Migration, Remittances, and Growth

by

Nurgul Ukueva

Department of Economics
Duke University

Date: ____________________________
Approved:

____
Pietro Peretto, Advisor

____
Charles Becker

____
Michelle Connolly

____
Alessandro Tarozzi

Dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy
in the Department of Economics
in the Graduate School of
Duke University
2010

Abstract

(Economics)

Migration, Remittances, and Growth

by

Nurgul Ukueva

Department of Economics
Duke University

Date: ______________________

Approved:

____
Pietro Peretto, Advisor

____
Charles Becker

____
Michelle Connolly

____
Alessandro Tarozzi

An abstract of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Economics in the Graduate School of Duke University
2010

Abstract

In the first chapter of my dissertation I analyze the effect of migration and remittances on a small, open, migrant-sending country in the context of an endogenous growth model with technology transfers. I demonstrate that, due to a dynamic feedback effect from economic conditions to migration and from migration to economic development in an economy exposed to migration, initial conditions can determine its long-run steady state, leading to the rise of vicious or virtuous circles of development. Countries with a low level of technological development may end up in a poverty trap, in which a low level of development results in low wage rates and consequently high migration rates. The high migration and loss of manpower in a general equilibrium setting generates less demand for the adoption of leading technologies, reducing incentives to invest into new technologies. This reduced incentive effect in turn leads to low output and low wages and even higher migration in future periods. Potentially, as in the case of depopulated countries and regions the economy diverges from the worlds growth rate and eventually ends up being emptied out. In addition, I show, that altruistic remittances as an important by-product of migration allow people to share the benefits of technological advances developed elsewhere and dampen the negative impact of migration. In particular, remittances remove the limiting case of emptying out of the economy and reduce the chances of ending up in a poverty trap.

In the second chapter of my dissertation, I study the implications of migration

and remittances for an economy with financial frictions. I introduce migration and remittances into Schumpeterian endogenous growth model with financial constraints and derive the conditions under which migration and remittances can have positive or negative impacts on the country's growth and convergence. I show that the results depend on the degree of the country's financial development and its distance to the technological frontier. Importantly, I show that if the financial constraint is strong, so that the economy is diverging from the world's growth path, then migration and remittances can have growth effects and can increase the steady state growth rate of the country as well as the likelihood that the country will converge to the world's growth path.

My third chapter uses a new household-level panel dataset from Kyrgyzstan to study the determinants and implications of remittances and inter-household transfers in general in Kyrgyzstan. We find that remittances in Kyrgyzstan are positively correlated with the income of the receiving households and that the remittance-receiving households have a higher probability of purchasing durable goods then households not receiving remittances.

To my grandfather Turduev Abdyldabek

Contents

List of Tables

List of Figures

Acknowledgements

I am highly indebted to the members of my committee Pietro Peretto, Charles Becker, Michelle Connolly, and Alessandro Tarozzi. I am especially grateful to my advisors Pietro Peretto and Charles Becker for their invaluable guidance, support and encouragement. I am also thankful to Craig Burnside, Kent Kimbrough, Rachel Kranton, Marjorie McElroy, John Seater, Huseyin Yildirim and all participants of Triangle Trade, Dynamics, Macro Lunch Group, Duke Macro and International Finance Reading Group, and Duke Micro Theory Lunch Group for their helpful comments and suggestions.

Last but not least, I owe my deepest gratitude to my family. This dissertation would not have been possible without them standing by my side, inspiring, encouraging and supporting me every step of the way.

1

Migration, Remittances, and Growth

1.1 Introduction

It is difficult to imagine a globalized world without migration. Recent data on migration (Docquier and Marfouk (2004)) show that more than 50 percent of the population of a country like Grenada lives in OECD countries. For the top 10 (in relative terms) migrant-sending nations, more than 30 percent of their population live in OECD countries. An important feedback from migrants is the remittances they send back home. Remittances have become an increasingly important source of external funding for developing countries. Since the 1990s, the growth of remittances has exceeded that of private capital flows and official development aid. They are now the second largest source of external funding after FDI, exceeding official development assistance ([29]). This growing importance of international migration and remittances motivate better understanding of the links among migration, remittances and economic development. Making better use of these human and financial flows also has recently attracted a great deal of attention of policy makers and researchers. In light of these developments, the objective of this paper is to study long-run macroeconomic implications of migration and remittances on the economy of the migrant-sending country.

On the migration side, this paper is related to the literature on migration and convergence[1]. In addressing the issue of convergence, the standard neoclassical growth model predicts that with migration low income countries should grow more rapidly, factor payments and income levels between migrant-sending and receiving countries should converge, and migration should die away over time. In this sense, the neoclassical growth model suggests that allowing free labor mobility should be beneficial for the sending country. Recently, [23] quantify these benefits for the case of Europe and North America and finds that removing barriers to labor mobility would raise the total aggregate output by more than 8%.

However, other studies ([16], [31]) argue that the predictions of the neoclassical model on migration and convergence are not supported by empirical evidence. For instance, [31] argue that migration does not disappear over time, migrant-receiving countries such as US, Canada, Australia have been hosting migrants for over a century. The result that migration enhances convergence not confirmed by empirical evidence (see for example [7] for Europe, Japan and US, or [34] for rural-urban migration).

To explain these inconsistencies between theoretical predictions and empirical evidence, several studies have turned to endogenous growth models. Using endogenous growth models, [11] and [30] conclude that migration is always detrimental for the sending country and migratory flows never end. [16] provides a solid microeconomic foundation for the decision of people to migrate. He studies migration in the context of a two-sector model with increasing returns to scale and finds that with migration,

[1] It should be highlighted that the main focus of this paper is on the implications of migration for a migrant-sending country. To better focus this research question and also noting recent empirical findings that migration can have important implications for small developing countries (see for example [9]), I study the effects of migration on a small, open, migrant-sending economy, whereas the papers, mentioned above, look at the two-country models of migration.

convergence may occur for some parameter values, despite the presence of increasing returns to scale. Faini's model features diminishing returns to the reproducible factor and does not generate endogenous self-sustainable growth. [24] study migration in the context of an endogenous growth model with capital accumulation and spillovers. They find that while migration positively affects the sending country in the steady state, the differences existing between two countries do not disappear.

This paper also uses an endogenous growth model and follows [16] in modeling people's decision to migrate and contributes to the existing literature in the following dimensions. First, the literature on migration and convergence does not distinguish between investing in technology and investing in physical capital, and abstracts from the role that markets play in determining the incentives of the firms to invest into research and new technologies. Second, the papers mentioned above do not analyze the process of technology transfer and therefore do not address the question of whether migration can lead to long-run divergence even in the presence of technology transfer.

To address these issues, following recent Schumpeterian growth models (see [3] and [6]), I look at technological development, and in particular, development by means of adopting advanced foