remittances are determined partly by the earnings of the migrant and partly by his years of schooling. Lucas and Stark also note a positive trend between these flows of money and per capita income of the household.

Oberai and Singh (1980) using a household survey in the Ludhiana district of the Indian Punjab report a positive relation between low income migrant and the probability of remittances and a negative correlation between the number of household members working and this same likelihood. In addition, the authors find that the level of education does not affect the decision whether or not to remit.

Based on a nationwide survey of households in Kenya, Knowles and Anker (1981) present empirical evidence on issues related to remittances. The authors first stress that remittances are primarily limited to members of the nuclear family. Moreover they conclude that migrant's income of the sending unit, education level, sex, ownership of a house back home and the fact of a spouse residing away all positively affect the probability to remit. Knowles and Anker add that the length of time a migrant has resided away negatively affect these chances. Also migrant's schooling and income negatively influence the level of remittances.

Funkhouser (1995) uses data from El Salvador and Nicaragua to investigate and compare the determinants of remittances in both countries. Funkhouser applies a separable utility function that values both absentee's utility and the household utility. The author also follows a linear functional form in estimating remittances. Funkhouser presents fairly similar findings for El Salvador and Nicaragua. In both countries education is negatively related to the probability of remittances while it is positively associated to the level of these money transfers. Using the Salvadoran data Funkhouser notes that age and gender do not affect the likelihood and the level of remittances. In Nicaragua, age is adversely correlated with both the probability and the amount of

remittances. Furthermore, Funkhouser examines familial relationship and the period of time spent abroad and their effects on remittances.

Rodriguez (1996) uses a data set from the Philippines to note a positive connection between the age of the migrant, time since migration and the chance of remitting. However, equally to Knowles and Anker this incidence decreases for long absences. Rodriguez also remarks that being a member of the nuclear family increases the probability of remitting. Similarly to Oberai and Singh, Rodriguez does not find a clear association relating education to remittances.

Lianos (1997) focuses on the remittances to Greece from Germany for a period of 30 years. Lianos tests the significance of a set of factors in terms of their effects on remittances. The author finds that the level of migrant's income has a positive and major effect on remittances to Greece. Lianos also calculates the elasticity of remittances with respect to income. This elasticity is greater than one suggesting a large response of remittances for any small change in income. Furthermore, Lianos finds that household income in the country of origin does not significantly influence the level of remittances.

Clearly, the empirical evidence on the determinants of remittances is inconclusive. I summarize these findings in Table 2.1.

Both Oberai and Singh (1980) and Rodriguez (1996) find that education and remittances are not related. Lucas and Stark (1985) along with Knowles and Anker (1981) find a relationship between these two even though they do not agree on its direction. In addition, Lianos (1997) finds that household income is uncorrelated with remittances while Lucas and Stark (1985) document a positive correlation. These results

support a need for more empirical studies on the determinants of remittances. The following section outlines a theoretical model of remittance behavior.

Table 2.1
Summary of the Literature Findings

Authors	Data	Findings
Oberai and Singh (1980)	Rural Household Survey in the Ludhiana District of the Indian Punjab (March – April 1977)	Years of schooling do not affect the prob. and the level of remittances. Migrant's income has a positive effect on the probability of remittances. The number of working household members negatively affects this likelihood.
Knowles and Anker (1981)	Household Survey in Kenya (December 1974)	Male, gender and years of schooling have a positive effect on the probability of remitting. Migrant's income and receiving household's income have a negative effect on this likelihood.
Lucas and Stark (1985)	Household Survey of Migration in Botswana (1978 – 1979)	Years of schooling, migrant's income and the receiving household's income positively affect the level of remittances.
Funkhouser (1995)	*El Salvador*: Survey conducted by Segundo Montes (1987) *Nicaragua*: Household Survey in Managua (December 1989)	*El Salvador*: Age and gender have no effect on the probability and the level of remittances while years of schooling have an adverse effect on the likelihood of remitting and a positive effect on the level of remittances. *Nicaragua*: Age negatively affects the prob. and the level of remittances. Gender has no significant effect on remittances. Years of schooling have an adverse effect on the likelihood of remitting and a positive effect on the level of remittances.
Rodriguez (1996)	Survey of Overseas Philippians workers (SOW – 1991)	Age, years since migration, relationship to HH positively affect the probability of remitting. Age and years since migration negatively affect the level of remittances. Years of schooling have no effect on the level of remittances.
Lianos (1997)	Statistical Data come from diverse sources	Migrant's income positively affects the level of remittances. The receiving household's income has no effect on the level of remittances.

2.3. Model

This paper builds on the model in Funkhouser (1995). A model of remittance behavior considers an emigrant's utility that is a function of his own utility and that of the receiving household in the home country. I assume a separable utility function given by:

$$U\left(U_{ij};U_j\right)=U_{ij}\left(C_{ij}\right)+V\left\{U_j\left(C_j\right),Z_j\right\} \tag{2.1}$$

where $U_{ij}^{'}>0;U_j^{'}>0;U_{ij}^{''}<0$ and $U_j^{''}<0$; i refers to a particular migrant and j refers to a specific receiving household, U_{ij} is emigrant i own utility which depends on consumption C_{ij}, U_j refers to the receiving household j utility which depends on its consumption C_j and Z_j defines a vector that includes the receiving household characteristics.

The emigrant chooses remittances level to maximize a separable lifetime utility function such as:

$$\sum_t U_{ij}\left\{C_{ijt}\right\}\left(1/\left(1+\sigma_u\right)^t\right)+V\left\{U_j\left(Y_{jt}+R_{ijt}+N_{jt}\overline{R}_t\right),Z_j\right\}\left(1/\left(1+\sigma_v\right)^t\right) \tag{2.2}$$

subject to

$$C_{ijt}+R_{ijt}=I_{ijt} \tag{2.3a}$$

$$I_{ijt}=\beta_0+X_{ijt}\beta_1+\varepsilon_{ijt} \tag{2.3b}$$

where C_{ijt} is emigrant's consumption at time t, Y_{jt} is household income earned by receiving household j in the native country at time t, R_{ijt} refers to remittances received by the receiving household j from migrant i at time t, N_{jt} identifies the number of

other household emigrants at time t, $\overline{R}_{jt}$ quantifies the average remittances per other emigrant at time t, I_{ijt} is the income of the emigrant i at time t, X_{ijt} describes a vector of emigrant's characteristics at time t, $\left(1/(1+\sigma_u)^t\right)$ is a discount rate applied to emigrant utility function, and $\left(1/(1+\sigma_v)^t\right)$ is a discount rate applied to the receiving household utility function.

Solving this maximization problem leads to the first order condition for a positive level of remittances at time t:

$$-\left(U_{ij}^{'}\right)\left[1/(1+\sigma_u)\right]^t dR + \partial V/\partial U_j\left(U_j^{'}\right)\left[1/(1+\sigma_v)\right]^t dR = 0 \tag{2.4}$$

Solving for the level of remittances yields an implicit remittance equation

$$R_{ijt}^{*} = R\left(\sigma_u, \sigma_v, X_{ijt}, Y_{jt}, N_{jt}, \overline{R}_{jt}\right) \tag{2.5}$$

In a censored regression model Eq. (2.5) determines both the probability of remitting and the level of remittances. I use a linear functional form given by:

$$R^{*} = \alpha + \beta X + \pi Z + u \tag{2.6}$$

in which X is a vector that includes emigrants' characteristics, Z is a vector that consists of household characteristics in the recipient country; and u is a normally distributed error term $u \sim N(0, \sigma^2)$. The objective of exploring the determinants of remittances lies in estimating Eq. (2.6). The domain of the dependent variable is censored since the observed remittances are never negative. Remittances are zero for a large number of observations. I rewrite Eq. (2.6) to explicitly illustrate this:

$$R_{ij} = \begin{cases} \alpha + \beta X_{ij} + \pi Z_j + u_{ij} & \textit{if and only if } \alpha + \beta X_{ij} + \pi Z_j + u_{ij} \succ 0 \\ 0 & \textit{otherwise} \end{cases} \tag{2.7}$$

such that $i = 1,...k_j$; $j = 1,...J$ and k_j is the total number of migrants in household j and J is the total number of receiving households.

In a nutshell, to explore the determinants of remittances I need to estimate Eq. (2.6). Ordinary least squares (OLS) yield biased estimates because of the nature of the dependent variable. Two alternative approaches are usually adopted to estimate Eq. (2.6). The first one is a Heckman (1979) two-step procedure. This method requires that the decision to remit is a two-step decision: the likelihood of remitting and the level of remittances. The second approach is a censored Tobit model. This model assumes that the decision to remit is a one-step decision and therefore requires that all determinants have the same sign effect on the likelihood and the level of remittances. In this paper the second approach is dictated by Eq. (2.5) since it determines both the probability of remitting and the level of remittances.

2.4. Data and Estimation Method

2.4.1. Data

The data set is from the 2001 Nicaraguan Encuesta Nacional de Hogares sobre Medición de Niveles de Vida (EMNV). This is a nationally representative survey that was administered by the Nicaraguan Institute for Statistics and Census. The national living standards measurement survey (LSMS) was established by the World Bank in 1980. The LSMS collects data on many dimensions of the household well-being including consumption, income, employment, education and migration. The data set contains 4001 households including 22,810 household members. The survey was administered in 2001. Receiving household members were asked about their age,

education, property, income, occupation, businesses and any agricultural activities. This survey includes a remittances model where a knowledgeable member of the receiving household was asked about other household members who do not live in the household. All the information about emigrants is extracted from their primary receiving household. I have information on their destination, labor force status, age, education, their relationship to the head of the main household and also their year of migration. The remittances module documents 897 migrants in total.

Unlike all previous studies I have information on the sender and the recipient from the same source, the original receiving household. One contribution of this paper is that I am able to track information on both sides of the remittance behavior from the same source. This ability to identify each individual allows me to further understand how intra-family decisions are made regarding the allocation of resources across households that are separated by the migration of some of its members (Menjívar, 1995).

Even with this unique data set I can only precisely recognize the decision to remit of migrants. I cannot identify the exact amount of remittances sent by each migrant.[4] This lack of information causes a problem since I cannot identify the exact amount remitted by each migrant. To avoid this problem I separate migrants into three categories based on their decision to participate in the remitting process. The first category includes migrants who do not remit such that their remittances are zero. The second category has migrants who remit but also who belong to households with only

[4] A knowledgeable member of the receiving household was asked whether migrant i remits or not. The same member was also asked about the monetary value of remittances that the household received in the last 12 months.

one migrant remitting ($s_j = 1$ where s_j is the number of remitting migrants in household j). Again I know the exact amount that these migrants are sending. The third category consists of migrants who remit and who belong to multiple remitting migrants' households ($s_j > 1$). In this last category I do not observe the exact amount of remittances for each migrant remitting. I average the total amount of remittances received by the original household on all the migrants who remit. The following subsection explains in details the estimation method.

1.4.2. Estimation Method

I re-write Eq. (2.6) as the following:

$$R_{ij} = \alpha + \beta X_{ij} + \pi Z_j + u_{ij} \tag{2.8}$$

I take the average of Eq. (2.8) by summing over migrants who are remitting within each receiving household with multiple migrants remitting and then dividing by s_j . This leads to Eq. (2.9) which, hereafter, I refer to as the average model:

$$\frac{1}{s_j}\sum_{i=1}^{s_j} R_{ij} = \frac{1}{s_j} R_j = \alpha + \frac{1}{s_j}\beta\sum_{i=1}^{s_j} X_{ij} + \pi Z_j + \frac{1}{s_j}\sum_{i=1}^{s_j} u_{ij} \tag{2.9}$$

where R_j is the total amount of remittances received by household j from all remitting migrants belonging to household j and s_j is the number of migrants who remit in household j . If the number of remitting migrants s_j is either zero or one then the model follows Eq. (2.8). Otherwise the model is defined by Eq. (2.9). Also, since $u_{ij} \sim N(0,\sigma^2)$ then the new error term $e_j = \frac{1}{s_j}\sum_{i=1}^{s_j} u_{ij}$ is not homoskedastic with

$e_j \sim N(0, \sigma_j^2)$. Therefore, Eq. (2.9) defines a heteroskedastic Tobit with a known form of heteroskdeasticity. In fact:

$$Var(e_j) = Var\left(\frac{1}{s_j} \sum_{i=1}^{s_j} u_{ij} \right) = Var\left(\frac{1}{s_j} \left(u_{1j} + u_{2j} + u_{3j} + \ldots + u_{s_j j} \right) \right) \qquad (2.10)$$

Eq. (2.10) holds for all households and can be rewritten as:

$$\frac{1}{s_j} \left(\text{cov}(u_{ij}; u_{ij}) \right) + \frac{1}{s_j} (s_j - 1) \left(\text{cov}(u_{ij}; u_{sj}) \right) = \frac{1}{s_j} \sigma^2 (1 + (s_j - 1)\rho) = \sigma_j^2 \qquad (2.11)$$

where s is a migrant other than migrant i in household j, $\text{cov}(u_{ij}; u_{ij}) = Var(u_{ij}) = \sigma^2$, $\text{cov}(u_{ij}; u_{sj}) = \sigma_j$ and $corr(u_{ij}; u_{sj}) = \dfrac{\text{cov}(u_{ij}; u_{sj})}{std(u_{ij}) * std(u_{sj})} = \rho$. The variance of the new error term is a function of the variance of the original model in Eq. (2.8), the number of remitting migrants within a household and the correlation of the error terms of different remitting migrants who belong to the same receiving household.

The correlation coefficient ρ measures the correlation between u_{ij} and u_{sj}.[5] A positive ρ suggests that if migrant i remits then migrant s also remits and both remittances amounts move in the same direction. This suggests some competition between migrants within the same receiving household. A less aggressive hypothesis proposes that migrants coming from the same receiving household share the same background and behave in a similar manner. If migrant i sees a need to remit then migrant s sees the same need and also remits and the latter is conditional on their

[5] The following condition $\rho > \dfrac{-1}{s_j - 1}$ applies for $s_j \geq 2$ to insure a positive variance.

abilities to remit. A negative ρ implies a negative relationship between the error terms of the remitting migrants in the same household. This indirect connection defines a crowding out effect. The fact that migrant i is remitting discourages other migrants in the same receiving household from remitting. This negative relationship might also represent an ex-ante agreement on the remitting behavior between all migrants within the same receiving household.[6] Both of these cases indicate that remitting decisions among migrants belonging to the same receiving household are interdependent. Finally, if ρ is equal to zero then migrants' decisions to participate in the remitting process are independent.

The coefficients in Eqs. (2.8) and (2.9) α , β and π , are the same as the coefficients in Eq. (2.6) which insure the same interpretation of the results. I estimate the average model using maximum likelihood estimation. The likelihood function $L_j = \sum_{i=1}^{k_j} \ln L_{ij}$ for the average model is the following:

$$\ln L_{ij} = \ln\left[1 - \Phi\left(X'\gamma\right)\right] = \ln\left[1 - \Phi\left(X'\beta * \theta\right)\right] \qquad \text{if } s_j = 0 \quad (2.12)$$

$$\ln L_{ij} = 0.5 * \left[\ln\left(\theta^2\right) - \left(\theta R_{ij} - X'\gamma\right)^2\right] \qquad \text{if } s_j = 1 \quad (2.13)$$

$$\ln L_{ij} = 0.5 * \left[\ln\left(\frac{\theta^2}{h_j + \rho\left(1 - h_j\right)}\right) - \frac{1}{h_j + \rho\left(1 - h_j\right)}\left(\theta R_{ij} - X'\gamma\right)^2\right] \qquad \text{if } s_j > 1 \quad (2.14)$$

[6] A positive correlation coefficient can also signal an ex-ante agreement where migrants have agreed on a remitting schedule.

where $\Phi(.)$ is the standard normal cumulative distribution function and $\gamma = \frac{\beta}{\sigma}; \theta = \frac{1}{\sigma}$.[7] I maximize L_j with respect to $\gamma; \theta$ and ρ. In the following subsection I describe the data.

2.4.3. Descriptive Statistics

Table 2.2 presents a comparison of characteristics between emigrants and native population. Migrant are twice likely to be in their 20s relative to native population. Emigrants tend to be male and more educated and the households they left behind are more likely to reside in urban areas.[8]

Table 2.2
Characteristics of Native and Emigrant Population (percentages)

	Nicaragua 2001	
	Native	Emigrants
Age		
Between 21 and 30	15.2	33.8
Region		
Urban	52.9	71.8
Gender		
Male	49.4	53.2
Education		
Less than 4 Years	63.3	47.6
Proportion Remitting	-	53.6
Mean Years Since Migration	-	5.9
Mean Remittances per Month (U.S. dollars)	-	40.2
Total Sample Size	22,810	897

[7] The likelihood function for the third case ($s_j > 1$) is derived from the likelihood function of the second case ($s_j = 1$) with $\gamma_j = \frac{\beta}{\sigma_j}$; $\theta_j = \frac{1}{\sigma_j}$; $\sigma_j = \sigma\left(h_j + \rho\left(1 - h_j\right)\right)^{0.5}$ and $h_j = \frac{1}{s_j}$.

[8] There is no significant difference in the years of education between different migrants who belong to the same receiving household.

The average number of years since migration is roughly six years. The proportion of migrants remitting is 54% and the mean remittance is around US$ 40 per month.[9] The average amount of remittances is similar in magnitude to what Funkhouser (1995) found.

Table 2.3 presents characteristics of emigrants by destination. The main two destinations for Nicaraguan migrants are Costa Rica and The United States.

Table 2.3
Characteristics of Emigrants by Destination (percentages)

	Nicaragua 2001	
	Developing	Developed
Age		
Between 21 and 30	37.6	25.7
Region		
Urban	64.7	86.8
Gender		
Male	53.5	52.4
Education		
Less than 4 Years	60.9	19.4
Proportion Remitting	47.6	68.0
Mean Years Since Migration	4.8	8.4
Mean Remittances per Month (U.S. dollars)	29.4	50.4
Total Sample Size	609	288

Notes: 1- The destination developing includes the following: Algeria, Argentina, Brazil, China, Colombia, Costa Rica, Cuba, El Salvador, Guatemala, Guinea, Haiti, Honduras, Mexico, Panama and Tunisia. Costa Rica constitutes 86 percent of this sample. 2- The destination developed includes Canada, Greece, Sweden and the United States.

Costa Rica accounts for 58% share of the Nicaraguan emigrants. The United States accounts for 28%. In Table 2.3 I define two main subsets of destinations and include all the developing countries under developing and all the developed countries

[9] I use 13.44 Nicaraguan Cordobas for one 2001 U.S. dollar as an exchange rate from to the Banco Central de Nicaragua.

under developed.[10] Nicaraguan emigrants' characteristics in developing countries are different from those in developed countries for gender composition. Emigrants in developing countries come from different regions, are less educated and tend to be more in their 20s compared to those in developed countries. The highest proportion of remitting is by emigrants in developed countries with a 68%. The proportion of emigrants remitting in developing countries is less than 50%. As expected, the average amount remitted per month is higher for migrants living in developed countries. This number is also higher than the mean of the total sample. This is hardly surprising because in general developed countries offer higher standards of living, higher wages and stronger currency denominations than any other developing country. Living in the U.S. or Canada for example gives emigrants a stronger remitting power which translates into higher levels of remittances.

I also stress on the significant difference between the mean years since migration. One plausible explanation is that countries like the U.S. and Canada signal long term migration intentions due to availability of opportunities and more stable economies.[11]

In the following I restrict the sample size to emigrants older than 13.[12] Table 2.4 describes the proportion of migrants remitting by relationship to the head of the receiving household and by groups of migrants. A large portion of emigrants are the offspring of the head of the household. Only about 5.2% of the emigrants are spouses of

[10] For a complete list of countries please refer to Table 2.3.
[11] Migrants who belong to the same multiple migrant household seem to share the same destination country since 80% of receiving households report all their migrants living in the same country.
[12] I limit the sample of emigrants in the household to those emigrants older than 13 because the minimum age for employment in the two most popular destinations for Nicaraguan emigrants is 15 in Costa Rica (The Costa Rican Constitution and The Labor Code) and 14 in the United States (Fair Labor Standards Act).

Table 2.4
Emigrant Population Aged 14 and up: Proportion Remitting by Relationship to the Head of the Receiving Household and by Group (percentages)

		Proportion Remitting	
Relationship to the Head of the Receiving Household			
If Spouse of the Head of the Household	5.22	72.09	
If Child of the Head of the Household	61.97	62.35	
If Parent of the Head of the Household	3.04	60.00	
If Child in law of the Head of the Household	4.01	51.52	
If Sibling of the of the Household	10.45	46.51	
If Grandchild of the Head of the Household	7.65	39.68	
If Other Relationship to the Head of the Household	3.89	34.38	
If Not Related to the Head of the Household	3.77	58.06	
	100.00		
Emigrant Population by Groups			
Working	80.68	63.55	
Student	8.87	30.14	
Stay at-Home Wife	7.53	46.16	
Other	2.93	12.5	
Sample Size			823

the head of the household. Siblings to the head of the household form approximately 10% of the total number of emigrants. These groups are ranked by the closeness of the relationship between the migrant and the head of the household from closest to farthest. This ranking also coincides with the ranking of the fraction of emigrants remitting except for the last group, not related, where I note a surprising 58% remitting. I suppose either a strong friendship or some investment opportunities behind this high proportion.

Table 2.4 also separates the emigrant population into four subgroups. Approximately 80% of emigrants have a job. Around 64% of the working emigrants send money back home. As expected the proportion of students remitting is 30% much smaller than those migrants working.

In Table 2.5 I discuss the characteristics of the receiving households by number of remitting emigrants per household. Out of 495 households that have at least one migrant living abroad, 41% have at least one migrant remitting. It seems that there is a negative relationship between the number of remitting migrants and the percentage of working head of households. Section 2.5 presents the results.

Table 2.5
Distribution of Receiving Households and Their Characteristics by Number of Sending Emigrants Aged 14 and up (percentages)

Number of Sending Emigrants per Household	Percentage of Households	Mean Years of Education of the Head of the Household	Percentage Residing in Urban Areas	Percentage Working Head of Household
0	36.77	2.67	73.63	74.73
1	41.82	2.91	75.63	61.35
2	14.55	2.98	61.11	55.56
3	4.24	2.19	76.19	47.62
4 or more	2.62	3.15	76.92	46.15
All Households	100.00	2.81	72.73	64.44
Sample Size of Receiving Households				495

2.5. Results

In this section I discuss the set of independent variables that form X and Z in Eq. (2.6). At the remitting decision stage a migrant's individual characteristics play a major role. I include migrants' age, gender, level of schooling, employment status, destination, years living abroad and the relationship to the head of the receiving household. Likewise I expect the receiving household's attributes to have an effect on the migrant's remitting decisions. I include the receiving household area of residence, the labor status and the years of education of the head of the household.

Table 2.6 outline three model specifications with different subset of independent variables for the average model presented in Section 2.4. Column (1) shows the maximum likelihood estimates of a heteroskedastic Tobit on both emigrant and receiving household characteristics. Column (2) includes a set of emigrant's characteristics while column (3) includes the receiving household's characteristics.[13] Migrant's gender, the labor force status, destination and the relationship to the head of the receiving household all significantly affect the remitting behavior. The education level and the labor status of the head of the household also affect the remitting process.[14]

One of the contributions of this paper is quantifying the results. Table 2.7 decomposes the heteroskedastic Tobit coefficients into two effects: a change in the probability of remitting and a percentage change in the amount remitted.

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[13] A list of definitions and descriptive statistics of the variables is in Appendix A. All the independent variables are in discrete form. The dependent variable is the logarithm of monthly remittances measured in 2001 U.S. dollars.

[14] The variables of migrant education and years since migration are defined around their median which is four years. The variable of head of household education is defined around four for comparison purpose with the migrant education variable (the median is three for this variable).

Table 2.6
Maximum Likelihood Estimates for a Heteroskedastic Tobit Average Model of the Amount Remitted by Emigrants Aged 14 and up

	Amount Remitted		
Variables	(1)	(2)	(3)
Intercept	-0.551	-2.18***	1.993***
	(0.648)	(0.533)	(0.424)
Emigrant Characteristics			
1 if Age between 21 and 30	0.387	0.259	-
	(0.269)	(0.271)	
1 if Male	-0.462*	-0.523**	-
	(0.265)	(0.268)	
1 if Education less than 4 Years	-0.327	-0.426	-
	(0.291)	(0.283)	
1 if Years since Migration less than 4	-0.318	-0.279	-
	(0.255)	(0.258)	
1 if Working	2.200***	2.251***	-
	(0.357)	(0.364)	
1 if Emigrant Resides in a Dev. Country	1.273***	1.327***	-
	(0.294)	(0.294)	
1 if Spouse of the Head of the Household	2.032***	2.032***	-
	(0.515)	(0.539)	
1 if Parent of the Head of the Household	1.549**	1.830***	-
	(0.654)	(0.688)	
1 if Child of the Head of the Household	0.866***	0.905***	-
	(0.294)	(0.297)	
Household Characteristics			
1 if Urban Residence	-0.690**	-	-0.305
	(0.284)		(0.286)
1 if Education of HHH less than 4	-0.702**	-	-1.103***
	(0.282)		(0.286)
1 if Head of the Household Working	-0.938***	-	-1.129***
	(0.239)		(1.129)
Log Likelihood	-675.07	-686.14	-725.71
Theta = θ	0.361***	0.355***	0.331***
	(0.013)	(0.012)	(0.009)
Rho = ρ	0.314*	0.392**	0.392**
	(0.168)	(0.180)	(0.172)
Sample	661	661	661

Table 2.7
Summary of The Change in Amount of Remittances and Change in Probability of Remitting Results of Model (1) in Table 2.6

	Average Model	
	Percentage Change in Probability	Percentage Change in Amount
Variables		
Intercept	-7.93	-19.2
Emigrant Characteristics		
1 if Age between 21 and 30	5.57	13.5
1 if Male	-6.64	-16.1
1 if Education less than 4 Years	-4.71	-11.4
1 if Years since Migration less than 4	-4.58	-11.1
1 if Working	31.6	76.8
1 if Emigrant Resides in a Dev. Country	18.3	44.4
1 if Spouse of the Head of the Household	29.2	70.9
1 if Parent of the Head of the Household	22.2	54.1
1 if Child of the Head of the Household	12.4	30.2
Household Characteristics		
1 if Urban Residence	-9.93	-24.1
1 if Education of HHH less than 4	-10.1	-24.5
1 if Head of the Household Working	-13.5	-32.7

Male migrants are less likely to remit. The probability of remitting decreases by around 7% for male migrants. These findings strengthen the belief of gender differences in the remitting behavior. Migrants who have a job are 32% more likely to remit than those who are not working. Also the percentage change in the level of remittances is a large increase of 77% for working migrants. Living in the U.S. or Canada increases both the probability (18%) and the percentage change in the amount of remittances (44%).

The labor status and the destination of the migrant seem to have a significant role in the remitting behavior for Nicaraguans. Together they shape the remitting ability of migrants.

The probability and amount of remittances increase for migrants belonging to the nuclear family. The increase in the probability and the amount is the largest for the migrants who are the spouse or the parent (29% to 22% for the probability and 71% to 54% for the change in the amount) compared to migrants who are the child of the head of the household (12% to 30%). The difference in these magnitudes is most likely explained by the responsibility that spouses and parents share toward the receiving household. Spouses and parents share the responsibility of providing for the receiving household while this responsibility is not that evident for child migrants. Also the large difference of the percent change in the amount between a migrant spouse and a migrant parent strengthens this hypothesis since it also illustrates the difference between the roles of parents and spouses (Menjívar et al., 1998, page 104).

From the household characteristics, the likelihood of remitting and the percentage change in the amount remitted decrease for migrants belonging to a receiving household with a head of household who reports less than four years of education (10% and 25% respectively). The same results apply for receiving households with a working head (14% and 33% respectively). A working head of the receiving household signals a stable source of income and possibly less need for financial help.

The main contribution of the paper is quantifying the interaction among remitters within the same receiving household. Social interactions and decision making are topics

of huge interests for economists. In fact, the literature on the interaction among members of the same household is extensive (see, for example, Becker, 1974; Bergstorm, 1989). However, no paper has extended this literature into the theory of migrant remittance behavior. I measure the remittance behavior between migrants belonging to the same household. The correlation coefficient ρ is positive for all three regressions. This coefficient is significantly different from zero at the 5% significance level and is around 0.39 for two of the three regressions. In order to measure ρ with more precision I re-estimate the average model with fewer controls.

Table 2.8
Maximum Likelihood Estimates for a Heteroskedastic Tobit Average Model of the Amount Remitted by Emigrants Aged 14 and up: Fewer Controls

	A	B	C	D	E	F
Variables						
Intercept	-1.673***	-0.204	0.161	0.056	0.297	0.190
	(0.380)	(0.218)	(0.202)	(0.206)	(0.198)	(0.200)
1 if Working	2.327***					
	(0.369)					
1 if in Dev. Country		1.483***				
		(0.260)				
1 if Parent of HHH			0.942			
			(0.796)			
1 if Spouse of HHH				1.810***		
				(0.532)		
1 if Sibling of HHH					-1.158**	
					(0.468)	
Theta = θ	0.333***	0.329***	0.323***	0.330***	0.325***	0.322***
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Rho = ρ	0.438***	0.338**	0.475***	0.593***	0.505***	0.470***
	(0.160)	(0.162)	(0.169)	(0.196)	(0.175)	(0.170)
Log Likelihood	-718.41	-725.80	-740.08	-735.53	-738.97	-740.90
Sample	661	661	661	661	661	661

Note: 1- * denotes significance at 10% level, ** at 5% level, *** at 1% level. 2- HHH means head of the receiving household 3-Dev. Country refers to developed country.

Table 2.8 present six different specifications. For instance, column A includes the labor status of the migrant while column B represents the average model controlling for migrant's destination.

The correlation coefficient is significant at the 1 percent significance level for five of the six cases and in all these cases the estimates of ρ are greater than the ones presented in Table 2.6. Column F includes no controls and estimates ρ to be around 0.47. I refer to this value as the benchmark value.[15]

The remitting decision of migrant i seems to be directly related to the remitting decision of migrant s taken into consideration that both migrants belong to the same receiving household.[16] One can say that migrants within the same receiving households compete through remittances. If migrant i remit then migrant s remits and remits more. Migrants compete to get the attention of the receiving household.

Another hypothesis proposes that migrants belonging to the same receiving household share the same background and therefore behave in the same manner. For instance, if migrant i sees a need to remit then s sees the same need and also remits. Also one can think of an ex-ante agreement hypothesis between migrants. Migrants agree on a predetermined schedule of remitting.

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[15] Note that this model allows me to calculate the homoskedastic variance of the original model. From Table 2.8 column F I find that θ is equal to 0.322 which means that σ^2 is around 9.64.

[16] Moreover, Tables A.3 to A.4 in Appendix A provide the normal form for a supposed game between migrants within the same receiving household. Again evidence suggests that there is a positive relationship between the migrants remitting decisions in the same receiving household. Close to 80% of migrants who belong to two migrants' receiving households share the same strategy concerning remitting. For households with three and four migrants this number goes down to 46.4% and 55.5% but is still the dominant habit.

The relationship of the migrant to the head of the receiving household is not necessarily the same for all migrants. The difference in the relationship to the head of the household can define a different association with the receiving household and therefore a different approach towards remitting. I test this suggestion by pooling on all migrants who are children of the head of the household. Migrants who are children of the head of the household represent the largest group of emigrants.

Table 2.9
Migrant Remitting Decisions Among Different Samples: Relationship of the Migrant to the Head of the Household, Labor Status and Destination

	Child	Child and Working	Child and living in Costa Rica	Child and living in U.S. or Canada
Variable				
Intercept	0.445**	0.946***	0.161	0.829**
	(0.234)	(0.227)	(0.301)	(0.334)
Theta = θ	0.349***	0.355***	0.360***	0.317***
	(0.012)	(0.014)	(0.017)	(0.017)
Rho = ρ	0.514**	0.254	0.701**	0.459*
	(0.224)	(0.164)	(0.355)	(0.264)
Log Likelihood	-459.94	-395.62	-291.67	-235.54
Sample	408	341	269	191

Note: * denotes significance at 10% level, ** at 5% level, *** at 1% level.

Table 2.9 illustrates four equations with different sub-samples and no controls.[17] The first column includes migrants who are the children of the head of the household. The other columns add more restrictions on the children sample by labor status and destination. The correlation coefficient estimates do not differ much from the benchmark

[17] An attempt was made to classify the relationships between migrants themselves based on the relationship to the head of the receiving household. This attempt leads to inaccurate classifications since I cannot exactly observe the link between multiple migrants.

value except for the migrants who are children and living in Costa Rica. The estimate of ρ captures the highest correlation (0.70) in the remitting decisions among migrants living in Costa Rica and who are siblings. The high correlation estimate might be explained by the fact that many Nicaraguans migrate to Costa Rica to work in the coffee harvest and share the same remitting behavior.

2.6. Conclusion

In recent years remittances have gained international spotlight. Migrant remittances can affect the performance of the economy as a whole and can also impact the behavior at the household level. One way to develop economic policies that take full advantage of these money flows is to understand the remitting behavior.

This paper examines the remitting behavior of Nicaraguans. It presents three contributions: a unique data set, quantifying the correlation of the remitting decisions and calculating the changes in the likelihood and amount of remittances. I use a unique data set where I have information on the sender and the receiver from the same source. I estimate a heteroskedastic Tobit with a known form of heteroskedasticity to capture both the probability of remitting and the levels of remittances. Gender, labor force status and destination of the migrant along with the nuclear family all have significant effects on the remitting behavior. The labor force status and the education level of the head of the receiving household influence the migrant's decision to participate in the remitting behavior.

From policy perspective, it seems that foreign migration policies are likely to have significant effects on remittances to Nicaragua since these policies are likely to

affect the destination of Nicaraguan migrants. Also any economic shocks in the destination countries affect the remittance process in Nicaragua by affecting the labor status of the Nicaraguan migrant. On the other hand, domestic policies that affect the composition of the emigrant pool through gender, receiving household characteristics and even the relationship of the migrant to the head of the household are also likely to affect the amount of remittances sent back to Nicaragua.

In addition, migrants belonging to the same receiving household seem to make decisions concerning remittances in accordance with other migrants in the same household. I find evidence supporting a positive correlation between migrants' remitting decisions. For policy makers this is of great significance. Remittance policies that directly target particular migrants are also expected to affect the remittance decisions of other migrants belonging to the same receiving household. The full effect of such policies can be separated into direct effect through the main policy objective and an indirect effect through the significant correlation between the remitting decisions.

Also, this direct correlation introduces a set of hypotheses on the remitting decisions. Migrants within the same receiving household might be competing, behaving in the same manner based on their shared background or simply implementing an ex-ante agreement. It is not very clear from the results in this paper which model of household behavior is supported (collective versus unitary) (Browning and Chiappori, 1998). Also it is not obvious whether the remitting decisions of migrants belonging to the same receiving household should be modeled as a cooperative process (ex-ante

agreement). More evidence from other data sets is needed in order to investigate this set of hypotheses. This approach forms the next step in this line of research.

CHAPTER III

WHY REMIT? THE CASE OF NICARAGUA

3.1. Introduction

In the last two decades remittances have been on the rise. Official estimates show that remittances averaged around 60 billion U.S. dollars per year in the 1990s (World Bank) and reached 167 billion U.S. dollars in 2005 (World Bank's Global Economic Prospects). Several studies document that remittances already exceed foreign aid and foreign direct investment (FDI) for some developing countries (Connell and Brown, 2004; De Haas, 2006; Heilmann, 2006; Chami et al., 2006). This fact raised questions on whether remittances can be seen as a possible source of growth (Durand et al., 1996; Widgren and Marin, 2002).

Remittances differ from other types of capital flows in three main aspects. First, remittances go directly into the hands of the households in the receiving countries rather than indirectly through private or governmental institutions. Second, capital flows such as FDIs are in general profit driven and therefore are positively related to GDP growth. However, this is not always the case for remittances. Remittances are not always profit driven and can be altruistically motivated. Finally, FDIs tend to be less stable relative to remittances (Orozco, 2002).

Uncovering the reasons for remitting is crucial for policy implication for several reasons. From the original household perspective, the forces behind remittances can shed some light on households' migration strategies (De La Brière et al., 2002). In fact

Hoddinott (1994) stresses that remittances should be incorporated in the model of household migration decisions. Hoddinott also notes that remittances can be part of a long term contract between the head of the original household and the migrating member.

From a macroeconomic look, remittances are thought to be intended to ease the burden of poor economic performance on local recipients (Chami et al., 2005). Therefore altruistically motivated remittances are expected to be countercyclical with income growth and consequently can decrease the scope of the government intervention in recession times. In this particular case, policies built on predictions that remittances behave in the same manner as other types of capital flows might have unanticipated consequences.

The literature on remittances has mostly focused on finding the determinants of remittances. In this paper I present a simple theoretical model of remittance behavior. I consider remittances as unidirectional flows from the migrant in a host country to the original household in the home country which I refer to in this paper as the receiving household. This allows me to consider the reaction of remittances to a bad state outcome on the receiving household. This is the first paper that looks at the response of remittances to shocks that pertain to the receiving household. This is crucial in terms of investigating the remittance behavior since most remittances consider the migrant as a source and the receiving household as the end destination and therefore, they are expected to react to any income shocks at the receiving end. This setup gives two broad motivations for remitting: altruism where migrants simply care about the receiving

household members' welfare and self-interest where migrants remit for investment opportunities that are expected to yield a certain payoff in the future. I test the theoretical predictions of this model using survey data from Nicaragua. I quantify the results of the heteroskedastic Tobit for policy purposes.

Altruism seems to be the main motivation behind the remitting behavior to Nicaragua. Moreover the remitting behavior is not identical across gender. Female migrants seem to behave more altruistically toward the receiving household.

This chapter proceeds as follows. Section 3.2 provides a brief summary of the existing literature. Section 3.3 presents a simple theoretical model of remittance behavior. Section 3.4 introduces the data and explains the estimation method. Section 3.5 includes the results and section 3.6 represents the conclusion.

3.2. Literature Review

Lucas and Stark (1985) discuss several hypotheses for motivations to remit. Three reasons for remitting are presented ranging from pure altruism to pure self-interest spanning a more tempered point of view combining these two extremes. Under pure altruism a migrant derives utility from the utility of those persons at home. A migrant therefore enjoys remitting because this will subsequently increase his utility. Under pure self-interest the migrant's satisfaction depends on self-interest goals that range from inheritance, investments, and the intention of one day returning home. A third possible motive is viewing remittances as part of an arrangement between the migrant and persons at home. This arrangement is seen as a mutually beneficial contract between the two parties.

Agarwal and Horowitz (2002) is one of the first papers that relate the remittance behavior and the motivation behind remitting in a theoretical model. Agarwal and Horowitz set up a two period model taking into consideration the possibility of multiple migrants per household. They solve for the first order conditions of a migrant's expected utility function and define an implicit remittance function for two cases: pure altruism and the insurance motive. The key result lies in the significant effect of the number of other migrants on remittance under altruism. However the number of migrants does not affect average remittance under the risk-sharing case. Agarwal and Horowitz use data for Guyana to test their theoretical predictions. Their empirical findings show significant differences in the remitting process of migrants from multiple and single migrants' households. Their findings support altruism as a main motivation for remitting.

Brown and Poirine (2005) make use of the theory of intergenerational transfers to sketch a two-period informal, intrafamilial loan arrangement to analyze migrants' remittances of Pacific Island migrants in Sydney, Australia. They develop an alternative theory based on parental behavior that lies between strong altruism and self-interest that they refer to as "weak altruism". Their results imply that neither strong altruism nor pure self-interest needs to be used to explain intergenerational transfers in low-income countries. They suggest linking the theory of private intergenerational transfers, the theory of human capital investment to the theory of migrants' remittances when investigating remittance behavior.

In a more recent paper Amuedo-Dorantes and Pozo (2006) stress upon the part of remittances transferred to buy two types of insurance: family-provided and self-provided

insurance. The authors use data on Mexican immigrants to measure income risk and find that increases in the latter raise both the likelihood and the percentage of migrants' earnings remitted for insurance purposes.

All the papers listed above focus on the risk sharing aspect of remitting by investigating the effects of a bad state outcome in the host country on the migrants' remitting behavior. While an income shock in the host country is important in determining the remitting ability of the migrant, remittances are consequences of migration and they are expected to react to shocks in the receiving country. In the following section I present a theoretical model of migrant remitting behavior that allows for a bad state shock on the receiving household.

3.3. Theoretical Model

The goal of this chapter is to derive a hypothesis on the migrant's remitting behavior. In this section I present a variant of the model presented in Agarwal and Horowitz (2002).

The model presented in Agarwal and Horowitz (2002) defines the bad state shock to be migrant specific and therefore originates in the destination country of the migrant. In this chapter I include a bad state shock on the receiving household and investigate the remitting behavior of migrants towards that shock. The main reason behind the placement of the bad state shock is that migration and remittances are to a certain extent related (Hoddinott, 1994). In this regard, exploring the reaction of remittances to an income shock in the receiving household might be crucial for determining the remitting behavior. Moreover, in the theoretical model presented in

Agarwal and Horowitz (2002) migrants expect monetary transfers from the receiving household in case of a bad state outcome in the host country. The authors model the flow of remittances as a two way stream. In this paper I model remittances as unidirectional monetary flows with the origin being the migrants and the final destination being the receiving households.

In effect, the Nicaraguan dataset analyzed in this chapter includes 505 families that have migrants living abroad of which only 16 families send monetary transfers to these migrants. Out of these 16 families, six families also receive remittances from migrants. This last number of families is around 1.1% of the number of the families that have migrants living abroad in the Nicaraguan 2001 survey sample. Table 3.1 presents the characteristics of households and migrants by the level of monetary engagement of the receiving households in the remitting process conditional on having one migrant living abroad. Comparing households that receive remittances in column (B) to households that send remittances in column (C), the main difference is in the location of residence. Households that send remittances tend to reside in urban areas. In addition, differences include the gender composition and labor force status of the head of the household, the destination of the migrant, and the relationship of this migrant to the head of the receiving household. Male and working head of households tend to form the bulk of the receiving households that send remittances abroad. Moreover, it seems that a migrant's move to a developed country requires households in Nicaragua to share the cost of the move. In fact, receiving households that send remittances represented in columns (C) and (D) show larger percentages of migrants living in developed countries

relative to those households that receive remittances and those that do not send or receive. For those households with dual remittances flows, column (D), the striking difference is the location of the residence and the destination of the migrant.

Table 3.1
Characteristics of Receiving Households and Migrants by Remitting Process

	Households that Do Not Receive Nor Send Remittances (A)	Households that Receive Remittances (B)	Households that Send Remittances (C)	Households that Send and Receive Remittances (D)
Receiving Households				
Percent Residing in Urban Areas	73.3	71.8	81.2	100.0
Percentage Head of Household Male	58.3	49.1	60.0	66.6
Percent Head of Household Working	75.0	57.6	86.6	100.0
Mean Age Head of Household	51.6	54.5	50.6	48.5
Mean Years of Education of Head of Household	3.2	2.8	2.8	3.3
Sample	180	309	16	6
Migrants				
Mean Migrant Age	28.0	30.3	29.5	33.1
Mean Migrant Education	6.9	4.5	4.5	4.8
Mean Years of Migration	5.7	6.7	7.4	9.0
Percent Residing in Developed Countries	20.0	36.3	48.6	66.6
Percent Working	62.3	78.5	75.6	94.4
Percent Male	54.2	52.8	51.3	50.0
Sample	260	600	37	18

Note: 1- All the households in this table have at least one migrant living abroad. 2- Developed Countries include Canada, Greece, Sweden and United States.

To summarize, the receiving households that participate in sending remittances have on average notably higher percentages of working head of households, male head of households and younger head of households. Now focusing on only columns (A) and (B) I note that there might be a threshold level of households' characteristics that define

receiving households which do not send or receive versus those that do send monetary transfers to migrants living abroad. The percentages of working head of the household, residing in urban areas and male head of household are indeed higher under column (A) than those in column (B) but still lower than the percentages in column (C). Also the migrants who belong to households in column (C) tend to be living in developed countries.[18]

Additionally, the small number of families who engage in two direction remittances seem to be consistent across low income countries. Agarwal and Horowitz (2002) report a very similar finding for Guyana (1.4%). For the purpose of this chapter I ignore remittances from receiving households because it seems that across developing countries the frequency of two-way remittances is relatively small. In the following subsection I present the theoretical model.

3.3.1. Pure Altruism

Based on the previous section, I assume that migrants do not receive monetary transfers from their original household. This assumption leaves out the specific case of risk-sharing that the literature has extensively modeled but it does follow the empirical evidence more closely (Agarwal and Horowitz, 2002; Amuedo-Dorantes and Pozo, 2006). I build a two period model where a migrant who cares about the welfare of the receiving household has the following utility:

$$U_i = \alpha \log C_{i1} + \beta \log C_{i2} + \delta \log C_H \tag{3.1}$$

[18] The subset of developed countries as a destination for Nicaraguan migrants includes Canada, Greece, Sweden and United States. The countries that did not make it in this sample are Algeria, Argentina, Brazil, China, Colombia, Costa Rica, Cuba, El Salvador, Guatemala, Guinea, Haiti, Honduras, Mexico, Panama and Tunisia. Both samples cover the destination of all the migrants in the Nicaraguan 2001 survey sample.

where α is the weight on migrant i's consumption in period 1 given by C_{i1}, β is the weight on migrant i's consumption in period 2 given by C_{i2} and δ is the weight on C_H, the recipient household consumption. The weights on consumption are positive such as $0 < \alpha$ and $0 < \beta$ and $0 \leq \delta$. The receiving household consumption depends on high income Y_H with probability of π and low income Y_L with probability of $1 - \pi$, with $Y_H - Y_L > 0$. The receiving household consumption also depends on the total remittances received by the household R. The total remittances R can be written as $r_i + kr_{-i}$ where r_i is migrant i's own remittances and, k is the number of other migrants belonging to the same receiving household who remit on average r_{-i}. The altruistic migrant chooses r_i to maximize utility subject to:

$$C_{i1} = Y_{i1} - r_i \tag{3.2}$$

$$C_{i2} = Y_{i2} \tag{3.3}$$

and

$$C_H = \pi Y_H + (1 - \pi) Y_L + r_i + kr_{-i} \tag{3.4}$$

where Y_{i1} is the migrant's income in the first period and r_i is the migrant's remittances. The second period migrant's consumption C_{i2} depends on the migrant's second period income Y_{i2}. The migrant chooses the level of remittances to maximize utility subject to (3.2), (3.3) and (3.4). The first order conditions (FOC) are:

$$\frac{\partial U}{\partial r} = \frac{-\alpha}{Y_{i1} - r_i} + \frac{\delta}{\pi Y_H + (1 - \pi) Y_L + r_i + kr_{-i}} = 0 \tag{3.5}$$

Solving for r_i from Eq. (3.5) I define a remittance function given by:

$$r_i^* = r(Y_{i1}; Y_H; Y_L; k; \pi) \tag{3.6}$$

Eq. (3.6) states that remittances sent by migrant i depends on the migrant's first period income, the receiving household income, the number of other migrants belonging to the same receiving household, and the probability of a good state in the receiving country. Using the implicit function theorem, I derive two hypotheses on migrants' remitting behavior[19]:

$$\frac{\partial r}{\partial k} = -\frac{-\delta C_H^{-2} r_{-i}}{-\alpha C_{i1}^{-2} - \delta C_H^{-2}} < 0 \tag{3.7}$$

$$\frac{\partial r}{\partial \pi} = -\frac{-\delta C_H^{-2}(Y_H - Y_L)}{-\alpha C_{i1}^{-2} - \delta C_H^{-2}} < 0 \tag{3.8}$$

Both derivations represented in Eqs. (3.7) and (3.8) have a negative sign. This suggests that altruistic migrants' remittances respond negatively to both the number of other migrants belonging to the same receiving household and the probability of a good state in their original country. As the number of migrants from the same household increases, the amount of remittances sent by migrant i decreases. Also, as the likelihood of a good state increases it is more likely for an altruistic migrant to decrease remittances sent home. This is consistent with the belief that remittances are often thought to be intended to mitigate the burden of poor economic performance on the receiving household.

[19] The derivations are in Appendix B.

These two hypotheses follow from the altruistic migrant's utility function where the consumption of the receiving household directly enters the migrant utility. For self-interest motivated remitters the utility of the receiving household does not enter the migrant's utility function as explained in more detail in the next subsection.

3.3.2. Self-Interest

In the following I consider the opposite case of pure altruism. For a pure self-interest migrant the receiving household's welfare does not enter the utility function and this is given by $\delta = 0$. Therefore the utility function of a self-interest motivated remitter is:

$$U_i = \alpha \log C_{i1} + \beta \log C_{i2} \tag{3.9}$$

This migrant maximizes utility subject to:

$$C_{i1} = Y_{i1} - r_i \tag{3.10}$$

and

$$C_{i2} = Y_{i2} + g(r_i) \tag{3.11}$$

where for each dollar remitted migrants receive a return on their investment $g(1)$ where $g'(r_i) > 0$ and $g''(r_i) > 0$. Migrant i again chooses r_i to maximize the following utility:

$$U_i = \alpha \log(Y_{i1} - r_i) + \beta \log(Y_{i2} + g(r_i)) \tag{3.12}$$

subject to constraints (3.9) and (3.10). The FOC is the following:

$$\frac{\partial U}{\partial r} = \frac{-\alpha}{Y_{i1} - r_i} + \frac{\beta g'(r_i)}{Y_{i2} - g(r_i)} = 0 \tag{3.13}$$

From Eq. (3.13) and the implicit function theorem it is clear that $\frac{\partial r}{\partial k} = 0$, and $\frac{\partial r}{\partial \pi} = 0$ which suggests that the number of other migrants in the receiving household and the likelihood of a good state have no effect on the amount remitted by a self-interest motivated migrant. These findings follow from the self-interest migrant utility function which does not account for the welfare of any member of the receiving household.

Both cases of remittance behavior discussed above give distinct theoretical predictions that can be empirically tested. In the next section I describe the data and the estimation method.

3.4. Data and Estimation Method

3.4.1. Data

The data set is a national living standards measurement survey (LSMS) administrated in 2001 in Nicaragua. The LSMS was established by the World Bank. This nationally representative survey includes data on several aspects of the household and includes 4191 families in 4001 households[20]. The survey comprises a remittances module where a knowledgeable member of the receiving household in Nicaragua was asked about other household members living abroad. The remittances module includes a total of 897 migrants who belong to 505 families residing in Nicaragua. I have information on the migrants' destination, labor force status, age, gender, education, and years of migration. I also have information on the receiving household. I know the number of migrants who belong to the same household, the labor force status, gender,

[20] In some cases more than one family live in one household. For the migrants sample the number of families is the same as the number of households.

age and education of the head of the receiving household, as well as the residence of the receiving household.

3.4.2. Estimation Method

In order to investigate the migrant's remitting behavior I need to determine the signs of two relationships: remittances r_i and the number of other migrants k and also remittances r_i and the likelihood of a good state π or a bad state $1-\pi$.

The dependent variable r_i is never negative. The level of remittances is zero for a large number of observations which means that the data on remittances are truncated since remittances are unobserved for the migrants that do not participate in the remitting process. In a censored regression model, Eq. (3.6) determines both the probability of remitting and the level of remittances. I consider a remittance Eq. which has remittances by Nicaraguan migrants as a function of individual and household characteristics:

$$r_i = \beta_0 + \beta_1 X_i + \beta_2 Z + u_i \tag{3.14}$$

where X_i includes migrants' individual characteristics, Z refers to the household characteristics and $u_i \sim N(0, \sigma^2)$. The migrants and households characteristics enter the remittances implicit function in Eq. (3.6) through the migrants' and the receiving households' income levels. In the Nicaraguan survey data, I do not observe migrants' income. However I know the migrants' characteristics (age, gender, education, destination, years living abroad and labor force status) and I use those as a proxy for income. In Eq. (3.6) the migrant's first period income Y_{i1} is therefore a function of migrants' characteristics given X_i by $Y_i(X)$. For the receiving household I do observe

the income but for endogeneity reasons I follow the same approach and use the receiving heads of households' characteristics Z to proxy for their income level.

Ordinary least squares (OLS) give biased estimates because of the nature of the dependent variable. The Tobit model uses the same set of covariates to model both the decision to remit and the amount of remittances. However the coefficients on the likelihood of remitting and the amount remitted from a Tobit have the same sign. Following Wooldridge (2003), comparing the results of a standard probit to the Tobit can be an assessment of the suitability of the Tobit model. For comparison reasons I show the results of a standard Probit and compare the signs of the statistically significant coefficients with the signs of the significant coefficients from the Tobit equation.

The Nicaraguan survey data identifies migrants who are remitters but does not identify the exact amount remitted by those migrants. I know the total supply of remittances received by a particular receiving household, the number of migrants living abroad and which of these migrants are remitters and which are not. It seems that this type of data problem is not uncommon. In fact the same problem exists in the Guyanese data explored by Agarwal and Horowitz (2002). To overcome this data limitation I proceed with two different approaches. The first approach is to define what I will refer to hereafter as the average model. I re-write Eq. (3.14) as follows:

$$r_{ij} = \beta_0 + \beta_1 X_{ij} + \beta_2 Z_j + u_{ij} \tag{3.15}$$

where i refers to a specific migrant belonging to the receiving household j. I take the average of Eq. (3.15) by summing over remitters in household j and dividing by the number of remitters s_j. This leads to the following equation:

$$\frac{1}{s_j}\sum_{i=1}^{s_j} r_{ij} = \frac{1}{s_j} R_j = \beta_0 + \beta_1 \frac{1}{s_j}\sum_{i=1}^{s_j} X_{ij} + \beta_2 Z_j + \frac{1}{s_j}\sum_{i=1}^{s_j} u_{ij} \tag{3.16}$$

where R_j is the total supply of remittances to household j. If the number of remitting migrants s_j is either zero or one then the model follows Eq. (3.15). Otherwise the model is defined by Eq. (3.16). Note that the coefficients in Eqs. (3.14), (3.15) and (3.16) are the same which insures the same interpretation of the results. Note that since $u_{ij} \sim N(0,\sigma^2)$ then the new error term $\frac{1}{s_j}\sum_{i=1}^{s_j} u_{ij}$ is not homoskedastic with $\frac{1}{s_j}\sum_{i=1}^{s_j} u_{ij} \sim N(0,\sigma_j^2)$. Therefore, Eq. (3.16) defines a heteroskedastic Tobit with a known form of heteroskdeasticity. In fact:

$$Var\left(\frac{1}{s_j}\sum_{i=1}^{s_j} u_{ij}\right) = Var\left(\frac{1}{s_j}\left(u_{1j} + u_{2j} + u_{3j} + \ldots + u_{s_j j}\right)\right) \tag{3.17}$$

Eq. (3.17) can be rewritten as:

$$Var(\frac{1}{s_j}\sum_{i=1}^{s_j} u_{ij}) = \frac{1}{s_j}\sigma^2(1 + (s_j - 1)\rho) = \sigma_j^2 \tag{3.18}$$

where s is a migrant other than migrant i in household j, $\text{cov}(u_{ij};u_{ij}) = Var(u_{ij}) = \sigma^2$, $\text{cov}(u_{ij};u_{sj}) = \sigma_j$ and $corr(u_{ij};u_{sj}) = \frac{\text{cov}(u_{ij};u_{sj})}{std(u_{ij}) * std(u_{sj})} = \rho$. The variance of the new error term is a function of the variance of the original model in Eq. (3.8), the number of remitting migrants within the receiving household and the correlation of the error terms

of different remitting migrants who belong to the same receiving household.[21] Finally I estimate the average model using maximum likelihood estimation.[22]

The second approach is to limit the sample to those migrants belonging to households with at most one remitting migrant. For each of those migrants I can exactly identify the amount remitted. I count 387 households in that category which constitutes around 78% of the 494 receiving households. The new migrant sample is 555 which represent around 62% of the original 897 migrants. However, there is some concern regarding selectivity bias. Households with at most one remitting migrant probably share unobserved characteristics that make them form a non random sample. The selection issue comes into play in forming the limited sample: households with at most one remitting migrant. In order to overcome this issue I follow Heckman (1979). The next section discusses the selection bias problem in more details. In addition, section 5 elaborates more on the data and presents the results of these two approaches.

3.5. Results

To explore the remittance behavior of Nicaraguan migrants I need to investigate the relationship between r_i and k, and between r_i and π. However before going into the results I examine the data in more detail. Table 3.2 examines the characteristics of the receiving households by number of other migrants. Table 3.2 searches for any possible relationship between the number of other migrants and receiving household

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[21] This condition $\rho > \frac{-1}{s_j - 1}$ is necessary when $s_j \geq 2$ to guarantee a positive variance.

[22] More details on the likelihood function of the average model are presented in Appendix B.

characteristics that might play a role in the sign of the coefficient on k. There is no clear pattern that can be inferred from Table 3.2.

Table 3.2
Characteristics of Receiving Households by Number of Other Migrants k

k	Percentage Residing in Urban Areas	Percentage Working Head of Household	Percentage Head of Household Male	Mean Age Head of Household	Mean Years Education Head of Household	Sample
0	75.3	68.3	49.6	52.7	2.9	300
1	64.7	62.8	58.1	52.4	2.7	105
2	63.4	56.1	58.5	57.8	2.4	41
3	90.9	59.0	59.0	56.8	2.9	22
≥ 4	69.2	46.1	50.0	54.9	2.2	26
All	72.4	64.5	52.6	53.4	2.8	494

The percentage of head of household working seems to be decreasing with the number of other migrants but with three other migrants in the household this number picks up again and then with more than four other migrants it decreases again. Note that the larger the number of other migrants is, the smaller the sample of households is. The other household characteristics do not show any specific pattern.

In order to capture the probability of a good state versus the probability of a bad state I define two different measures. The first proxy is a dummy variable that is one if the head of the receiving household left the last job for a particular set of reasons. In total, fifteen different answers are listed. The question in the Nicaragua survey is not very clear about when the head of the receiving household left their last job. Table 3.3 lists the reasons and the distribution of households by reason. The list does not follow any particular order and the reasons are listed as they appear in the survey. The reasons

that the heads of household mention include liquidation of the enterprise, being fired, retirement plans, end of contract, seasonal work, lack of work, personal duties, school duties, lack of safety at work, harassment in the work place and illness. I presume that leaving for all of the reasons in Table 3.3 except for the following reasons: retirement plan, end of contract and studies (reasons numbered 3, 5 and 12 in Table 3.3) is a measure of bad outcome. I exclude these latter reasons from the construction of the bad outcome measure because they define reasons that could have been expected and therefore the receiving household could have acted upon ahead of time.

Table 3.3
Distribution of Households by Reason of Head of the Household Leaving the Last Job

Reasons	Percentage	Count
1- The enterprise was liquidated	1.8	9
2- You were dismissed	0.6	3
3- Retirement Plan	0.2	1
4- By age	3.6	18
5- End of the contract	1.6	8
6- Agricultural cycle/seasonal work ended	0.2	1
7- You are pensioned off	2.4	12
8- You earned not much money	2.0	10
9- You did not like your job	0.6	3
10- Not much work	0.0	0
11- Family/home duties	4.6	23
12- Studies	0.0	0
13- Insufficient industrial safety	0.4	2
14- Improper treatment or psychological pressures	6.6	33
15- Illness	1.0	5
Sample	25.6	128

A second measure of the likelihood of a bad state is the length of time that the head of household has been without work. Out of 494 heads of household 128 have been looking for a job for at least one day. From Table 3.4, 101 heads of household out of 128

have been looking for a job for at least one year. I construct a dummy variable for those households that have been looking for a job for more than one year. I chose the longest search time (the other choices are days, weeks and months) since a long period of time better tests the remitting behavior of migrants. It also signals a worse financial situation for the households relative to the other search periods.

Table 3.4
Distribution of Households by Length of Job Search

Time Spent looking for a Job	Percentage	Count
Days	0.7	1
Weeks	0.7	1
Months	19.5	25
Years	78.9	101
Sample	25.6	128

Note that both proxies define two different income levels for the receiving household. If the head of the household is unemployed or has been looking for a job for more than a year, then, in either case, the total income level of the receiving household must be different from the total household income in the opposite situation.

Table 3.5 presents the characteristics of households by measure of bad state and the characteristics of those households not affected by a bad state shock. For both measures the majorities of households are located in urban areas and have a female head of household. The mean age of the head of the household is around 60 years old. Those households not affected reside in relatively more rural areas than those affected and also have a majority of male head of households.

Table 3.5
Characteristics of Receiving Households by Measures of Bad State versus Unaffected Households

Measure of Bad State	Percentage Residing in Urban Areas	Percentage Head of Household Male	Mean Age Head of Household	Mean Years of Education Head of Household
Left Last Job (Sample: 128)	82.8	38.2	60.1	2.6
More than 1 Year looking for a Job (Sample: 101)	84.1	31.6	61.8	2.5
Not Affected (Sample: 366)	68.8	57.6	51.0	2.8

Table 3.6 shows the characteristics of the pool of migrants who originated from non-affected head of households, from head of households who left their job for one of the 15 reasons in Table 3.3 and those head of households who have been looking for a job for at least one year. Table 3.6 investigates any differences in migrants' characteristics that determine migrants' income Y_i. The only striking difference is the gender composition of the migrants' population. More than 50% of the migrant population from unaffected households is male whereas more than 50% of migrants from affected households are females.

From the theoretical model in Section 3.3 the characteristics of the head of the receiving household and of the migrants determine their respective income levels. Eq. (3.14) includes migrants and household characteristics. Migrant's individual characteristics play a major role in the remitting decision. I control for age, level of schooling, gender, destination, years since migration and employment status of the

migrant. These characteristics affect the migrant's ability to remit. Moreover, I control for the head of the household education level, age, gender, the receiving household area of residence and the number of household nonmigrating members. The main two covariates in the theoretical model, the number of other migrants and the measure of bad state are also considered household characteristics.

Table 3.6
Migrants' Characteristics by Measures of Bad State versus Unaffected Households

Characteristics	Head of Household Not Affected	Head of Household Left Last Job	Head of Household More than 1 Year looking for a Job
Male	56.3	44.58	44.1
Working	74.6	73.9	76.9
Residing in a Developed Country	30.9	33.7	35.3
Mean Age	28.9	30.1	31.3
Mean Education	3.6	3.9	3.9
Sample	623	249	195

Note*:* 1- Male, Working and Residing in a Developed Country are percentages. 2- Developed Country destination includes the United States, Canada, Greece and Sweden.

Before going into the results I investigate the selection bias problem in more details. Table 3.7 compares the households and migrants' characteristics across two different samples: the limited sample, which includes migrants who belong to households with at most one remitting migrant, and the total migrant sample. All characteristics between these two samples seem to match suggesting that the limited sample is a reliable representation of the total migrant population. The only significant discrepancy is the percentage of migrants living in developed countries. For the limited sample, the percentage of migrant living in developed countries is 25% while for the

Table 3.7
Characteristics of Receiving Households and Migrants for Households with at most One Remitting Migrant (Limited Sample) versus Full Migrant Sample

	Households with at Most One Remitting Migrant	Full Migrant Sample
Receiving Households		
Percent Residing in Urban Areas	0.74	0.72
Percentage Head of Household Male	0.51	0.52
Percent Head of Household Working	0.67	0.64
Mean Age Head of Household	52.8	53.4
Mean Years of Education of Head of Household	2.8	2.6
Sample	387	494
Migrants		
Mean Migrant Age	28.5	29.3
Mean Migrant Education	3.4	3.7
Mean Years of Migration	5.7	6.0
Percent Residing in Developed Countries	0.25	0.31
Percent Working	0.70	0.74
Percent Male	0.52	0.53
Sample	555	872

Note: 1- All the households in this table have at least one migrant living abroad. 2- Developed Countries include Canada, Greece, Sweden and United States.

total sample it is around 31%. However, since unobservable factors can affect the membership to the limited sample I investigate what variables can help determine the association with this sample.

Table 3.8 compares the relationship of the migrant to the head of the receiving household for three samples: limited sample, the remaining migrants not belonging to the limited sample and total migrant sample. The first column in Table 3.8 is notably different from both columns (2) and (3). It seems that migrants forming the limited sample are more likely to be spouses and parents to the head of the receiving household

than the migrants belonging to the other two samples. The migrants forming the limited sample are less likely to be the child of the head of the receiving household relative to the other two migrant samples.

Table 3.8
Relationship of the Migrant to the Head of the Receiving Household for Households with at most One Remitting Migrant, Full Migrant Sample and the Remaining Sample

	Limited Sample	Not in Limited Sample	Full Sample
Relationship of the Migrant to the Head of the Receiving Household			
Percentage if Spouse	5.9	2.5	4.7
Percentage if Parent	3.4	1.8	2.8
Percentage if Child	55.6	65.2	59.1
Sample	555	317	872

Note: 1- All the households in this table have at least one migrant living abroad. 2- Developed Countries include Canada, Greece, Sweden and United States.

I proceed with spouse and parent as the variables defining membership to the limited sample to correct for selection bias. I do that partly because of the differences of the percentages in Table 3.8 and partly because I expect that in the case of being the spouse or the parent of the head of the receiving household chances are that there would be at most one remitting migrant. I also include in the selection equation the labor status, education level, age, gender, destination, years since migration of the migrant and the residence location, education level, age and gender of the head of the receiving household because these characteristics have an effect the ability to remit.[23]

[23] The results of the selection equation (first stage Probit) are in Table B.3 in Appendix B.

Table 3.9
Probit Estimates for Eq. (3.14): All Migrants

	Amount Remitted	
Variables	(1)	(2)
Intercept	-0.5137**	-0.4993**
	(0.2199)	(0.2188)
Number of other Migrants = k	-0.0443*	-0.0434*
	(0.0248)	(0.0247)
Bad State Measure = $1-\pi$	0.1726	0.1041
	(0.1120)	(0.1194)
1 if Working	1.0687***	1.0648***
	(0.1149)	(0.1151)
1 if Education less than 4 Years	-0.206**	-0.2062**
	(0.1022)	(0.1020)
1 if Male	-0.1807*	-0.1834*
	(0.0953)	(0.0954)
1 if Age greater than 29	0.2805***	0.2805***
	(0.1085)	(0.0954)
1 if Destination is Developed Country	0.4598***	0.4572***
	(0.1160)	(0.1157)
1 if Years since Migration greater than 5	-0.0456	-0.0469
	(0.1108)	(0.1106)
1 if Urban Residence	-0.2863**	-0.2806**
	(0.1123)	(0.1122)
1 if Education of HHH less than 4	-0.3084**	-0.3011**
	(0.1216)	(0.1212)
1 if HHH Male	-0.0221	-0.03164
	(0.0957)	(0.0954)
1 if HHH age is greater than 64	0.0696	0.0910
	(0.1060)	(0.1067)
Number of Nonmigrants	0.0436**	0.0434**
	(0.0172)	(0.0171)
Log Likelihood	-506.38	-507.17
Sample	872	872

Note*:* 1- Columns refer to two different measures for the good state probability: column (1) refers to a dummy variable for households where the head had lost the last job for one of the reasons discussed in Table 3.3. Column (2) refers to a dummy variable for those head of households who have been looking for a job for at least one year. 2- HHH refers to head of the receiving household. 3-* denotes significance at 10% level, ** at 5% level, *** at 1% level.

Table 3.9 presents the results of a standard Probit on Eq. (3.14). As mentioned in Section 3.4, I can exactly identify the remitters from the non-remitters and this fact will identify the dependent variable in the Probit equation. I compare the signs of the

statistically significant coefficients in the Probit equation to the signs of the coefficients in the main results presented in Tables 3.10a and 3.10b. All the statistically significant coefficients from the Probit equation and from Tables 3.10a and 3.10b have the same signs. I turn now to the main results.

Table 3.10a presents the results of two proxies of good state following the average model explained in section 3.4. Table 3.10b limits the sample to those receiving households with at most one remitting migrant. In Tables 3.10a and 3.10b column (1) refers to a dummy variable for households where the head had lost the last job for one of the reasons discussed above and column (2) refers to a dummy variable for those head of households who have been looking for a job for at least one year. I control for the budget constraint of the migrant by including age, gender, level of education, labor force status and destination of migrants which implicitly determine migrants' income. I also control for household characteristics as the level of education, the age and gender of the head of the receiving household and the location of the household.

In the average model the variables of interest in this chapter have the sign of the altruistic migrant model. However the coefficient on k is also significant at the 1% significance level. Nicaraguan migrants decrease the amount remitted with the increase of migration in the original household that they belong to. The coefficients on $1-\pi$ match the theoretical predictions of the altruistic model but are not statistically significant under both proxies. Having a job, being a female and living in a developed country increase remittances. Being older than 30 seems to positively affect the remitting decision. The location of the residence of the receiving household also matters.

Table 3.10a
Tobit Estimates for Eq. (3.14) following the Average Model: All Migrants

	Amount Remitted	
Variables	(1)	(2)
Intercept	-0.9169*	-0.8821
	(0.5610)	(0.5586)
Number of other Migrants = k	-0.8700***	-0.8713***
	(0.1071)	(0.1078)
Bad State Measure = $1-\pi$	0.3896	0.3695
	(0.2887)	(0.3143)
1 if Working	2.5565***	2.5498***
	(0.3339)	(0.3344)
1 if Education less than 4 Years	-0.2452	-0.2519
	(0.2706)	(0.2699)
1 if Male	-0.8370***	-0.8404***
	(0.2448)	(0.2497)
1 if Age greater than 29	0.8398***	0.8379***
	(0.2778)	(0.2780)
1 if Destination is Developed Country	1.1550***	1.1574***
	(0.2871)	(0.2876)
1 if Years since Migration greater than 5	-0.1876	-0.1898
	(0.2703)	(0.2702)
1 if Urban Residence	-0.4500*	-0.4528*
	(0.2801)	(0.2806)
1 if Education of HHH less than 4	-0.2080	-0.1915
	(0.2687)	(0.2673)
1 if HHH Male	-0.3634	-0.3650
	(0.2376)	(0.2399)
1 if HHH age is greater than 64	-0.1087	-0.1030
	(0.2939)	(0.2960)
Number of Nonmigrants	0.0508	0.0482
	(0.0407)	(0.0407)
Log Likelihood	-641.29	-641.49
Theta = θ	0.3899***	0.3898***
	(0.0151)	(0.0151)
Rho = ρ	0.6398***	0.6373***
	(0.2109)	(0.2116)
Sample	708	708

Note*:* 1- Columns refer to two different measures for the good state probability: column (1) refers to a dummy variable for households where the head had lost the last job for one of the reasons discussed in Table 3.3. Column (2) refers to a dummy variable for those head of households who have been looking for a job for at least one year. 2-* denotes significance at 10% level, ** at 5% level, *** at 1% level. 3- Robust standard errors are in parentheses.

Table 3.10b presents the results of a sample selection corrected estimation on Eq. (3.14) limiting the sample to migrants belonging to receiving households with at most

one remitting migrant. Similar results to the average model are found in this sample of 555 migrants.

Table 3.10b
Sample Selection Estimates for Eq. (3.14): Households with at Most One Remitting Migrant

	Amount Remitted	
Variables	(1)	(2)
Intercept	1.1499***	1.1617***
	(0.3101)	(0.3109)
Number of other Migrants = k	-0.2568***	-0.2540***
	(0.0378)	(0.0388)
Bad State Measure = $1-\pi$	0.2153	0.1435
	(0.1721)	(0.1912)
1 if Working	0.7901***	0.7926***
	(0.1419)	(0.1415)
1 if Education less than 4 Years	-0.1472	-0.1446
	(0.1484)	(0.1485)
1 if Male	-0.2828**	-0.2866**
	(0.1241)	(-0.1246)
1 if Age greater than 29	0.3843**	0.3808**
	(0.1533)	(0.1537)
1 if Destination is Developed Country	0.6309***	0.6273***
	(0.1849)	(0.1858)
1 if Years since Migration greater than 5	-0.0510	-0.0522
	(0.1522)	(0.1526)
1 if Urban Residence	-0.0918	-0.0776
	(0.1617)	(0.1605)
1 if Education of HHH less than 4	-0.1198	-0.1009
	(0.1866)	(0.1868)
1 if HHH Male	-0.2720**	-0.2898**
	(0.1345)	(0.1347)
1 if HHH age is greater than 64	0.1323	0.1458
	(0.1784)	(0.1861)
Number of Nonmigrants	0.0173	0.0154
	(0.0244)	(0.0243)
Log Likelihood	-1516.47	-1517.04
Sigma = σ	1.4529	1.4544
Lambda = λ	-0.4866***	-0.4871***
Sample	555	555

Note*:* 1- Columns refer to two different measures for the good state probability: column (1) refers to a dummy variable for households where the head had lost the last job for one of the reasons discussed in Table 3.3. Column (2) refers to a dummy variable for those head of households who have been looking for a job for at least one year. 2-* denotes significance at 10% level, ** at 5% level, *** at 1% level. 3- Robust standard errors are in parentheses.

The signs on k and $1-\pi$ match the theoretical predictions of the altruistic migrant. Again, only the coefficient on k is statistically significant. The other covariates also follow the same pattern as the variables in the average model except now the gender of the head of the household significantly affects remittances.

To summarize, there is some empirical evidence that points to some extent to the theoretical predictions of the altruistic migrant model developed in Section 3.3. Controlling for the migrants' budget constraint and some head of household characteristics, migrants remit less when the number of other migrants increase and they also remit more in case of negative income shock in the receiving household. However, Nicaraguan migrants seem to react more to the number of migrants in their original household in Nicaragua. In both approaches the coefficient on k is negative and significant. The coefficient on $1-\pi$ is positive in all these cases but again not statistically significant. The labor status, destination and gender of the migrant affect the remitting decision and seem to be robust across all three approaches. The receiving household income level also seems to affect the remitting decision since the household income level is determined by the education of the head of the household, the gender of the head of the household and the location of the residence. All these characteristics affect the remitting decision.

Note that the average model computes the correlation coefficient between the error terms of the remitting migrants belonging to the same receiving households. The correlation coefficient ρ is positive, statistically significant and close to 0.63 in value. This positive value suggests that the remitting decision of migrants belonging to the

same receiving household is positively correlated. Also, from Table 10b I calculate the sample selection parameter λ to be around -0.48 and statistically significant suggesting that a sample selection bias does exist in building the limited sample.

For policy purposes, Table 3.11 separates the Tobit coefficients of both variables of interests from the average approach into two effects: a change in the probability of a remitting and a percentage change in the amount remitted. One additional migrant decreases the probability of remittances by no more than 13%. Migrants are 6% more likely to remit in case of a bad state shock. For the amount percentage changes, migrants remit 28% less with one additional migrant and they remit between 13% more in response to a bad income shock.

Table 3.11
Summary of The Change in Amount of Remittances and Change in Probability of Remitting Results for column (1) in Table 3.10a

	Percentage Change in Probability	Percentage Change in Amount
Variables		
Number of other Migrants = k	-13.39	-28.95
Bad State Measure = $1-\pi$	5.99	12.97

This finding raises questions concerning the consequences of the trade-off between migration and per migrant remittances in developing countries. One additional migrant leaving the labor exporting country decreases per migrant remittances by a number close to 13%. This negative relationship might have unanticipated effects on the overall impact of migration and remittance on the original country. For instance, the

finding in Adams and Page (2005) that an increase in both international migration and remittances decrease poverty in developing countries might not hold anymore.

One interesting finding across both approaches is the robustness of the migrant gender variable. In all equations (including the Probit equations) female migrants seem to remit more than male migrants. In the Nicaraguan sample female migrants constitute more than 47% of the total migrants' population. This gender neutrality makes the remitting behavior across gender an interesting topic. Following Vanwey (2004) I further investigate the gender heterogeneity in the migrant behavior. Table 3.12 repeats the same estimation approaches while limiting the sample to male and then female migrants.

Table 3.12
Estimates for Eq. (3.14) with Different Specifications: Male versus Female

	Average Model		Limited Sample	
	Male	Female	Male	Female
Number of other Migrants = k	-1.8871***	-1.1680***	-0.2868***	-0.2178***
	(0.3846)	(0.2200)	(0.0462)	(0.0589)
Bad State Measure = $1-\pi$	0.2501	0.7544**	-0.1093	0.6097**
	(0.3844)	(0.3708)	(0.2160)	(0.2611)
Likelihood	-376.39	-363.94	-787.17	-713.53
Sample	400	370	290	265

Note: 1- The bad state measure is the first proxy used under column (1) in Tables 3.10a and 3.10b. The same results are found using the second measure of the bad state but they are not reported here. 2-* denotes significance at 10% level, ** at 5% level, *** at 1% level. 3- Robust standard errors are in parentheses. 4- All the equations in this table include the same set of covariates in Tables 3.10a and 3.10b.

In all cases the coefficient on the number of other migrants k is negative and significant. However the coefficient on the bad state measure $1-\pi$ is only positive and significant for female migrants. The results seem to point out that male migrant do not

really respond to an income shock at the receiving household. However, female migrants respond to the same income shock and their response falls under the altruistic model predictions. Table 3.12 suggests that female migrants have a different remitting behavior.

3.6. Conclusion

This chapter presents a theoretical model of migrants' remitting behavior. I consider two main motivations towards remitting: altruism and self-interest. This chapter contributes to the remittances literature by investigating the reaction of remittances to a bad state outcome on the receiving household rather than on the migrant. The remittance literature has focused on studying the remittance behavior in regards to a bad outcome shock to the migrant which leads to an ex-ante risk-sharing behavior. In this chapter migrants do not expect monetary transfers from the original households. This assumption is consistent with the data evidence from poor developing countries.

In the theoretical predictions of the model a pure altruistic migrant receives direct satisfaction from the welfare of the original household. The total supply of remittances enters the receiving household consumption function and therefore the migrant’s utility function. On the contrary pure self-interest motivated migrants do not receive satisfaction from the welfare of the receiving household. The theoretical predictions suggest that the number of other migrants who belong to the same receiving household has a negative effect on remittances in the case of altruistically motivated migrants and no effect at all on the self-interest driven migrants. Also the probability of a good state in the receiving country which affects the level of income in the receiving household has a

negative effect on remittances for an altruistic migrant and again no effect for a self-interest motivated migrant.

I test the findings of the theoretical model with data from Nicaragua. I use a 2001 LSMS data and define two proxies for the bad state outcome and find some empirical evidence supporting altruism as a main motivation behind remittances in Nicaragua. The results here are in accord with Agarwal and Horowitz (2002). The number of other migrants belonging to the same household seems to play a crucial role in determining the remittance behavior. I also test the gender heterogeneity of the remitting behavior and find supporting evidence that female migrants seem to behave more altruistically than their male counterparts.

Remittances can be motivated by pure altruism without any economic aspirations but they can also be self motivated in terms of an implicit contract between the original household and the migrant which includes for example inheritance plans. In the former case migrants belonging to the same original household together insure that the original household is not in financial need and therefore an increase in the number of migrants is expected to decrease remittances per migrant. In the latter case there is no clear connection between the number of migrants and remittances since migrants act by self-interest. From policy perspective and in the case of altruistically motivated remittance, to maximize remittances per migrant, labor exporting countries can work on incentives for keeping potential migrants from joining other household members. Therefore sending countries' governments can affect remittances per migrant by targeting potential migrants. These governments need to be aware of the existing trade-off between the

number of migrants belonging to the same receiving household and remittances per migrant. One potential policy interest is to find the optimal k that maximizes remittances per migrant.

Finally, researchers such as Hoddinott (1994) model remittances and migration as a family decision. From that point of view there is some concern regarding the endogeneity of the number of other migrants. This concern raises questions pertaining to the choice of instruments and their validity. This forms the next step in research.

CHAPTER IV

THE EFFECTS OF REMITTANCES ON A SMALL OPEN ECONOMY

4.1. Introduction

Remittances have been on the rise for the last several decades. International estimates of official remittances flows suggest that the total amount of remittances received by developing countries has reached 167 billion U.S. dollars in 2005, up by 73% from 2001 (World Bank's Global Economic Prospects). Moreover, remittances constitute a significant share of some countries' gross domestic product or GDP (Neyapti, 2004; Heilmann, 2006). The apparent increase in remittances may in part be attributed to the rapid growth of money transfer institutions, making the money flows more visible, by decreasing the average transaction cost of remitting. However, another part of the increase in measured remittances is an indication of an actual increase in these monetary flows, and remittance flows have grown from only satisfying basic needs to providing durable goods for the recipient households.

Remittances gain their significance not just from their size but from the potential and actual effects of these money flows on both the society and the individual. Remittances affect labor market decisions, school retention levels, export sector competitiveness, and create moral hazard problems (Funkhouser, 1992; Glytsos, 2002; Edwards and Ureta, 2003; Amuedo-Dorantes and Pozo, 2004; Chami et al., 2005).

The increasing volume of monetary remittances has led to an interest in studying the effects of remittances. Several studies have documented that for several developing

countries total remittances already exceed foreign aid and compete in size with foreign direct investment or FDI (Connell and Brown, 2004; De Haas, 2006; Heilmann, 2006; Chami et al., 2006). While FDI flows are assumed to be profit driven and therefore considered as a source of development, the increase in remittances also has the potential to promote economic growth through higher domestic demand.

Remittances may be motivated by many factors. Lucas and Stark (1985) look at remittances as motivated by either altruism or self-interest. The principal motivation behind remittances may have important implications for the effect of remittances on output in the recipient country. Some researchers believe that altruistically motivated remittances are countercyclical with domestic output; others consider remittances as procyclical with domestic output when they are mainly motivated by self-interest plans.

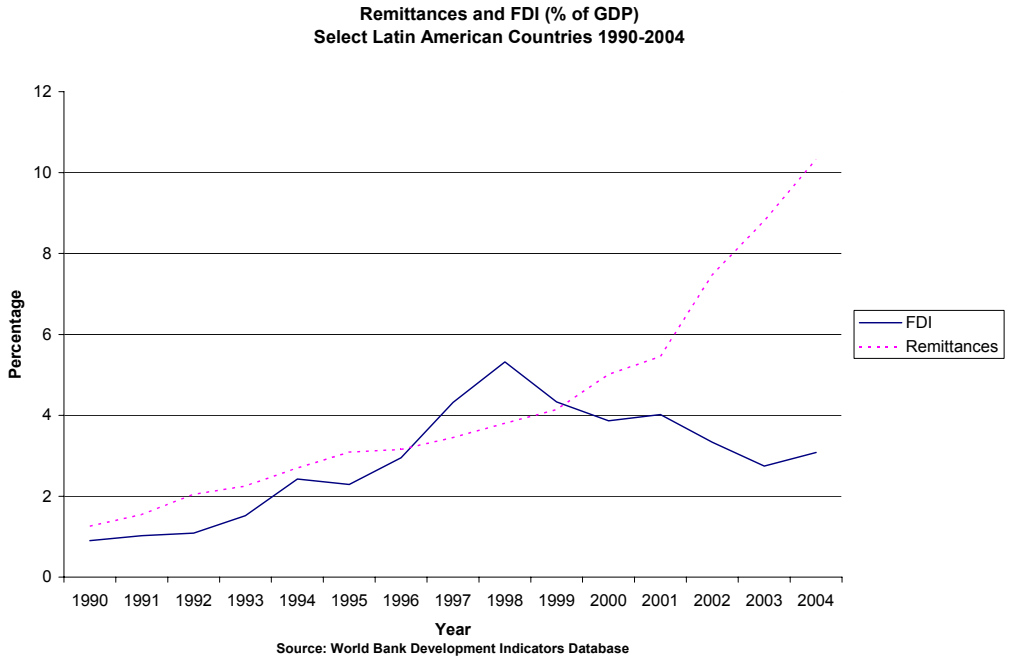


Fig. 4.1. Trends of FDI and Remittances for a sample of Latin American Countries

Fig. 4.1 indicates the increasing importance of remittances in select Latin American countries, comparing remittances and FDI as shares of GDP. The sample includes Bolivia, Brazil, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, and Peru. Remittances have surpassed FDI in magnitude starting in 1999, and remittances have been growing while FDI is shrinking.

Most of the remittance literature focuses on the microeconomic implication of such flows, for the sender or the receiver of these funds. The literature on the macroeconomic impact of remittances on the recipient country is sparse. This chapter explores the impact of remittances flows on output, consumption, interest and exchange rates in the recipient country. In particular, I explicitly model remittances in a small open economy and analyze the impact of shocks to money, remittances and output. I expand a limited participation model that requires that money balances be held to finance certain types of purchases and agents incur adjustment costs on money holdings. These two requirements generate a large and persistent liquidity effect consistent with the stylized facts (Hairault et al., 2004). The impact of the adjustment costs on the predetermined allocation of money cash available for consumption is then analyzed to see how the main real variables of the economy respond to a remittances shock.

One of the contributions of this chapter is the ability to examine the dynamic response of major macroeconomic variables to remittances shock. Another important contribution is the capacity to observe the impact on the main economic variables when I allow for different end uses of remittances, and monetary injections. In fact, many

domestic governments are interested in developing policy tools to direct a portion of remittances towards investment (DeParle, The New York Times Magazine April 22, 2007). I distinguish between the direct effect of remittances on output through investment and the indirect effect through consumption and its multiplier effect. Being able to distinguish the end use of remittances is crucial in looking at the final effect on output in the economy (Burgess and Haksar, 2005; Heilmann, 2006; Sayan, 2006). Finally, this chapter also presents a welfare analysis of remittances shock and investigates how remittances affect the utility of the representative agent.

The remainder of this chapter is organized as follows. Section 4.2 presents a brief summary of the literature review. Section 4.3 formulates a theoretical model. Section 4.4 discusses the results and section 4.5 summarizes and concludes.

4.2. Literature Review

Residents of labor exporting countries receive substantial annual flows of remittances. Countries like India and Mexico each received documented remittances of more than 9 billion U.S. dollars in 2001 (IMF Balance of Payments Yearbook 2001). Fig. C.1 in Appendix C shows that remittances were 40% of GDP in Guatemala by 2004, approaching 15% in Honduras, above 8% in Ecuador, and over 30% in El Salvador. Even in larger economies such as Mexico remittances approached 1% of GDP by 2004. One common characteristic of remittances in all these ten Latin American countries is the continuous increase of remittances relative to GDP. In fact, except for Bolivia and Brazil, remittances seem to show a stable increase in percentage of GDP between 1990 and 2004.

Durand et al. (1996) argue that remittance can stimulate the economic activity both directly through investment and indirectly through consumption. Even if the large percentage of remittances is used for private consumption, some smaller portion is used in productive investment. When applied to large sums of remittances this investment portion may be significant. Furthermore the authors argue that large use of remittances for consumption stimulates the demand for goods and services in the receiving country, leading to increases in production, employment and disposable income.

Widgren and Martin (2002) include remittances with FDI and foreign aid as possible sources of accelerating economic growth, although they warn about the nature of remittances. Remittances are not profit driven and are often thought to be intended to mitigate the burden of poor economic performance on the local recipients. Chami et al. (2005) also suggest that remittances are compensatory in nature, and document a negative correlation between remittances and GDP growth.

Heilmann (2006) argues that remittances differ from other capital flows. Remittances consist of a transfer of ownership between two individuals to increase the recipients' disposable income. Further, remittances are not evenly distributed. Heilmann outlines the case for remittances promoting a sustainable level of development but also warns of potential inflation due to stimulation of internal demand for imports due to remittances.

Chami et al. (2006) develop a stochastic dynamic general equilibrium model that includes government policies to study the implication of remittances for monetary and fiscal policies in the recipient country. They explore the behavior of a subset of real and

nominal variables in remittance-dependent economies and in economies where remittances are not significant. The authors demonstrate that optimal monetary policy will differ between the remittance-dependent economy and an economy with no significant remittances.

The literature seems to present two opposing positions concerning the effects of remittances on the economy of the receiving country (Keely and Tran, 1989; León-Ledesma and Piracha, 2004; De Haas, 2006). On one hand, remittances do increase the standard level of living of receiving households.[24] These flows of funds are spent on consumption, health and education. On the other hand, remittances are mainly spent on consumption and rarely directly invested in productive projects. Remittances increase dependency and may increase economic instability.

In the following section I develop a theoretical model to investigate the effects of remittances on key variables in a small open economy.

4.3. Theoretical Model

This section presents a limited participation model that requires money balances be held to finance certain types of purchases, and agents incur an adjustment cost when altering their money holdings. This model has been used to rationalize a large and persistent liquidity effect. I assume that any monetary shock occurs after households have decided on their deposit balances, and therefore these will generate a liquidity effect. However, this is not sufficient to yield a persistent liquidity effect, so I also introduce an adjustment cost on cash money holdings, M_t^c.

[24] Djajić (1986) and (1998) show that remittances can also increase the welfare of all residents in the labor exporting countries not just those receiving positive amount of remittances.

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

$$\Omega_t = \frac{\xi}{2}\left(\frac{M^c_{t+1}}{M^c_t} - \theta\right)^2 \tag{4.1}$$

Here the long run value of $\frac{M^c_{t+1}}{M^c_t}$ is equal to the parameter θ, so both the level of Ω_t and its derivative with respect to $\frac{M^c_{t+1}}{M^c_t}$ is zero in the steady state. The cost of changing M^c_t is an increasing function of the parameter ξ.

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

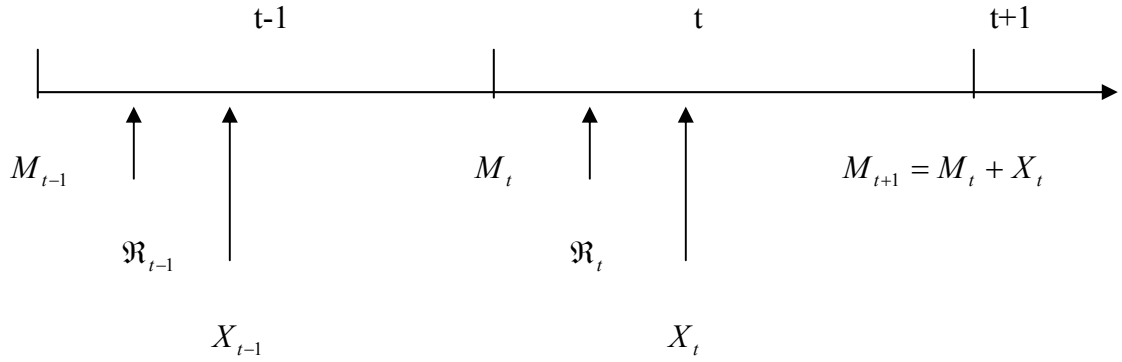
4.3.1. Timing of Decisions

I model a small open economy that includes a representative consumer-household, a goods-producing firm, a central bank, and a financial intermediary. The model takes into consideration markets for goods, labor, loanable funds, foreign assets, and money. Within each period the timing of decisions follows these five stages:

- At the end of period $t-1$ the representative household decides the amount of deposits and also the amount of cash it wants to hold during the next period. When the household chooses these variables, deposits (M_t^b) and cash (M_t^c), it does so taking into account that changing money cash holdings (M_t^c) is costly.
- At the beginning of period t, migrants living abroad remit funds to agents in the small open economy. After observing the remittances flow, the Central Bank decides on a monetary injection in order to achieve its desired level of money in the economy.
- The credit market then opens. Bank deposits are available in quantity M_t^b and the firm determines its demand for capital and labor to produce an internationally identical good. The firm borrows from the financial intermediary to finance the needed investment for production.
- The perfectly competitive goods market then opens, and both production and purchasing decisions are made.
- Finally, the foreign asset market opens at the end of the period, and the representative household makes its decision to purchase or sell foreign assets, with returns given by the exogenous world interest rate. Labor gets paid at this stage, and firms pay off their loans to the financial intermediary. As the household owns the bank and the firm, household receive dividend payments from the bank and firm as part of household income.

I assume that the evolution of money follows the time line presented below, with the flow of remittances ($\Re$) occurring before the Central Bank decides on the monetary

injection (X) necessary to achieve the desired monetary growth (M) of the small open economy. Consequently, the money growth rate is a function of the remittances flow into the economy.



4.3.2. Structure of the Model

The goods market is characterized by perfect competition, as the domestic firms and the rest of the world compete in the production of an identical good, whose price in domestic currency is given by P_t . Therefore the law of one price holds. Letting e_t denote the price of foreign currency in terms of domestic currency, and keeping in mind that the small open economy assumption implies that the price of the good in foreign currency (P^*) and the foreign interest rate (i^*) are exogenous, then purchasing power parity is given by:

$$P_t = e_t P^* \tag{4.2}$$

4.3.2.1. The Household

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

$$\sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \tag{4.3}$$

where C_t is consumption and L_t is leisure hours. I normalize the time endowment to unity, so leisure is given by $L_t = 1 - H_t - \Omega_t$ where H_t is hours worked and Ω_t represents the time spent adjusting money balances. To facilitate calibration of the model I assume a parametric utility function. The per-period utility function is a constant elasticity of substitution (CES) utility as in Christiano (1991), given by

$$U(C_t, L_t) = \frac{\left[C_t^{1-\gamma} L_t^{\gamma}\right]^{1-\sigma}}{1-\sigma} \tag{4.4}$$

where γ is the relative weight of leisure and σ defines the inverse of the intertemporal elasticity of substitution with $\sigma > 0$ and $0 < \gamma < 1$.

When the goods market opens, in the fourth stage, the cash-in-advance (CIA) constraint takes the form:

$$P_t C_t \leq M_t^c + \phi \Re_t + \varphi X_t \tag{4.5}$$

where M_t^c denotes the amount of cash hold by the household for consumption purchases at the beginning of the period, $\Re_t$ is the amount of money received as remittances by the household, and X_t is the amount of money being injected by the central bank. Here ϕ and φ are parameters that take values between 0 and 1, the first one determining the percentage of remittances available for consumption (as opposed to being held as bank deposits) and the second one determining the percentage of the monetary injection available for consumption (as opposed to being first channeled through the financial

intermediary).[25] These parameters allow us to change the channel in which remittances and monetary injections affect the economy, and to see how the end use of remittances and monetary injections matter.

The household can hold foreign assets that yield a risk-free nominal interest rate i^*. In each period the household buys foreign assets B_{t+1} (denominated in the foreign currency). Because these foreign assets are denominated in the foreign currency, the nominal exchange rate becomes a key variable in the portfolio decision of the household.

The household budget constraint is given by:

$$M_{t+1}^c + M_{t+1}^b + e_t B_{t+1} + P_t C_t \le M_t^c + \phi\Re_t + \varphi X_t + P_t w_t H_t + (1+R_t)M_t^b$$

$$+ e_t(1+i_t^*)B_t + D_t^f + D_t^b \qquad (4.6)$$

Thus at time *t* the household determines consumption C_t and labor supply H_t, as well as the amount of money deposited in banks, M_{t+1}^b, the amount of money kept as cash, M_{t+1}^c, and the foreign asset position B_{t+1}. Household income is determined by the real wage w_t, and the profits (or dividends) received at the end of the period from the firm and the bank, D_t^f and D_t^b. The nominal interest rate on deposits is given by R_t.

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

$$V(M_t^c, M_t^b, B_t) = \underset{\{C_t, H_t, M_{t+1}^c, M_{t+1}^b, B_{t+1}\}}{Max} \left\{ U(C_t, 1-H_t-\Omega_t) + \beta \underset{t}{E} V(M_{t+1}^c, M_{t+1}^b, B_{t+1}) \right\}$$

[25] I introduce ϕ to allow for the possibility of policies that induce (force) agents to keep a certain amount of remittances as deposits (increasing funds available for investment) and φ to allow for different channels through which money is injected by the central bank, helicopter drops directly to households or through banks.

subject to the cash-in-advance constraint (4.5) and the budget constraint (4.6). Letting λ_t denote the Lagrangian multiplier associated with the budget constraint, the first order necessary conditions for the household's choice of consumption, labor, money deposits, money-cash holdings, and foreign assets take the form

$$\lambda_t = \beta \underset{t}{E}\left[(1+R_{t+1})\lambda_{t+1}\right] \tag{4.7}$$

$$-U_{H_t} = w_t P_t \lambda_t \tag{4.8}$$

$$e_t \lambda_t = \beta E_t[e_{t+1}(1+i^*)\lambda_{t+1}] \tag{4.9}$$

$$P_t w_t \lambda_t \frac{\xi}{M_t^c}\left(\frac{M_{+1t}^c}{M_t^c} - \theta\right) + \lambda_t = \beta \underset{t}{E}\left[\frac{U_{C_{t+1}}}{P_{t+1}}\right]$$

$$+ \beta \underset{t}{E}\left[P_{t+1} w_{t+1} \lambda_{t+1} \frac{\xi M_{t+2}^c}{(M_{t+1}^c)^2}\left(\frac{M_{t+2}^c}{M_{t+1}^c} - \theta\right)\right] \tag{4.10}$$

Eq. (4.7) requires equality between the costs and benefits of bank deposits, while Eq. (4.8) requires equality between the marginal disutility of working and the marginal benefit – the real wage multiplied by the Lagrange multiplier. Eq. (4.9) requires equality of the current marginal cost of buying foreign assets (in terms of wealth) with the gains in the following period from holding such assets today, and Eq. (4.10) equates the costs and benefits related to the choice made at time *t* of money holdings available for consumption in the following period. It is clear that if the adjustment costs are zero (ξ=0) then Eq. (4.10) will just equate the household's cost of holding money in the current period to the marginal utility of consumption in the following period, properly discounted. However, when adjustment costs exist ($\xi \neq 0$), the household will compare

the cost of changing money holdings (cash) today to the benefits accrued in the next period with respect to the purchasing power of money holdings and the in-advance time saved rearranging the household portfolio.

4.3.2.2. The Firm

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

$$Y_t = e^{z_t} K_t^{\alpha} H_t^{1-\alpha} \tag{4.11}$$

where $\alpha \in [0,1]$ and K is physical capital. The firm's objective is to maximize the discounted stream of dividend payments, where I consider the value of this discounted dividend stream to its owner, the household. Thus the firm's decision trades off paying dividends at the end of the current period versus reinvesting those dividends in physical capital of the firm. The firm receives its profits at the end of the period, so the firm borrows funds from the bank to invest in physical capital at the beginning of the period, with the cost of borrowing given by the nominal interest rate R_t. Consequently, the profits of the firm are given by[26]:

$$D_t^f = P_t Y_t - P_t w_t H_t - P_t (1 + R_t) I_t \tag{4.12}$$

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

$$I_t = K_{t+1} - (1 - \delta) K_t \tag{4.13}$$

where δ is a constant rate of depreciation. The decision about the use of dividends, either payments to households or reinvestment in the firm, is captured by the ratio of the multipliers associated with the budget constraint of the household in the value function

[26] Note that I assume that firms can only borrow for incremental investments, which need to be paid off completely by the end of the period.

(see Eq. (4.7)), as it reflects the consumer's variation in wealth. The value function of the firm is then:

$$V(K_t) = \underset{\{H_t, K_{t+1}\}}{Max} \{D_t^f + E_t\left[\beta \frac{\lambda_{t+1}}{\lambda_t}\right] V(K_{t+1})\} \tag{4.14}$$

Note that the discount factor $\beta \frac{\lambda_{t+1}}{\lambda_t}$ can be written as $[E_t(1+R_{t+1})]^{-1}$, illustrating the fact that the appropriate discount rate is time varying and reflects the market-determined interest rate.

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

$$w_t = (1-\alpha)\frac{Y_t}{H_t} \tag{4.15}$$

$$1 + R_t = \beta E_t\left[\frac{P_{t+1}\lambda_{t+1}}{P_t\lambda_t}\left(\alpha \frac{Y_{t+1}}{K_{t+1}} + (1-\delta)(1+R_{t+1})\right)\right] \tag{4.16}$$

Eq. (4.15) indicates that the cost of hiring an additional worker should equal that worker's marginal productivity, and Eq. (4.16) requires equality between the cost and benefit of the marginal investment.

4.3.2.3. The Central Bank

In each period the economy's monetary authority first observes the remittances flow and then injects a given amount of money into the loanable funds market, X_t. Thus the money stock evolves according to:

$$M_{t+1} = M_t + X_t \tag{4.17}$$

where the Central Bank's money injection is defined as

$$X_t = (\theta_t - 1)M_t \tag{4.18}$$

and where θ_t represents the monetary growth factor, itself possibly a function of the size of the remittances flow. Eq. (4.17) indicates that money growth in the economy depends on the existing stock of money M_t and the monetary injection implemented by the Central Bank X_t.

The monetary growth factor θ_t is allowed to respond to remittances flows (sterilization, etc.) and is written as:

$$\log(\theta_{t+1}) = (1-\rho_\theta)\log(\bar{\theta}) + \rho_\theta \log(\theta_t) + \rho_g \log(g_t) + \varepsilon_{\theta,t+1} \tag{4.19}$$

I also define g_t as the growth factor for remittances, which evolves according to the first order autoregressive process:

$$\log(g_{t+1}) = (1-\rho_g)\log(\bar{g}) + \rho_g \log(g_t) + \varepsilon_{g,t+1} \tag{4.20}$$

and I specify the shock to the production function in its usual form:

$$\log(z_{t+1}) = (1-\rho_z)\log(\bar{z}) + \rho_z \log(z_t) + \varepsilon_{z,t+1} \tag{4.21}$$

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

4.3.2.4. The financial Intermediary

At the beginning of the period, the commercial bank (financial intermediary) receives deposits from the household M_t^b, receives a portion of remittances as deposits,

and receives a portion of the monetary injection from the monetary authority, X_t.[27] These funds are then available for lending to the firm to pay for the firm's investment in physical capital. At the end of the period, the firm repays its loans, and the bank returns deposits to the household along with the appropriate interest payment.

The bank's asset balance is given by:

$$P_t I_t = M_t^b + (1-\phi)\Re_t + (1-\varphi)X_t \tag{4.22}$$

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

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

$$D_t^b = (1+R_t)P_t I_t - (1+R_t)M_t^b - (1+R_t)(1-\phi)\Re_t \tag{4.23}$$

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

$$D_t^b = (1+R_t)(1-\varphi)X_t \tag{4.24}$$

4.3.2.5. Closing the Model

To complete the model specification I combine both Eqs. (7) and (9) to define an uncovered interest rate parity condition (UIP):

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[27] The deposit amount from remittances could be zero if the total amount of remittances received is immediately disbursed to the agent such that it will just add to money-cash available for consumption. The monetary injection X_t is a helicopter drop with the additional condition that (i) can be injected into the financial intermediaries at the beginning of the period, they can lend it out, and then are distributed to the households, together with the earned interest, (ii) can be injected directly to the household for consumption, or (iii) any combination of (i) and (ii).

$$\underset{t}{E}\left[P_{t+1}\lambda_{t+1}\frac{(1+R_{t+1})}{\pi_{t+1}}\right]=\underset{t}{E}\left[P_{t+1}\lambda_{t+1}\frac{e_{t+1}}{e_t}\frac{(1+i^*_{t+1})}{\pi_{t+1}}\right] \tag{4.25}$$

I model a small open economy with international assets freely traded, so a no-arbitrage condition leads to UIP.

Finally to close the model I need a specific form for remittances. I assume that remittances are based on the income of the receiving economy, and I further assume that remittances are negatively correlated with income deviations from the steady state. Thus remittances increase when the receiving country experiences an economic downturn. The specification follows Chami et al. (2006), and is written as:

$$\Re_t = E_t\left[\vartheta P_t\left(\frac{Y^{ss}}{Y_t}\right)^{\tau} e^{g_t}\right] \tag{4.26}$$

A special case of interest would be $\tau = 0$, so that remittances respond only to the domestic price level and the growth rate g. For values of $\tau > 0$ remittances react to the state of the recipient economy. Remittances increase with poor economic performances in the receiving country.

4.3.3. Equilibrium

The system's equilibrium is characterized by the set of prices and quantities:

$$\Omega_t^P = \{w_t, R_t, P_t, e_t\}_{t=0}^{\infty}$$

$$\Omega_t^C = \{C_t, H_t, B_{t+1}, M_{t+1}, M_t^b, \Re_t\}_{t=0}^{\infty}$$

$$\Omega_t^Q = \{Y_t, H_t, K_{t+1}\}_{t=0}^{\infty}$$

and the vector of exogenous foreign variables $\{P^*, i^*\}$. Given these prices and quantities, the set of quantities Ω^C maximizes the household's expected intertemporal utility subject to (4.5) and (4.6), the set of quantities Ω^Q maximizes the profits of the firm subject to (4.11) and (4.14), and the set of prices Ω^P ensures that the labor market, the loanable funds market, and the money market all clear while satisfying purchasing power parity.

Note that the household can hold any quantity of foreign assets that it finds optimal, subject only to its budget constraint. From Eq. (4.6) and market equilibrium I can infer that foreign asset holdings evolve according to:

$$e_t B_{t+1} - e_t(1+i^*)B_t = P_t(Y_t - C_t - I_t) + (1-(1+R_t)(1-\phi))\Re_t \tag{4.28}$$

Eq. (4.28) relates domestic production and absorption to an economy's foreign asset position, giving the balance of payments equilibrium. If a country's production is greater than its absorption, that country has a balance of trade surplus and a negative capital account, so its foreign asset holdings will increase.

The set of equations given by the first order conditions, the market equilibriums, and the laws of motion for physical capital, domestic money supply, foreign assets, and the monetary growth factor constitute a non-linear dynamic stochastic system. The system of equations is presented in the Appendix C together with the log-linearized system following Uhlig's (1999) methodology. To solve this system I calibrate certain basic parameters and find the steady state values of the relevant variables to characterize the long-run equilibrium of the economy.

4.3.4. Calibration and Steady State Equilibrium

The calibration of the standard parameters is based in part on Hairault et al. (2004), supplemented with specific parameters I derive from a sample of countries used for this study: Bolivia, Brazil, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, and Peru.

Table 4.1 lists the values of the basic parameters. The first column includes three parameters that follow standard calibration values. The capital share α is set to 0.36. The subjective discount factor β is set at 0.988, implying a real interest rate equal to 1.2% per quarter. The deprecation rate on capital δ is set to roughly 2.5% per quarter. I set the parameter γ to 0.70, which implies that the representative household devotes 80% of its time endowment to non-working activities. The remaining parameters are derived from data from the sample of ten Latin American countries covering the period 1990 to 2004. The data come from the World Bank's World Development Indicators database. The parameter v represents the average of the trade balance to GDP, and is used to determine the long-run real debt-to-GDP ratio in the steady state calculation. The long run inflation factor is given by π, and is based on the average inflation factor of the countries in my sample. I set the average money growth rate parameter θ to 1.0380 which implies 3.8% inflation per quarter. Remittances are calibrated to be 5% of GDP. The persistence coefficient of the remittance's shock, ρ_g, and the standard deviation of the remittance's innovation, σ_g, are obtained from regressions on the remittance's base of the countries in the sample. Similarly, the persistence coefficient of the monetary

shock, ρ_θ, and the standard deviation of the monetary innovation, σ_θ, are obtained from regressions on the adjusted monetary base of the countries in the sample.[28] Finally, I calibrate the technology shock, persistence and variance, to match the parameters of Chami et al. (2006).

I explicitly consider three values for the adjustment cost parameter ξ. I examine the benchmark case of no adjustment cost, $\xi = 0$ and also the cases of a small but positive adjustment cost, $\xi = 1$ to allow for the liquidity effect and of a larger adjustment cost $\xi = 10$ which represents around four minutes per week of lost time rearranging the portfolio (Karame et al., 2003).

Table 4.1
Model Calibration Values

$\alpha = 0.36$	$\gamma = 0.70$	$g = 1.055$	$\rho_g = 0.5814$	$\sigma_g = 0.022$
$\beta = 0.988$	$\vartheta = 0.0012$	$\theta = 1.038$	$\rho_z = 0.95$	$\sigma_z = 0.007$
$\delta = 0.025$	$\phi = 0.99$	$v = -0.03$	$\rho_\theta = 0.63$	$\sigma_\theta = 0.01558$

The equations are written to describe a stationary system and are presented in Appendix C. Nominal variables are made stationary by dividing them by the lagged domestic price level. The main variables are:

$$m_t = M_t / P_{t-1}; m_t^b = M_t^b / P_{t-1}; \pi_t = P_t / P_{t-1}; b_t = e_{t-1} B_t / P_{t-1}; \Gamma_t = \Re_t / P_{t-1}$$

[28] The relevant monetary base is the country's monetary base minus the monetary inflows of remittances, such that the Central Bank decides on the monetary growth after it sterilizes the monetary inflows.

In order to evaluate the implications of the positive exogenous shock in the limited participation model, different adjustment costs are introduced to observe the behavior of the nominal interest rate, output, nominal exchange rate, and consumption following such shocks, both in terms of impulse response functions as well as in quantitative terms.

4.3.4.1. Steady State Equilibrium

In this section, I outline the calculation of steady state equilibrium values for the remaining variables. Obviously adjustment costs disappear in the steady state, and steady state values do not need time subscripts. In the long-run equilibrium I assume the domestic inflation rate is given by the money growth rate, see Eq. (C.62) in Appendix C, so that $\pi = \theta$.

In the steady state the domestic and foreign inflation levels are the same, so Eq. (C.57) implies that the change in the nominal exchange rate $\Delta e = \frac{e_t}{e_{t-1}}$ is constant and equal to unity. Consequently the uncovered interest rate parity condition implies that the domestic and the foreign interest rates are equal ($R = i^*$). Finally, combining Eqs. (C.52) and (C.54) and, after some manipulation, I have that the domestic nominal interest rate in steady state is

$$R = \frac{\pi}{\beta} - 1$$

I can derive the steady state level of remittances from Eq. (4.26) as

$$\Gamma = \vartheta\pi$$

To find the steady state capital/output ratio (denoted κ) I get, from the stationarity of Eq. (C.61):

$$1+R=\beta\left[\alpha\frac{Y}{K}+(1-\delta)(1+R)\right]$$
$$\frac{1+R}{\beta}-(1-\delta)(1+R)=\alpha\frac{Y}{K}$$
$$\kappa\equiv\frac{K}{Y}=\alpha\left[\frac{\beta}{1+R-(1-\delta)(1+R)\beta}\right]$$

Then from the production function I can solve for the output/labor ratio:

$$\frac{Y}{H}=\kappa^{\frac{\alpha}{1-\alpha}}$$

which can be used in Eq. (C.60) to solve for the real wage:

$$w=(1-\alpha)\frac{Y}{H}$$

Solving for H in Eq. (C.51), and substituting Λ from Eq. (C.54), I can solve for the consumption/output ratio:

$$\frac{C}{Y}=\frac{w\beta}{\pi\gamma}\left[\frac{1}{Y}-\kappa^{-\frac{\alpha}{1-\alpha}}\right]$$

Letting $TB=Y-C-I+(1-(1+R)(1-\phi))\frac{\Gamma}{\pi}$ to be the domestic trade balance, and using the calibration for $v=TB/Y$, I obtain the long-run real debt-to-GDP ratio that is equal to the domestic trade balance as a share of GDP:

$$\frac{b}{Y}\left(1-\frac{1+i^{*}}{\pi}\right)=\frac{TB}{Y}=v$$

This and Eq. (C.64), together with the capital/output ratio, allows us to write the steady state output as:

$$Y = \frac{\left(\left[1 - (1+R)(1-\phi) \right] \vartheta - \dfrac{w\beta(1-\gamma)}{\pi\gamma} \right)}{\left(\nu - 1 - \dfrac{w\beta(1-\gamma)}{\pi\gamma} \kappa^{-\frac{\alpha}{1-\alpha}} + \delta\kappa \right)}$$

Then the steady state physical capital stock will be given by $K = \kappa Y$, and the steady state investment rate will be given by $I = \delta K$.

The steady state stock of foreign assets in real terms is derived from the balance of payments equilibrium (C.64), so the household's stock of foreign assets in real terms is:

$$b = \left(\frac{1}{1 - \dfrac{1+i^*}{\pi}} \right) \nu Y$$

Consequently, the steady state consumption level is given by:

$$C = Y + (1 - (1+R)(1-\phi)) \frac{\Gamma}{\pi} - I - \left(1 - \frac{1+i^*}{\pi} \right) b$$

Given that real money balances is defined by Eq. (C.55), its steady state level is:

$$m = m^b + m^c$$

Combining Eqs. (C.56) and (C.63), the steady state for real money balances is:

$$m = C - \frac{1}{\theta}\Gamma + I$$

Then using (C.56), the household's steady state deposit balances are:

$$m^b = [\pi - (1-\varphi)(\theta-1)]I - (1-\varphi)(\theta-1)C + \left[\frac{(1-\varphi)(\theta-1)}{\theta} - (1-\phi)\right]\Gamma$$

The marginal utility of wealth in the steady state is given by

$$\Lambda = \frac{\beta(1-\gamma)C^{-\gamma-\sigma(1-\gamma)}(1-H)^{\gamma(1-\sigma)}}{\pi}$$

The steady state values of these variables are presented in Table 4.2, under two alternative calibrations of remittances: remittances equal to 5% of GDP, and remittances equal to 10% of GDP.

Table 4.2
Steady State Values

	Remittances 5% GDP	Remittances 10% GDP
Nominal Interest Rate	0.0506	0.0506
Capital/output ratio	2.3062	2.3062
Output	0.3264	0.3140
Remittances	0.0161	0.0322
Capital	0.7529	0.7242
Investment	0.0188	0.0181
Bonds	0.7848	0.7549
Consumption	0.3325	0.3357
Real Money Balances	0.3358	0.3228
Real Money deposits	0.0066	0.0062
Real Money Cash	0.3292	0.3166
Real Wages	1.0240	1.0240
Lambda	0.8588	0.8505
Labor (hours worked)	0.2040	0.1963
Inflation	0.0380	0.0380
Utility	99.5112	99.5208
Trade Balance	-0.0095	-0.0091

The nominal interest rate is 5.06% per quarter in either instance, and the capital output ratio is unaffected by the level of remittances. The inflation rate is only dependent on the steady state money growth rate, and thus independent of the level of remittances. Output is affected somewhat by remittances, and falls almost 4% when remittances rise from 5% to 10%. This occurs because the capital stock and labor hours worked are also about 4% lower. Meanwhile consumption is higher by about 1% which implies that a permanent increase in remittances results in households choosing more leisure while also having more consumption. The representative agent's utility slightly increases suggesting that remittances are beneficial for households. However, remittances do not necessarily lead to an increase in steady state domestic production. Finally, remittances have a positive impact on the trade balance since the trade deficit falls by 4% when the percentage of remittances to GDP is doubled.

4.4. Results

Given the steady states values from the previous section, I analyze the aggregate dynamics of the nominal interest rate, output, the nominal exchange rate, and consumption following expansionary monetary, technological, and remittances shocks. I examine such dynamics under the assumption that remittances depend on the level of output of the receiving economy, thus being endogenously determined. Also, the model with no adjustment costs does not generate the large and persistent liquidity effect observed in the data, therefore I introduce a small but positive adjustment cost ($\xi = 1$) to generate this effect. In addition, I investigate a more realistic adjustment cost ($\xi = 10$)

equivalent to losing four minutes per week rearranging money deposits. A small open economy views foreign variables as constant.

The model presented in this chapter allows a variety of specifications for the percentage of remittances going to consumption and investment, and similarly for the monetary injection. However, the main dynamics can be observed in the baseline specification, with remittances used almost entirely for consumption ($\phi = 0.99$) and the monetary injection going through the financial intermediary for investment ($\varphi = 0$). Therefore, in the interest of a concise exposition, I present only the impulse responses for this case for all three types of shocks, monetary, technology and remittances shocks. Henceforward, I refer to this case as the baseline case. I briefly discuss at the end of each section how different assumptions on the distribution of remittances and monetary injections, between consumption and investment, affect the responses of the main variables studied here.

The results presented below are those assuming that the elasticity of substitution is equal to one. In Section 4.5, I discuss the role of the elasticity of substitution in more details.

4.4.1. Monetary Shock

The impulse response functions presented in this section are those following a 1% increase in the home money growth factor in period 0, under the assumptions described above. Hereafter the cases with no adjustment costs are illustrated with solid lines, the case with the small adjustment cost ($\xi = 1$) is presented with dashed lines, and the case with the larger adjustment cost ($\xi = 10$) is presented with dot lines.

4.4.1.1. Nominal Interest Rate Response

The monetary injection leads to a rise in the nominal interest rate, increasing on impact by 2.5 basis points and peaking on the third quarter with 5 basis points higher than steady state when there is no adjustment cost ($\xi = 0$), which is in accord with the positive response in the typical CIA models. By introducing adjustment costs I am able to generate the observed liquidity effect, with the monetary shock leading to a drop in the interest rate, falling by 14 basis points when the adjustment cost is small ($\xi = 1$) and by 50 basis points when there is a larger adjustment cost ($\xi = 10$). At the time the shock occurs, the increased monetary injection increases the money supply, increasing inflation and putting downward pressure on the nominal interest rate because households cannot withdraw their deposits within the period. This is the liquidity effect, and its persistent effect on the interest rate can be observed below in Fig. 4.2.

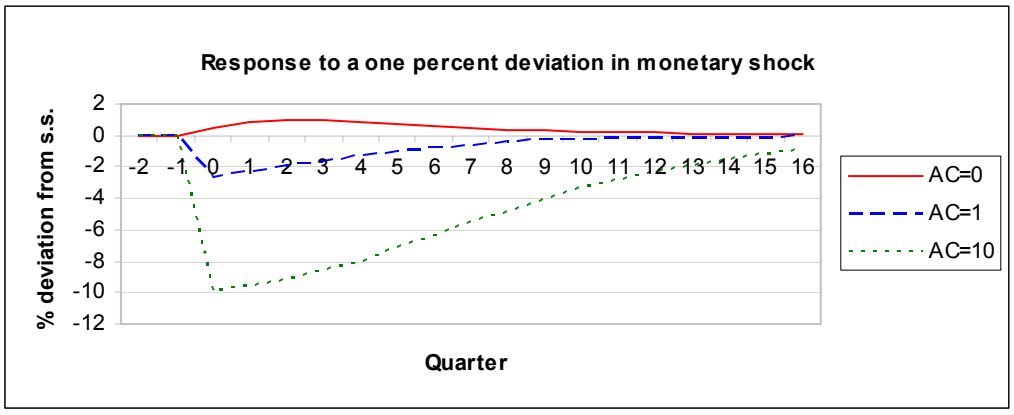


Fig. 4.2. Nominal Interest Rate Dynamics following a Monetary Shock

The monetary shock raises inflation momentarily, which reduces the value of real money balances and induces households to increase their holdings of money cash the following period to satisfy their consumption level, thus reducing its money deposits

(M_{t+1}^{b}). The magnitude of the drop in the interest rate is determined by the cost of money adjustments. However, even if the household reduces its money deposits the following period, the liquidity effect is persistent because firms raise their investment the period of the shock to take advantage of the lower interest rate and in anticipation of the relatively lower money supply that would result from the expected deposit withdrawals. This increased investment results in a larger capital stock, which lowers its marginal productivity, and forces firms to reduce their demand for loans more than the household's reduction of money deposits the following period, maintaining the nominal interest rate below its steady state level and producing a persistent liquidity effect.

4.4.1.2. Output Response

The output dynamics following a monetary shock are in accord with the dynamics observed in the data, but as the adjustment cost increases the recovery in output is stronger and its peak is delayed, with output peaking after three quarters in the case of the smaller adjustment cost and after five quarters in the case of the larger adjustment cost. After an initial decline below its steady state level resulting from the instantaneous fall in labor, the subsequent increase in labor and the increase in the capital stock resulting from the greater investment lead to an increase in output, as shown in Fig. 4.3. The initial fall in output gets larger as a bigger adjustment cost is accounted for.

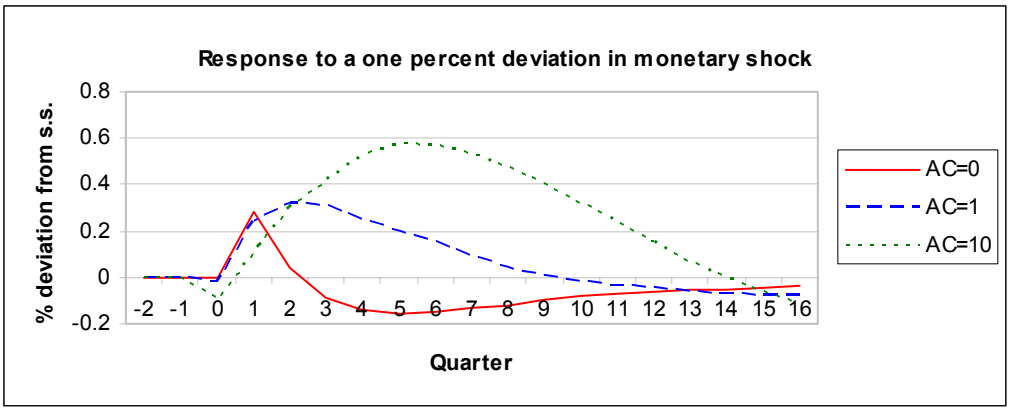


Fig. 4.3. Output Dynamics following a Monetary Shock

The expansionary monetary shock generates a positive wealth effect, which increases leisure in the first period because of the cash-in-advance constraint and adjustment cost of money holdings. However, from the second period onwards, when there are no adjustment costs the increase in real wages induce agents to increase labor above the initial steady state level, which combined with the surge in capital starting from the second period due to the lower cost of investment explains the increase in output in the short run. When adjustment costs are positive and as large as 10, work hours recover more strongly, which together with the surge in investment leads to increase capital the following period, lead to higher levels of output observed in the graph above.

4.4.1.3. Nominal Exchange Rate Response

In the case of no adjustment cost, the monetary injection causes the typical continuous depreciation of the nominal exchange rate. After the introduction of positive adjustment costs, the monetary injection leads to the instantaneous fall in the nominal interest rate, reducing the return on domestic savings, and inducing households to hold

more foreign assets. This leads to an instantaneous depreciation of the nominal exchange rate on impact, depreciating by 3.2% on impact when there is smaller adjustment cost ($\xi = 1$), and by 6.5% when there is the larger adjustment cost ($\xi = 10$). The overshooting of the nominal exchange rate shown in Fig. 4.4 is due to the uncovered interest rate parity (Eq. (4.25)), which requires the interest rate differential to be equal to the expected rate of appreciation, leading to the subsequent appreciation until it reaches its new steady state, as the liquidity effect is expected to be persistent.

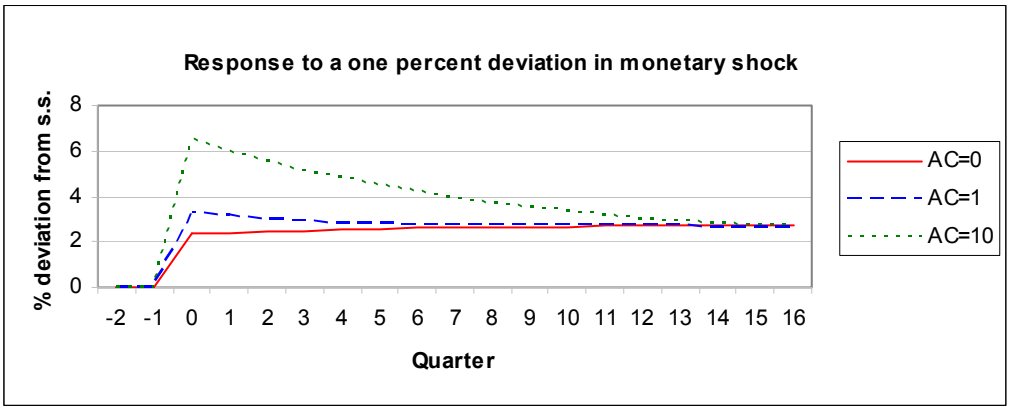


Fig. 4.4. Nominal Exchange Rate Dynamics following a Monetary Shock

The overshooting of the nominal exchange rate is accentuated by the size of the adjustment costs, as it creates a larger and persistent liquidity effect that requires a more accentuated appreciation. In fact, the higher ξ the more limited the withdrawal of private deposits, the farthest the fall in the interest rate, and the larger the initial depreciation of the exchange rate. Also, even if agents respond to the below-steady-state domestic interest rate with a continuously increase in their holdings of foreign bonds, the initial overshooting of the exchange rate is strong enough to allow for the subsequent appreciation, even if the demand for the foreign asset is still rising.

4.4.1.4. Consumption Response

The consumption dynamics following a monetary injection is primarily generated from the inflationary pressure during the period of the shock. Given that the consumption level is determined by the cash-in-advance constraint, and since the amount of money-cash can not be changed during the period of the shock, the inflation generated by the larger money supply reduces consumption instantaneously, mimicking the inverse dynamics of inflation with no adjustment costs, but returning to steady state more monotonically with positive adjustment cost. The consumption dynamics after the shock arises from the rearrangement between money-cash and money deposits. Since agents anticipate inflation, and in order to preserve their consumption in the future, households increase their future amount of nominal money cash the period of the shock (M^c_{t+1}). However, while it is relatively inexpensive to change the ratio $\frac{M^c_{t+1}}{M^c_t}$ when there are no adjustment costs, thus adjusting consumption quickly, this ratio would adjust smoothly when there are adjustment costs, inducing persistence in the adjustment of consumption.

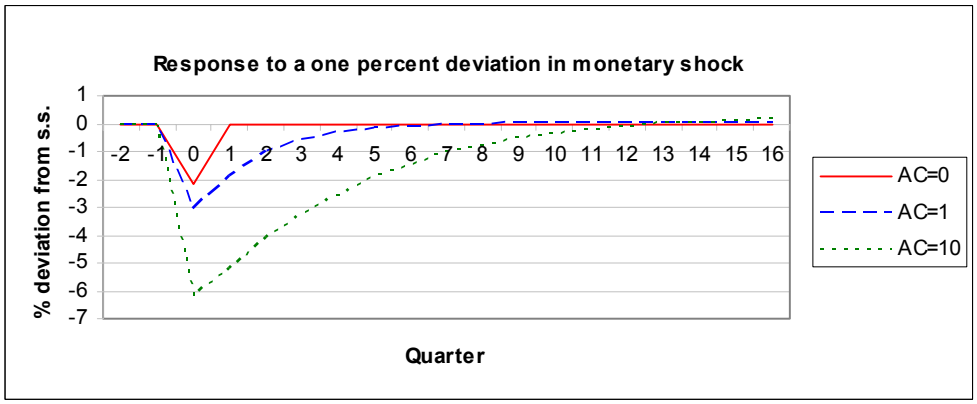


Fig. 4.5. Consumption Dynamics following a Monetary Shock

This model allows considering the influence, if any, of the channel by which remittances first impacts the economy. I can induce remittances to first end up in the hands of households as cash, loosening the cash in advance constraint. I can also direct some portion of remittances to end up in banks as deposits, which in the period of impact will mean additional funding available for bank loans to fund firm investment. However, the impact of a monetary shock is not significant in this modeling choice. The method by which remittances first enter the economy has almost nothing to do with the responses of the economy to a monetary shock.

This model also allows considering the influence, if any, of the channel by which a monetary injection first impacts the economy. I consider monetary injections that are basically helicopter drops on households, loosening the cash in advance constraint, and helicopter drops on banks. As the fraction of a monetary injection that is initially channeled through the financial intermediary is reduced, so that monetary injections directly fall to households and hence impact household consumption, the impulse response functions show very similar patterns that vary only slightly in magnitude but not in qualitative impact or in timing.[29] For example, as the fraction of the monetary injection that goes to the household for consumption increases, the response in the nominal interest rate and the exchange rate overshooting are reduced in magnitude, while the output and consumption responses are also reduced in magnitude, with the

[29] Results are available upon request.

'hump' in the output response also slightly delayed. These smaller dynamic responses also occur if the fraction of remittances available for consumption is reduced.

These results found here are similar to those obtained in related papers (i.e. Hairault et al., 2004; Chari et al., 2001; Christiano and Eichenbaum, 1992).

4.4.2. Technology Shock

I now analyze the behavioral response of the main macroeconomic variables to a positive 1% technology shock using the baseline specification.

4.4.2.1. Nominal Interest Rate Response

The introduction of the technology shock has a direct effect on output, which outweighs the fall in inflation to put upward pressure on the nominal interest rate. On impact, the nominal interest rate increases by 90 basis points when there is no adjustment cost ($\xi = 0$), and increases by 1.16 full point when there is the smaller adjustment cost ($\xi = 1$) and by 1.4 full point in the case of the larger adjustment cost ($\xi = 10$). The increase in output brought about by the technology shock lowers inflation and raises consumption the period of the shock, which fuels an important increase in investment to raise physical capital. This higher demand for loans exerts the pressure to raise the nominal interest rate above its initial steady state level as shown below in Fig. 4.6.

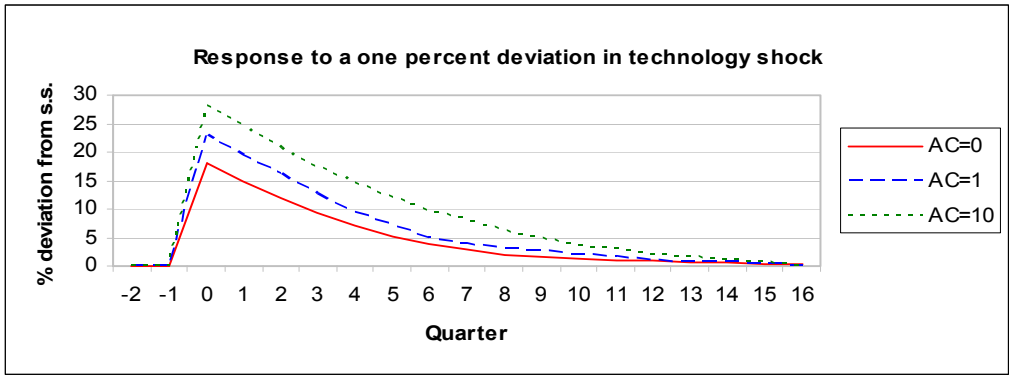


Fig. 4.6. Nominal Interest Rate Dynamics following an Output Shock

The dynamics of the nominal interest rate after the period of the shock is determined by the adjustment of money cash balances. When there is no adjustment cost, the period fallowing the shock is still dominated by the further increase in investment to satisfy the above-steady-state consumption level, and while the rise in inflation contributes to the continuous upward pressure on the interest rate, the larger increase in money deposits exerts a stronger pressure on the opposite direction, forcing the nominal interest rate down. The fall of the interest rate towards its steady state continuous thereafter as investment, inflation, and money deposits returns to their initial steady state levels. These dynamics are also observed for the case of positive adjustment cost, but the nominal interest rate returns to the initial level at a much lower pace, which is mainly do to the much smaller increase in money deposits, whose continuous increase for couple more periods is enough to outweigh the much lower decline in investment.

4.4.2.2. Output Response

The technology shock increases output by almost 1.8% on impact, irrespective of the existence of adjustment costs or not. The positive impact on physical capital is

reinforced by the increase in hours worked fueled by the rise in real wages. Since these two factors are the main determinants of the production function, their rise results in an increase in output that continues for another 10 quarters, peaking at almost 3.5% above the initial steady state level before starting to decline. These subsequent dynamics arise from the continuous increase in both physical capital and hours worked during these quarters, with the increase in physical capital being fueled by the above-steady-state levels of investment and the increase in labor supply being brought about by the direct effect on the real wage.

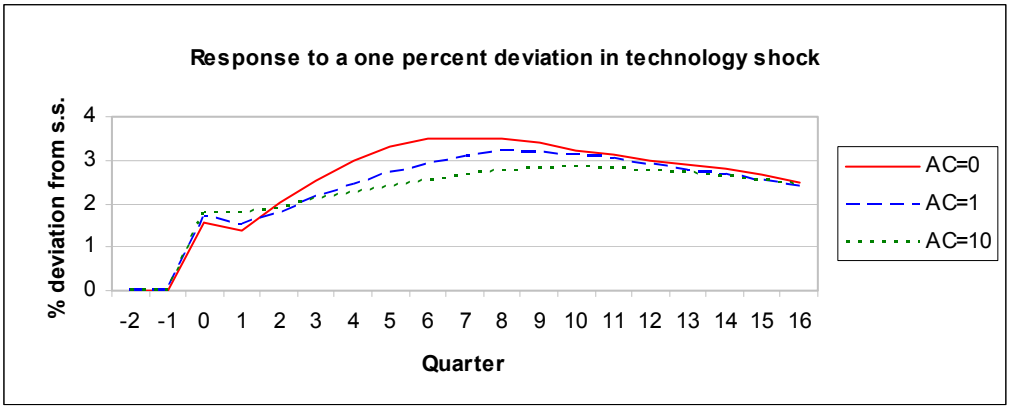


Fig. 4.7. Output Dynamics following an Output Shock

The positive effect on output is in accord with existing analyses of technological shocks, with its long lasting effect being determined by the continuous investment brought about by the large increase in money deposits that outweighs the higher than steady state interest rate.

4.4.2.3. Nominal Exchange Rate Response

The initial nominal exchange rate response to the positive technology shock is determined by the rise of the nominal interest rate, which is only partially neutralized by

the fall in inflation. The nominal exchange rate appreciates by 2.8% on impact when there are no adjustment costs ($\xi = 0$), by 3.5 when there is a small adjustment cost ($\xi = 1$) and by 5.5% when there is a larger adjustment cost ($\xi = 10$), as shown in Fig. 4.8. The overshooting of the exchange rate is governed by the uncovered interest rate parity condition that requires that the interest rate differential is equal to the expected rate of depreciation, which is accentuated when there is a positive adjustment cost. Since the increase in the nominal interest rate is expected to be persistent ($E_t R_{t+1} > 0$), the persistent positive interest rate differential generates the expected further depreciation of the exchange rate ($E_t \hat{e}_{t+1} - \hat{e}_t > 0$).

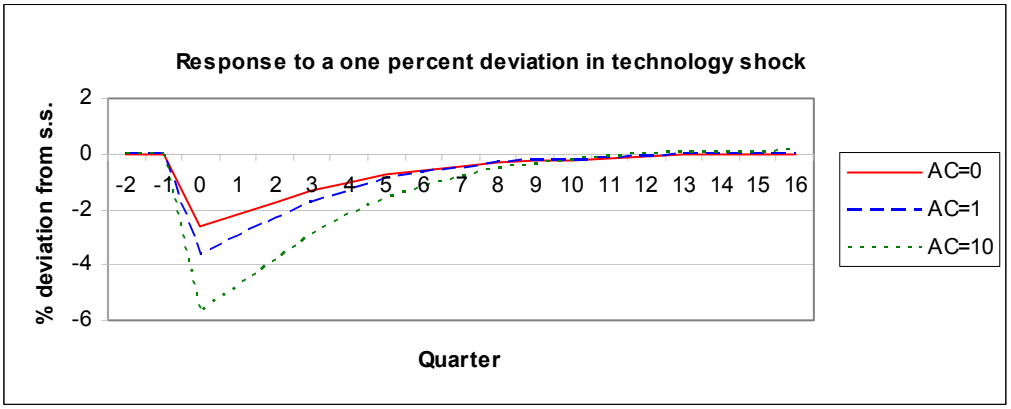


Fig. 4.8. Nominal Exchange Rate Dynamics following an Output Shock

From a balance of payments perspective, the above steady state domestic interest rate induces agents to reduce the holdings of foreign bonds, forcing the initial appreciation in the process. As the domestic interest rate return to its initial level, the rearrangement of foreign bonds gets reversed, with the resulting higher demand for foreign bonds pressuring the nominal exchange rate upwards and producing its continuous depreciation. The higher the adjustment cost the slower return of the nominal

interest rate to its initial level, causing a larger and longer fall in the demand for foreign bonds.

4.4.2.4. Consumption Response

The effect of the positive shock to technology on consumption is primarily determined by the cash-in-advance constraint, which is mainly influenced by the inflation dynamics and the flexibility to adjust the money balances. In the period of the shock, and since the amount of money-cash can not be changed during the period, the fall in inflation is almost fully translated in an increase in consumption, rising by almost 2.7% when there are no adjustment costs, by almost 3.5% when there is a small adjustment cost and by almost 5.5% in the case of the larger adjustment cost. However, the consumption dynamics following the period of the shock are affected by other factors. In the case of no adjustment costs, while consumption drops immediately in response to the rise in inflation to levels above the initial steady state, the downward pressure lowers consumption to a level below the initial steady state. This drop in consumption gets reversed from the second period onwards, as higher money cash holdings get reinforced by the return of inflation to steady state levels, giving way to a monotonic increase in consumption that leads to a higher steady state consumption level.

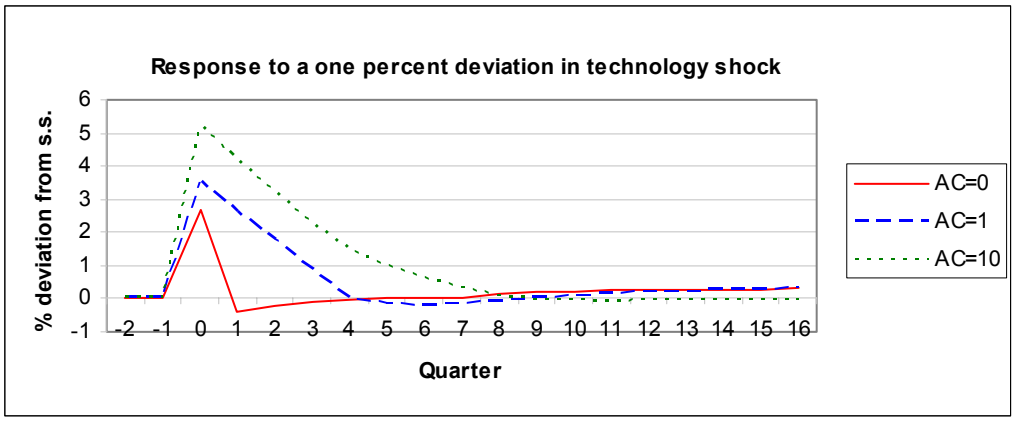


Fig. 4.9. Consumption Dynamics following a Technology Shock

The consumption dynamics following the period of the shock are much more stable when there is a positive adjustment cost, which is clearly expected when the milder adjustment in money balances is taken into account. In this case, while the inflation dynamics are only enhanced, the fact that money cash is brought back to its initial steady state level only slowly allows for levels of consumption above steady state return to the initial steady state at the same rate than money cash. This is why consumption falls only monotonically and slowly in this case.

The effect of the positive technology shock on the model is in accord with the existing literature, with the representative agent being able to increase output and consumption, which raises the domestic nominal interest rate and allows agents to reduce their holdings of foreign bonds at least in the short run, which produces the initial nominal exchange rate appreciation described above. These results are robust to the alternative distributions of remittances and monetary injection, as described in the monetary shock section, and the dynamics are only affected by small changes in magnitude.

4.4.3. Remittances Shock

Since continuous remittances flows can alter the behavior of the representative household, I analyze the behavior of the main macroeconomic variables to a remittances shock. As modeled in Eq. (4.19), the monetary growth factor is assumed to respond to remittances flows, and consequently it is also affected by the remittances shock.

4.4.3.1. Nominal Interest Rate Response

The introduction of a remittances shock also increases the money supply through the monetary growth specification, although to a much lower degree, and consequently also raises inflation momentarily during the period of the shock. This higher inflation produces a continuous depreciation of the nominal exchange rate for no adjustment cost or small adjustment cost, and an overshooting of the nominal exchange rate when the adjustment cost is larger, leading to an increase in the interest rate in the first case and a fall in the interest rate in the second case.

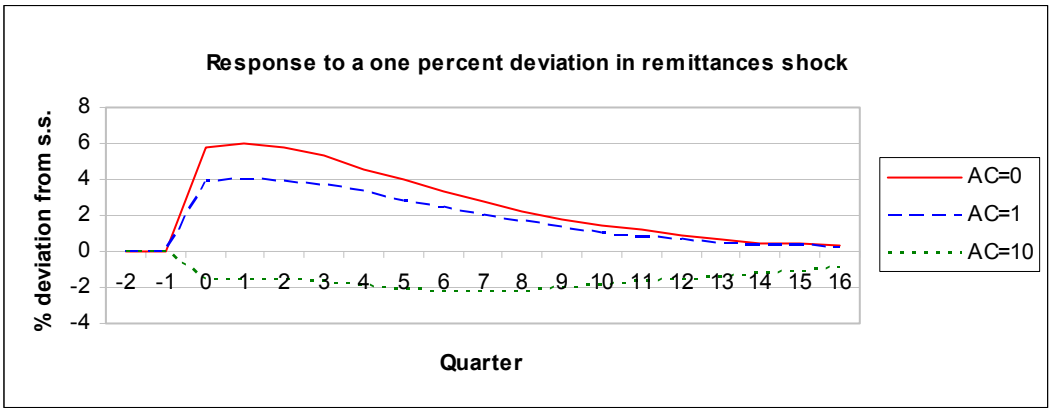


Fig. 4.10. Nominal Interest Rate Dynamics following a Remittances Shock

The dynamics of the nominal interest rate after the period of the shock are governed by the dynamics of investment and money deposits. When there is no

adjustment cost ($\xi = 0$), the recovery in investment combined with the reduction in money deposits in the subsequent period further increases the nominal interest rate. However, as investment continues to return to its steady state level in the following periods, real money deposits recover at a faster pace, thus creating downward pressure on the nominal interest rate that continues from then on. When there is a large positive adjustment cost ($\xi = 10$), the increase in investment in the period following the shock, combined with the reduction in money deposits, exerts a positive pressure on the nominal interest rate, which is counteracted by inflation below steady state, so that the nominal interest rate is almost unchanged from its previous level. It is only when money deposits also start to recover that there is upward pressure on the nominal interest rate. In fact, both investment and money deposits bounce back to levels above their initial steady state four quarters after the remittances shock, and inflation rises slowly back to its steady state level, forcing the interest rate to rise back to its original level monotonically, creating a persistent liquidity effect.

4.4.3.2. Output Response

The remittances shock decreases output irrespective of the existence of magnitude adjustment costs, but its long term dynamics are affected by the adjustment cost. When there is no adjustment costs the remittances shock slightly decreases the real wage in the period of the shock, raising the amount of time spend working, and as the capital stock is fixed, output also increases slightly. However, since labor further declines in the next two periods, as well as the capital stock, output decreases. This decline in labor and capital is only reversed four quarters after the remittances shock,

partly in response to the recovery in the real wage and partly in response to investment above steady state levels, increasing both labor and physical capital, and consequently monotonically raising output.

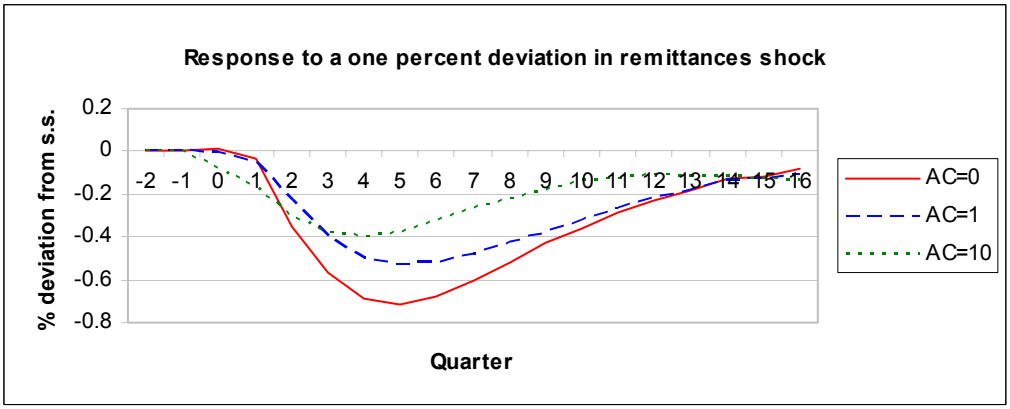


Fig. 4.11. Output Dynamics following a Remittances Shock

When adjustment costs are introduced into the model I observe a slight decrease in output during the period of the shock, which is due to a small fall in labor resulting from the slight increase in the real wage. In fact, as the real wage falls for the next four quarters, labor also falls and combined with the fall in the capital stock, decreases output in the next four quarters and as the real wage and investment recover so does labor and capital allowing the output to recover in the long term. It is worth noting that the initial downward pressure gets relieved as adjustment costs increase which is due to the smaller fall of investment that arises from the higher adjustment costs.

4.4.3.3. Nominal Exchange Rate Response

The initial exchange rate response to a positive remittances shock is mainly determined by the inflationary pressure emanating from the monetary growth factor specification, which leads to a proportional depreciation of the exchange rate on impact.

In particular, the positive 1.7% deviation from steady state in inflation is directly translated in a 1.7% depreciation from steady state in the nominal exchange rate when there are no adjustment costs, while in the case of a positive adjustment cost, a 2.4% deviation from steady state in inflation is directly translated in a 2.4% depreciation from steady state in the nominal exchange rate for the smaller adjustment cost, and a 5.3% deviation from steady state in inflation is directly translated in a 5.3% depreciation from steady state in the nominal exchange rate for the higher adjustment cost. This is shown in Fig. 4.12 below.

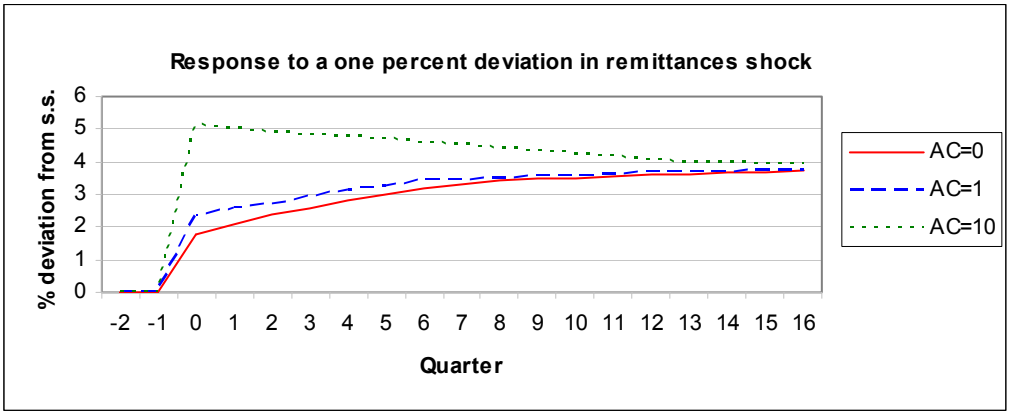


Fig. 4.12. Nominal Exchange Rate Dynamics following a Remittances Shock

Note that while subsequent dynamics are determined by the uncovered interest rate parity condition, they are dependent on the existence of adjustment costs. When there is no or very small adjustment costs ($\xi < 6$) the increase in the nominal interest rate resulting from larger fall in real money deposits is expected to be persistent ($E_t R_{t+1} > 0$), and this persistent positive interest rate differential in counterbalanced by the expected further depreciation of the exchange rate ($E_t \hat{e}_{t+1} - \hat{e}_t > 0$). When I

introduce a larger positive adjustment cost ($\xi = 10$), and with a liquidity effect that is expected to be persistent, the continual negative interest rate differential ($E_t R_{t+1} < 0$) is counterbalanced by the expected appreciation of the nominal exchange rate in this case ($E_t \hat{e}_{t+1} - \hat{e}_t < 0$), given rise to an overshooting of the exchange rate.

The remittances shock induces agents to hold more foreign bonds in both cases, following interest parity condition. With no or small adjustment costs, the initial rise in the domestic interest rate gets outpaced by the return on foreign bonds brought about by the depreciation of the exchange rate, thus inducing agents to increase their holdings of foreign bonds the first few periods after the shock, but then starts to slowly decline as the interest rate returns to its initial level while the exchange rate continues to depreciate at a much slower rate. In the case of the larger positive adjustment costs, the increase in foreign bonds is accentuated by the fall in the domestic interest rate during the period of the shock, but it then decelerates as the domestic interest rate begins to rise while the return on foreign bonds decreases as the exchange rate appreciates.

4.4.3.4. Consumption Response

The consumption dynamics following a remittances shock are primarily generated from the inflationary pressure during the period of the shock, which emanates from the monetary growth factor specification discussed above. Even if remittances are assumed to go in its entirety for consumption ($\phi = 0.99$), the increase in inflation by 1.7% the period of the shock (when there is no adjustment cost) and the fall in real money cash depress consumption by 1.6%, but then it quickly recovers the following period and ends up slightly below the initial steady state level. However, when I

introduce the smaller adjustment cost, the increase in inflation is two times larger, which outweighs the increase in remittances and fall in real money cash, resulting in a fall in consumption of about 2.2% while the increase in inflation is almost three times larger in the case of the larger adjustment cost which from the same pressure makes consumption 5% below its initial steady state level. The dynamics show consumption rising monotonically as a result of the subsequent fall in inflation to below-steady state levels and the recovery in both real money balances and money cash. This recovery is strong enough to pull consumption back to its original steady state, as shown below in Fig. 4.13.

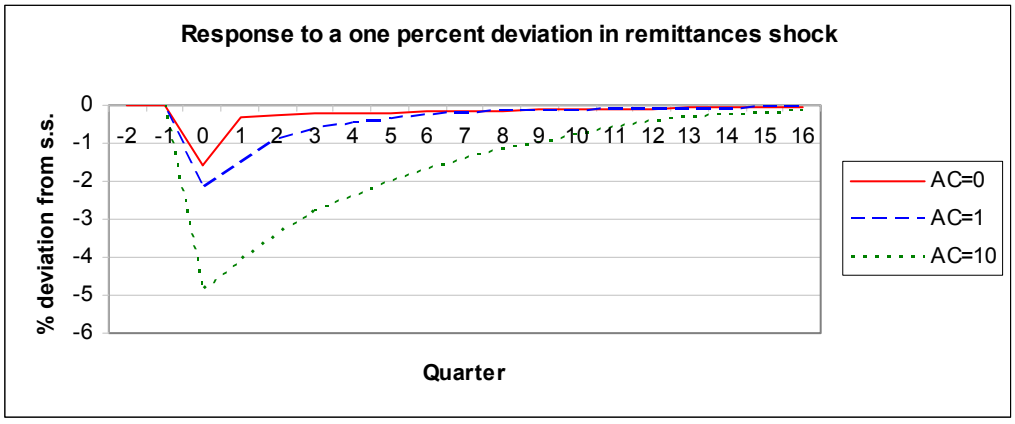


Fig. 4.13. Consumption Dynamics following a Remittances Shock

These dynamics can be explained by the rearrangement of money cash and money deposits. When there are no adjustment costs, the representative household reduces real money cash the period following the remittances shock, enough to outweigh the greater consumption power brought by the remittances shock, but in the following periods it quickly increases money cash holdings while inflation drops, allowing the household to start consuming at levels slightly below the steady state.

When there are adjustment costs, the reduction of real money cash the period following the remittances shock is much larger and outweighs the positive remittances shock. While it then increases monotonically, it stays below its initial steady state for the rest of the periods being investigated, as consumption does.

When the amount of remittances and money injection used for consumption and investment is altered, the resulting dynamics are similar to those reported here, differing only in magnitude.[30] In particular, as I lower the amount of remittances available for consumption, the nominal interest rate response becomes smaller. Output responses also show these dynamics, becoming smaller as I increase the fraction of remittances used for investment. The consumption's dynamic response also becomes smaller, dropping below steady state for a period, but then quickly recovering and staying close to the initial steady state level as I increase the fraction of remittances used for investment, while the nominal exchange rate dynamics after the initial depreciation also slowly turns to a small appreciation as the fraction of remittances used for investment increase. All these dynamic responses are also affected by the size of the adjustment costs, becoming more pronounced as adjustment costs increase but maintaining their qualitatively effects.

To further investigate these relative small responses to various distributions of remittances and monetary injections for consumption and investment, I also allow for remittances to be 10% of GDP, a magnitude that reflects a doubling in importance of remittances in the receiving economy. However, there are no major changes in the

[30] Results are available upon request.

responses of all variables and their dynamics are somewhat stable across different adjustment cost magnitudes.

4.4.4. Welfare Analysis

While the impact of a remittances shock on the main macroeconomic variables of the small open economy provides an adequate understanding of its effect at the macro level, its overall impact on the welfare of the representative agent is still somewhat allusive. In order to obtain the agent's welfare gain from a remittances shock, I now analyze the utility of the representative agent under the previous cases. In the case assuming that remittances are 5% of GDP, the steady state utility is 99.5112 while when remittances are 10% of GDP the steady state utility increases to 99.5208. When I introduce the positive 1% remittances shock utility falls in the period of the shock by 0.005% when there is no adjustment cost, by 0.02% when I introduce the smaller adjustment cost, and by 0.8% when I introduce the larger adjustment cost.[31] However, while utility bounces back in all cases to levels above its initial steady state level, as shown below in Fig. 4.14, the discounted utility with a positive remittances shock never reaches levels above the discounted utility without remittances shock for the time span examined, for all adjustment cost cases.

Nevertheless, when remittances are 5% of GDP, the per period utility rises above the initial utility level after three quarters in the case of no adjustment cost, and peaking after five quarters before starting to decline, but rises and peaks in a level above the initial utility value after one quarter when the adjustment cost is the largest. When

[31] The utility dynamics for the larger positive adjustment cost are available upon request.

remittances are 10% of GDP the per period utility rises above the initial utility level after three quarters in the case of no adjustment cost, and peaking after eight quarters before starting to decline, but rises and peaks in a level above the initial utility value after one quarter when the adjustment cost is the largest.

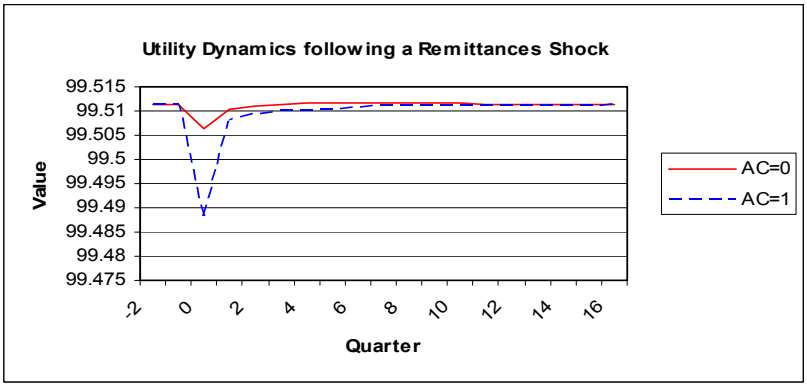
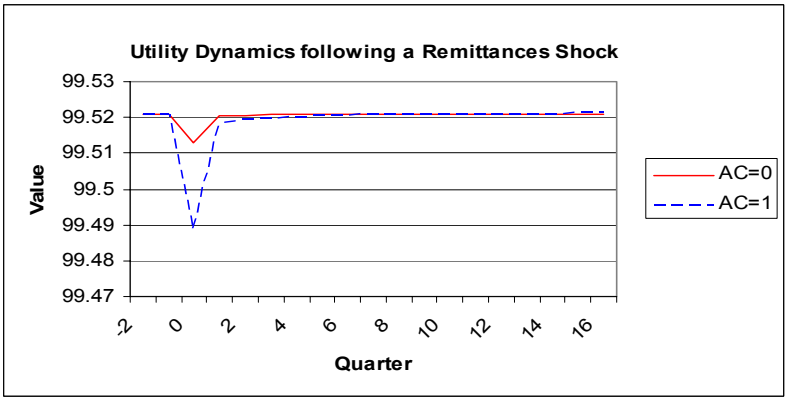
Remittances	
5% of GDP	
10% of GDP	

Fig. 4.14. Utility Dynamics following a Remittances Shock

While in the period of the shock I observe a decrease in utility in all the cases above, utility quickly recovers to levels above steady state, allowing the discounted

utility to recover to levels closer to the discounted utility levels of the small open economy that does not experiences a remittances shock. Also, the impact of the introduction of adjustment costs in the discounted utility deteriorates welfare, irrespective of the share of remittances relative to output. This is expected since it is a restriction in the adjustment of money balances, so agents can not quickly rearrange their consumption portfolio.

4.4.5. Intertemporal Elasticity of Substitution

In the cases discussed above σ is equal to one. However, the results in accord with Christiano (1991) emphasize the importance of the response of worked hours on the output response. For that matter, I discuss the role of the inverse of the intertemporal elasticity of substitution and investigate the cases when $\sigma = 0.5$ and $\sigma = 1.5$.

From Section 4.3.4.1, only the marginal utility of wealth Λ (lambda) depends on σ. Therefore the steady state values in Table 4.2 do not change except for lambda which decreases when σ increases.

As for the aggregate dynamics, when $\sigma = 0.5$ or for that matter $\sigma < 1$ then $U_{H_t C_t} < 0$ suggesting that an increase in consumption decreases the marginal utility of hours worked and therefore hours worked decrease. In this case consumption and hours worked are complements since the cross-price elasticity is negative. When the elasticity of substitution is greater than $\sigma > 1$, consumption and hours worked are substitutes since $U_{H_t C_t} > 0$.

Therefore, in Figs. 4.5 and 4.13 the immediate drop in consumption due to monetary and remittances shocks has different effects on hours worked depending on the

value of σ. Fig. 4.15 shows the response of output to a remittances shock under $\xi = 10$ for both cases $\sigma = 0.5$ and $\sigma = 1.5$. The immediate drop in consumption leads to an instantaneous increase in output following the increase in hours worked (labor) for $\sigma < 1$. In the case of $\sigma > 1$ the drop in consumption leads to an immediate decrease in output following the immediate drop in hours worked. However, the increase in capital in the following quarter outweighs the reduction in labor and causes output to increase.

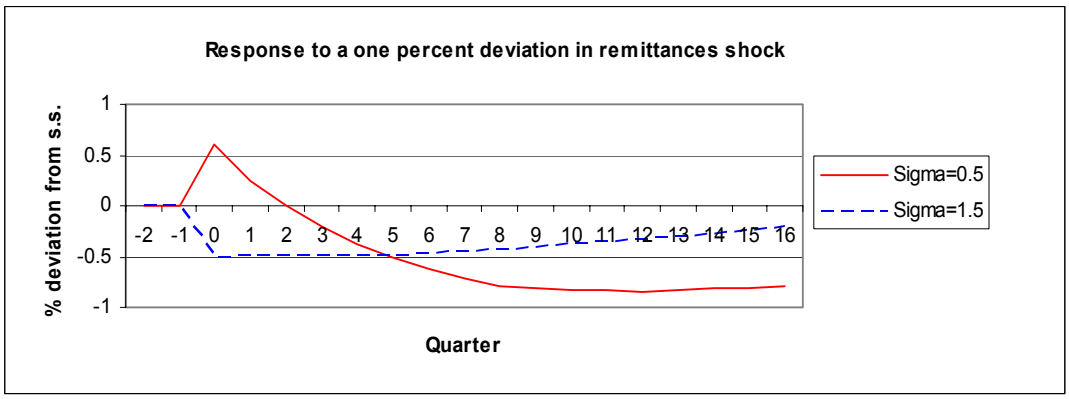


Fig. 4.15. Output Dynamics following a Remittances Shock with $\xi = 10$

This cycle is robust irrespective of the presence and the magnitude of the adjustment cost.

4.5. Conclusion

The limited participation model for a small open economy with remittances explicitly incorporated is able to capture important features from observed empirical responses of economic variables to monetary shocks. In particular, I capture important aspects in the dynamic response of the nominal interest rate, output, the exchange rate, and consumption. The introduction of adjustment costs on money holdings accentuate the persistence of the liquidity effect, and consequently expands the overshooting

dynamics of the nominal exchange rate, both in accord with existing empirical evidence on the result of monetary innovations. The technology shock results are also in accord with existing findings, in particular with those regarding the overshooting exchange rate appreciation in response to a positive shock.

A novel contribution of this chapter comes from the ability to examine the dynamic response of major macroeconomic variables -- namely the nominal interest rate, output, the nominal exchange rate, and consumption -- to remittances shocks. I find that a remittances shock in the model without adjustment costs will increase the nominal interest rate, decrease output and consumption, and cause a small but continuous depreciation of the nominal exchange rate. When there are positive adjustment costs the dynamic response of the nominal interest rate is reversed in sign and increased in magnitude. The response of output is diminished while that of consumption is magnified, with the size of the adjustment cost. Here consumption smoothly returns to its initial steady state due to the adjustment cost on money balances. In addition, adjustment costs produce the expected overshooting depreciation of the nominal exchange rate.

Furthermore, I investigate the impact of different modeling assumptions with respect to the initial impact of remittances on the economy, whether to loosen the cash in advance constraint facing households or to increase the supply of loanable funds at financial intermediaries. I find that these alternative specifications have scant impact on the dynamic responses of the variables I examine to a monetary shock, but these alternatives do affect the dynamic responses of macroeconomic variables to a

remittances shock. The size of the adjustment cost magnifies the influence the remittances shock, but not the direction. For policy implications, the results in this chapter suggest that altering the end use of remittances does not have a major impact on the main macroeconomic variables as a whole, therefore policies that aim at redirecting the use of remittances might have no real effect on the recipient economy.

Perhaps more important is the welfare response to a positive remittances shock. I find that utility falls as a result of a positive remittances shock irrespective of the existence of adjustment costs or the share of remittances in the economy, but it quickly recovers to levels above the initial utility level and remains higher thereafter. This means that while the positive remittances shock has a negative effect on utility the period of the shock, the negative effect slowly decreases as future utility is discounted.

I also examine the impact of a change in remittances on the steady state of the economy. As remittances are doubled as a percentage of the recipient country's output, both output and work hours fall by almost 4% while consumption increases by slightly more than 1%. Physical capital also falls by almost 4%. The distribution of real money balances also becomes affected by the doubling of the share of remittances, with real money cash decreasing by almost 4% while real money deposits decrease by almost 4%. It can be observed that the representative household increases its leisure as the share of remittances increases, which together with the fall in physical capital reduces output. This negative effect is counterbalanced by the increase in consumption brought about by the doubling of remittances.

This chapter has assumed remittances as endogenously determined by the recipient country's output. For future research it would be interesting to investigate the case where remittances are exogenous determined only by their growth rate.

CHAPTER V

CONCLUSION

In recent years remittances have gained international spotlight. Migrant remittances can affect the performance of the economy as a whole and can also impact the behavior at the household level. One way to develop economic policies that take full advantage of these money flows is to understand the remitting behavior.

Chapters II and III of this dissertation study the remitting behavior of Nicaraguans using a survey data conducted in 2001. Particularly, in Chapter II I investigate what affects the probability and amount of remittances. In Chapter III, I examine what drives migrants from Nicaragua to remit.

In Chapter I, I estimate a heteroskedastic Tobit with a known form of heteroskedasticity to capture both the probability of remitting and the levels of remittances. Gender, labor force status and destination of the migrant along with the nuclear family all have significant effects on the remitting behavior. The labor force status and the education level of the head of the receiving household influence the migrant's decision to participate in the remitting behavior.

Both foreign and domestic migration policies are likely to have significant effects on remittances to Nicaragua since these policies are likely to affect the destination, labor status, and the composition of the emigrant pool.

In addition, migrants belonging to the same receiving household seem to make decisions concerning remittances in accordance with other migrants in the same

household. I find evidence supporting a positive correlation between migrants' remitting decisions. For policy makers this is of great significance. Remittance policies that directly target particular migrants are also expected to affect the remittance decisions of other migrants belonging to the same receiving household. The full effect of such policies can be separated into direct effect through the main policy objective and an indirect effect through the significant correlation between the remitting decisions.

Also, this direct correlation introduces a set of hypotheses on the remitting decisions. Migrants within the same receiving household might be competing, behaving in the same manner based on their shared background or simply implementing an ex-ante agreement. It is not very clear from the results in this chapter which model of household behavior is supported (collective versus unitary) (Browning and Chiappori, 1998). Also it is not obvious whether the remitting decisions of migrants belonging to the same receiving household should be modeled as a cooperative process (ex-ante agreement). More evidence from other data sets is needed in order to investigate this set of hypotheses.

Chapter III presents a theoretical model of migrants' remitting behavior. I consider two main motivations towards remitting: altruism and self-interest. In the theoretical predictions of the model, a pure altruistic migrant receives direct satisfaction from the welfare of the original household. On the contrary pure self-interest motivated migrants do not receive satisfaction from the welfare of the receiving household. The theoretical predictions suggest that the number of other migrants who belong to the same receiving household has a negative effect on remittances in the case of altruistically

motivated migrants and no effect at all on the self-interest driven migrants. Also the probability of a good state in the receiving country which affects the level of income in the receiving household has a negative effect on remittances for an altruistic migrant and again no effect for a self-interest motivated migrant.

I test the findings of the theoretical model with data from Nicaragua. I use a 2001 LSMS data and define two proxies for the bad state outcome and find some empirical evidence supporting altruism as a main motivation behind remittances in Nicaragua. The number of other migrants, k, belonging to the same household seems to play a crucial role in determining the remittance behavior. I also test the gender heterogeneity of the remitting behavior and find supporting evidence that female migrants seem to behave more altruistically than their male counterparts.

From policy perspective and in the case of altruistically motivated remittance, to maximize remittances per migrant, labor exporting countries can work on incentives for keeping potential migrants from joining other household members. Therefore sending countries' governments can affect remittances per migrant by targeting potential migrants. These governments need to be aware of the existing trade-off between the number of migrants belonging to the same receiving household and remittances per migrant. One potential policy interest is to find the optimal k that maximizes remittances per migrant.

Finally, there is some concern regarding the endogeneity of the number of other migrants. This concern raises questions pertaining to the choice of instruments and their validity and definitely sets the stage for more research.

Chapter IV uses a limited participation model for a small open economy with remittances explicitly incorporated to capture important features from observed empirical responses of economic variables to monetary shocks. In particular, I capture important aspects in the dynamic response of the nominal interest rate, output, the exchange rate, and consumption. The introduction of adjustment costs on money holdings accentuate the persistence of the liquidity effect, and consequently expands the overshooting dynamics of the nominal exchange rate, both in accord with existing empirical evidence on the result of monetary innovations. The technology shock results are also in accord with existing findings, in particular with those regarding the overshooting exchange rate appreciation in response to a positive shock.

A novel contribution of this chapter comes from the ability to examine the dynamic response of major macroeconomic variables -- namely the nominal interest rate, output, the nominal exchange rate, and consumption -- to remittances shocks. I find that a remittances shock in the model without adjustment costs will increase the nominal interest rate, decrease output and consumption, and cause a small but continuous depreciation of the nominal exchange rate. When there are positive adjustment costs the dynamic response of the nominal interest rate is reversed in sign and increased in magnitude. The response of output is diminished while that of consumption is magnified, with the size of the adjustment cost. Here consumption smoothly returns to its initial steady state due to the adjustment cost on money balances. In addition, adjustment costs produce the expected overshooting depreciation of the nominal exchange rate.

Furthermore, I investigate the impact of different modeling assumptions with respect to the initial impact of remittances on the economy, whether to loosen the cash in advance constraint facing households or to increase the supply of loanable funds at financial intermediaries. I find that these alternative specifications have scant impact on the dynamic responses of the variables I examine to a monetary shock, but these alternatives do affect the dynamic responses of macroeconomic variables to a remittances shock. The size of the adjustment cost magnifies the influence the remittances shock, but not the direction. For policy implications, the results in this chapter suggest that altering the end use of remittances does not have a major impact on the main macroeconomic variables as a whole, therefore policies that aim at redirecting the use of remittances might have no real effect on the recipient economy.

Perhaps more important is the welfare response to a positive remittances shock. I find that utility falls as a result of a positive remittances shock irrespective of the existence of adjustment costs or the share of remittances in the economy, but it quickly recovers to levels above the initial utility level and remains higher thereafter. This means that while the positive remittances shock has a negative effect on utility the period of the shock, the negative effect slowly decreases as future utility is discounted.

I also examine the impact of a change in remittances on the steady state of the economy. As remittances are doubled as a percentage of the recipient country's output, output, work hours and physical capital fall while consumption slightly increases. It can be observed that the representative household increases its leisure as the share of remittances increases, which together with the fall in physical capital reduces output.

This negative effect is counterbalanced by the increase in consumption brought about by the doubling of remittances.

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APPENDIX A

Table A.1
Variance of the Error Term from the Average Model

Number of Remitting Migrants s_j	Average Model $Var_{AM}(e_j) = \frac{1}{s_j}\sigma^2(1+(s_j-1)\rho)$
0	σ^2
1	σ^2
2	$\frac{1}{2}\sigma^2(1+\rho)$
3	$\frac{1}{3}\sigma^2(1+2\rho)$
4	$\frac{1}{4}\sigma^2(1+3\rho)$
:	:
:	:
7	$\frac{1}{7}\sigma^2(1+6\rho)$

Table A.2
Variables Descriptive Statistics: Average Model with Sample Size equal to 661

Variable	Description	Mean	Std. Dev.	Min.	Max.
Remittances	Logarithm of Monthly Remittances measured in 2001 U.S. Dollars	1.29	1.61	0	6.22
1 if Age between 21 and 30	Age of the Migrant, equal to 1 if migrant is between 21 and 30 years old.	0.36	0.46	0	1
1 if Male	Gender of the Migrant, equal to 1 if migrant is a male.	0.52	0.47	0	1
1 if Education less than 4 Years	Education of the Migrant, equal to 1 if migrant's education is less than 4 years.	0.47	0.48	0	1
1 if Working	Labor Status, equal to 1 if migrant is working	0.78	0.40	0	1
1 if Emigrant Resides in D.C.	Destination of the migrant, equal to 1 if migrants live in developed countries.	0.30	0.45	0	1
1 if Years since Migration less than 4	Number of Years the migrant has been living out of Nicaragua, equal to 1 if the number of years is less than 4 years.	0.52	0.48	0	1
1 if Spouse of the Head of the Household	Relationship of the migrant to the head of the household, equal to 1 if the migrant is the spouse of the head of the household.	0.05	0.22	0	1
1 if Parent of the Head of the Household	Relationship of the migrant to the head of the household, equal to 1 if the migrant is the parent of the head of the household.	0.03	0.17	0	1
1 if Child of the Head of the Household	Relationship of the migrant to the head of the household, equal to 1 if the migrant is the child of the head of the household.	0.59	0.48	0	1
1 if Urban Residence	Resident of the migrant's Receiving Household, equal to 1 if it resides in an urban area	0.72	0.44	0	1
1 if Education of the Head of Household is less than 4 Years	Education of the Head of the Household, equal to 1 if Head of the Household's education is less than 4 years.	0.75	0.43	0	1
1 if Head of the Household Working	Status of the head of the Household, equal to 1 if head of the household working.	0.63	0.48	0	1

Table A.3
Migrants' Strategies for Two Households Migrants

		Migrant 2	
		Remit	Not Remit
Migrant 1	Remit	58.0 %	12.0 %
	Not Remit	7.0 %	23.0 %

Note*:* The sample consists of 200 migrants who belong to two migrants' households which is around 24% of the total migrants' population and 36% of the total multiple households' migrants' population. The numbers in the table consist of the number of incidence.

Table A.4
Migrants' Strategies for Three Households Migrants

		Migrant 3			
		Remit		Not Remit	
		Migrant 2		Migrant 2	
		Remit	Not Remit	Remit	Not Remit
Migrant 1	Remit	36.6 %	4.9 %	14.6 %	12.2 %
	Not Remit	7.3 %	7.3 %	7.3 %	9.8 %

Note*:* The sample consists of 123 migrants who belong to three migrants' households which is around 15% of the total migrants' population and 24% of the total multiple households' migrants' population. The numbers in the table consist of the number of incidence.

Table A.5
Migrants' Strategies for Four Households Migrants

		Migrant 4							
		Remit				Not Remit			
		Migrant 3				Migrant 3			
		Remit		Not Remit		Remit		Not Remit	
		Migrant 2				Migrant 2			
		R	NR	R	NR	R	NR	R	NR
Migrant 1	Remit	22.2 %	0.0 %	5.6 %	0.0 %	5.6 %	0.0 %	0.0 %	11.1 %
	Not Remit	11.1 %	5.6 %	0.0 %	0.0 %	0.0 %	5.5 %	0.0 %	33.3 %

Note: The sample consists of 72 migrants who belong to four migrants' households which is around 9% of the total migrants' population and 14% of the total multiple households' migrants' population. The numbers in the table consist of the number of incidence. R = Remit; NR = Not Remit.

APPENDIX B

B.1

Derivations of Eqs. (2.6) and (2.7):

From the FOC Eq. (2.5) in the altruism model

$$\frac{\partial U}{\partial r} = \frac{-\alpha}{Y_{i1} - r_i} + \frac{\delta}{\pi Y_H + (1-\pi)Y_L + r_i + kr_{-i}} = 0$$

and the implicit function theorem I can write:

$$\frac{\partial r}{\partial k} = -\frac{\frac{\partial FOC}{\partial k}}{\frac{\partial FOC}{\partial r}} = -\frac{-\delta C_H^{-2} r_{-i}}{-\alpha C_{i1}^{-2} - \delta C_H^{-2}} \prec 0$$

$$\frac{\partial r}{\partial \pi} = -\frac{\frac{\partial FOC}{\partial \pi}}{\frac{\partial FOC}{\partial r}} = -\frac{-\delta C_H^{-2}(Y_H - Y_L)}{-\alpha C_{i1}^{-2} - \delta C_H^{-2}} \prec 0$$

where $Y_H - Y_L \succ 0$.

For the self-interest model $\delta = 0$ which leads to $\frac{\partial r}{\partial k} = 0$ and $\frac{\partial r}{\partial \pi} = 0$.

Solving for r_i^* in Eq. (2.5):

Eq. (2.5) gives $\frac{-\alpha}{Y_{i1} - r_i} + \frac{\delta}{\pi Y_H + (1-\pi)Y_L + r_i + kr_{-i}} = 0$ which leads to

$$\alpha\pi Y_H + \alpha(1-\pi)Y_L + \alpha r_i + \alpha k r_{-i} = \delta Y_{i1} - \delta r_i$$

and therefore I can write $(\alpha + \delta) r_i = \delta Y_{i1} - \alpha\pi Y_H - \alpha(1-\pi)Y_L - \alpha k r_{-i}$

and then after rearranging some terms I get to the following:

$$r_i^* = \frac{\delta}{(\alpha+\delta)} Y_{i1} - \frac{\alpha}{(\alpha+\delta)} \pi (Y_H - Y_L) - \frac{\alpha}{(\alpha+\delta)} Y_L - \frac{\alpha}{(\alpha+\delta)} k r_{-i} = r(Y_{i1}; Y_H; Y_L; k; \pi)$$

The utility function is strictly quasi-concave which insures the uniqueness of the solution r_i^*.

B.2

The likelihood function $L_j = \sum_{i=1}^{k_j} \ln L_{ij}$ for the average model is the following where s_j is the number of remitting migrants in household j:

$$\ln L_{ij} = \ln\left[1 - \Phi(X'\gamma)\right] = \ln\left[1 - \Phi(X'\beta * \theta)\right] \qquad \text{if } s_j = 0 \qquad (2.12)$$

$$\ln L_{ij} = 0.5 * \left[\ln(\theta^2) - (\theta R_{ij} - X'\gamma)^2\right] \qquad \text{if } s_j = 1 \qquad (2.13)$$

$$\ln L_{ij} = 0.5 * \left[\ln\left(\frac{\theta^2}{h_j + \rho(1-h_j)}\right) - \frac{1}{h_j + \rho(1-h_j)} (\theta R_{ij} - X'\gamma)^2\right] \qquad \text{if } s_j > 1 \qquad (2.14)$$

where $\Phi(.)$ is the standard normal cumulative distribution function and $\gamma = \frac{\beta}{\sigma}; \theta = \frac{1}{\sigma}$.

The likelihood function for the third case ($s_j > 1$) is derived from the likelihood function of the second case ($s_j = 1$) with $\gamma_j = \frac{\beta}{\sigma_j}$; $\theta_j = \frac{1}{\sigma_j}$; $\sigma_j = \sigma(h_j + \rho(1-h_j))^{0.5}$ and $h_j = \frac{1}{s_j}$. I maximize L_j with respect to $\gamma; \theta$ and ρ.

Table B.3
First Stage Probit Estimates for the Sample Selection Estimates on Eq. (2.14) in Table 2.10b

	Amount Remitted
Variables	
Intercept	0.6395***
	(0.1864)
1 if Parent	0.4331
	(0.3023)
1 if Spouse	0.6224
	(0.2434)
1 if Working	-0.2575
	(0.1119)
1 if Education less than 4 Years	0.1249
	(0.1032)
1 if Male	-0.0177
	(0.0926)
1 if Age greater than 29	-0.1553
	(0.1126)
1 if Destination is Developed Country	-0.4801***
	(0.1095)
1 if Years since Migration greater than 5	0.0372
	(0.1070)
1 if Urban Residence	0.2512
	(0.1072)
1 if Education of HHH less than 4	0.0101
	(0.1149)
1 if HHH Male	-0.1876
	(0.0931)
1 if HHH age is greater than 64	-0.1286
	(0.1066)
Log Likelihood	-540.00
Sample	872

Note*:* 1- Columns refer to two different measures for the good state probability: column (1) refers to a dummy variable for households where the head had lost the last job for one of the reasons discussed in Table 2.3. Column (2) refers to a dummy variable for those head of households who have been looking for a job for at least one year. 2-* denotes significance at 10% level, ** at 5% level, *** at 1% level. 3- Standard errors are in parentheses.

APPENDIX C

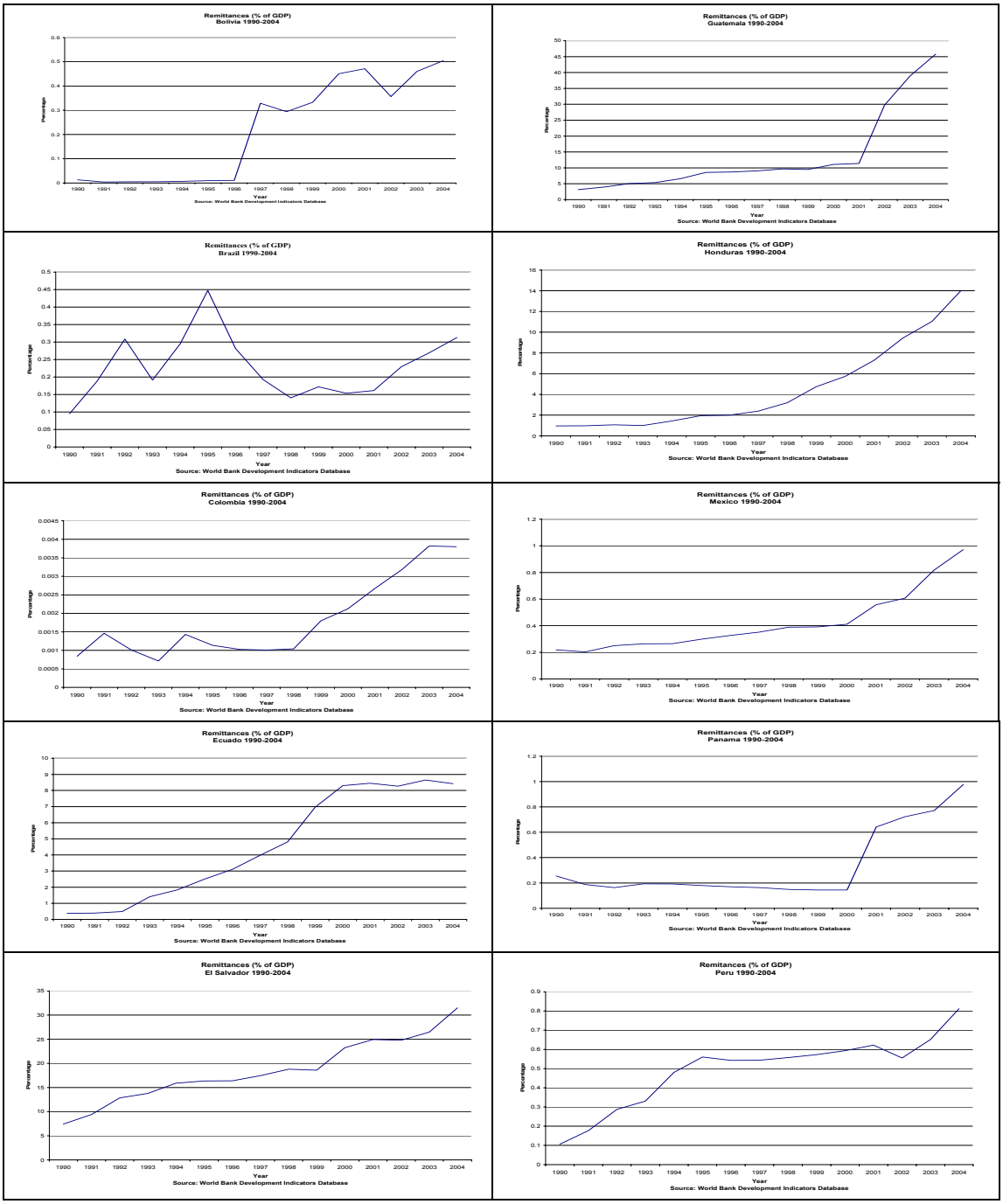

Fig. C.1: Remittances as Percentages of GDP for 10 Select Latin American Countries

C.2

I denote the shadow price associated with the household real wealth by $\Lambda_t = P_t \lambda_t$. The relevant equations in the limited participation model are defined the following way:

$$\Gamma_t = \underset{t}{E}\left[\vartheta (Y^{ss})^{\tau} \pi_t Y_t^{-\tau} e^{g_t}\right] \tag{C.27}$$

$$\Lambda_t = \beta \underset{t}{E}\left[(1+i_{t+1}^{*})\frac{e_{t+1}}{e_t}\frac{\Lambda_{t+1}}{\pi_{t+1}}\right] \tag{C.50}$$

$$-U_{H_t} = w_t \Lambda_t \tag{C.51}$$

$$\Lambda_t = \beta \underset{t}{E}\left[\frac{\Lambda_{t+1}}{\pi_{t+1}}(1+R_{t+1})\right] \tag{C.52}$$

The following variable is introduced for technical convenience: $\Delta M_t^c \equiv \frac{M_{t+1}^c}{M_t^c}$ which can be stationarized (to be used in the next equation) as

$$\Delta M_t^c = \frac{m_{t+1}^c \pi_t}{m_t^c} \tag{C.53}$$

$$w_t \Lambda_t \xi \frac{\pi_t}{m_t^c}\left(\Delta M_t^c - \theta\right) + \Lambda_t = \beta \underset{t}{E}\left[\frac{U_{C_{t+1}}}{\pi_{t+1}}\right] + \beta \underset{t}{E}\left[w_{t+1}\Lambda_{t+1}\xi \frac{\Delta M_{t+1}^c}{m_{t+1}^c}\left(\Delta M_{t+1}^c - \theta\right)\right] \tag{C.54}$$

$$m_t = m_t^b + m_t^c \tag{C.55}$$

$$\pi_t C_t = m_t^c + \phi \Gamma_t + \varphi(\theta_t - 1) m_t \tag{C.56}$$

$$\pi_t = \frac{e_t}{e_{t-1}} \pi_t^{*} \tag{C.57}$$

$$Y_t = e^{z_t} K_t^{\alpha} H_t^{1-\alpha} \tag{C.58}$$

$$I_t = K_{t+1} - (1-\delta) K_t \tag{C.59}$$

$$w_t = (1-\alpha)\frac{Y_t}{H_t} \tag{C.60}$$

$$1 + R_t = \beta \underset{t}{E}\left[\frac{\Lambda_{t+1}}{\Lambda_t}\left\{\alpha \frac{Y_{t+1}}{K_{t+1}} + (1-\delta)(1+R_{t+1})\right\}\right] \tag{C.61}$$

$$m_{t+1} = \theta_t \frac{m_t}{\pi_t} \tag{C.62}$$

$$\pi_t I_t = m_t^b + (1-\varphi)(\theta_t - 1) m_t + (1-\phi)\Gamma_t \tag{C.63}$$

$$b_{t+1} - \frac{e_t}{e_{t-1}}(1+i_t^{*})\frac{b_t}{\pi_t} = Y_t - C_t - I_t + [1-(1+R_t)(1-\phi)]\frac{\Gamma_t}{\pi_t} \tag{C.64}$$

$$\log(\theta_{t+1}) = (1-\rho_\theta)\log(\bar{\theta}) + \rho_\theta \log(\theta_t) + \rho_g \log(g_t) + \varepsilon_{\theta t+1} \quad \text{(C.65)}$$

$$\log(g_{t+1}) = (1-\rho_g)\log(\bar{g}) + \rho_g \log(g_t) + \varepsilon_{gt+1} \quad \text{(C.66)}$$

$$\log(z_{t+1}) = (1-\rho_z)\log(\bar{z}) + \rho_z \log(z_t) + \varepsilon_{zt+1} \quad \text{(C.67)}$$

Consequently, the log-linearized system of equations, following Uhlig (1999) methodology, is given by

$$0 = \underset{t}{E}\left[\hat{\pi}_t - \hat{\Gamma}_t - \tau\hat{Y}_t + \hat{g}_t\right] \quad \text{(C.27')}$$

$$0 = \underset{t}{E}\left[-\hat{\Lambda}_t + \hat{\Lambda}_{t+1} + \hat{e}_{t+1} - \hat{e}_t - \hat{\pi}_{t+1}\right] \quad \text{(C.50')}$$

$$0 = \hat{w}_t + \hat{\Lambda}_t - \left(1-\gamma(1-\sigma)\right)\frac{H}{1-H}\hat{H}_t - (1-\gamma)(1-\sigma)\hat{C}_t \quad \text{(C.51')}$$

$$0 = \underset{t}{E}\left[-\hat{\Lambda}_t + \frac{R}{1+R}\hat{R}_{t+1} + \hat{\Lambda}_{t+1} - \hat{\pi}_{t+1}\right] \quad \text{(C.52')}$$

$$0 = -\Delta\hat{M}^{c}_{t} + \hat{m}^{c}_{t+1} + \hat{\pi}_t - \hat{m}^{c}_{t} \quad \text{(C.53')}$$

$$0 = \underset{t}{E}\Bigg[-\Lambda\hat{\Lambda}_t - S\beta\hat{\pi}_{t+1} - S\beta\gamma(1-\sigma)\frac{H}{1-H}\hat{H}_{t+1} - S\beta\left(\gamma+\sigma(1-\gamma)\right)\hat{C}_{t+1}$$
$$+ \beta\pi^2\Lambda w\xi\frac{1}{m^c}\Delta\hat{M}^{c}_{t+1} - \pi^2\Lambda w\xi\frac{1}{m^c}\Delta\hat{M}^{c}_{t}\Bigg] \quad \text{(C.54')}$$

where $S = (1-\gamma)(1-H)^{\gamma(1-\sigma)}C^{-\gamma-\sigma(1-\gamma)}$

$$0 = -(m)\hat{m}_t + (m^b)\hat{m}^b_t + (m^c)\hat{m}^c_t \quad \text{(C.55')}$$

$$0 = \hat{\pi}_t + \hat{C}_t - \frac{m^c}{C\pi}\hat{m}^c_t - \frac{\Gamma\phi}{C\pi}\hat{\Gamma}_t - \frac{m\varphi}{C}\hat{\theta}_t - \frac{m\varphi}{C\pi}(\theta-1)\hat{m}_t \quad \text{(C.56')}$$

$$0 = -\hat{\pi}_t + \hat{e}_t - \hat{e}_{t-1} \quad \text{(C.57')}$$

$$0 = -\hat{Y}_t + \alpha\hat{K}_t + (1-\alpha)\hat{H}_t + \hat{z}_t \quad \text{(C.58')}$$

$$0 = \frac{I}{K}\hat{I}_t - \hat{K}_{t+1} + (1-\delta)\hat{K}_t \quad \text{(C.59')}$$

$$0 = -\hat{w}_t + \hat{Y}_t - \hat{H}_t \quad \text{(C.60')}$$

$$0 = \underset{t}{E}\Bigg[\left(\alpha\beta\frac{Y}{K} + \beta(1-\delta)(1+R)\right)\hat{\Lambda}_{t+1} + \left(\beta(1-\delta)R\right)\hat{R}_{t+1} + \alpha\beta\frac{Y}{K}\hat{Y}_{t+1} - \alpha\beta\frac{Y}{K}\hat{K}_{t+1}$$
$$-\left(\alpha\beta\frac{Y}{K} + \beta(1-\delta)(1+R)\right)\hat{\Lambda}_t - (R)\hat{R}_t\Bigg] \quad \text{(C.61')}$$

$$0 = -\hat{m}_{t+1} + \hat{m}_t - \hat{\pi}_t + \hat{\theta}_t \quad \text{(C.62')}$$

$$0 = -\hat{\pi}_t - \hat{I}_t + \frac{m^b}{I\pi}\hat{m}_t^b + \frac{m}{I\pi}(\theta-1)(1-\varphi)\hat{m}_t + \frac{(1-\varphi)m}{I}\hat{\theta}_t + \frac{\Gamma}{I\pi}(1-\phi)\hat{\Gamma}_t \quad \text{(C.63')}$$

$$0 = -\hat{b}_{t+1} + \frac{(1+i^*)}{\pi}\hat{e}_t - \frac{(1+i^*)}{\pi}\hat{e}_{t-1} + \frac{(1+i^*)}{\pi}\hat{b}_t + \left(\frac{Y-C-I-b}{b}\right)\hat{\pi}_t + \frac{Y}{b}\hat{Y}_t - \frac{C}{b}\hat{C}_t \quad \text{(C.64')}$$

$$-\frac{I}{b}\hat{I}_t + \left(\frac{(1-(1-\phi)(1+R))\Gamma}{b\pi}\right)\hat{\Gamma}_t - \frac{(1-\phi)R\Gamma}{b\pi}\hat{R}_t \quad \text{(C.65')}$$

$$\hat{\theta}_{t+1} = \rho_\theta\hat{\theta}_t + \rho_g\hat{g}_t + \varepsilon_{\theta t+1} \quad \text{(C.66')}$$

$$\hat{g}_{t+1} = \rho_g\hat{g}_t + \varepsilon_{gt+1} \quad \text{(C.67')}$$

$$\hat{z}_{t+1} = \rho_z\hat{z}_t + \varepsilon_{zt+1} \quad \text{(C.68')}$$

Solving

The system is given by 19 equations with 19 variables. The endogenous state variables $\{\hat{m}_t, \hat{b}_t, \hat{K}_t, \hat{m}_t^c, \hat{e}_t, \hat{\Lambda}_t\}$ include lambda and the nominal exchange rate in addition to the standard four variables, as Uhlig's toolkit suggests that variables dated $t-1$ or earlier should be considered state variables (in the case of $\hat{e}_t$) while the matrix of other endogenous variables should be non-singular in order for its pseudo-inverse to exists, allowing to re-declare $\hat{\Lambda}_t$ as an other endogenous state variable instead. The other endogenous variables of the system are $\{\hat{\pi}_t, \hat{m}_t^b, \hat{C}_t, \hat{R}_t, \hat{w}_t, \hat{H}_t, \hat{Y}_t, \hat{I}_t, \Delta\hat{\hat{M}}_t^c, \hat{\Gamma}_t\}$, and the exogenous state variable are $\{\hat{\theta}_t, \hat{g}_t, \hat{z}_t\}$.

VITA

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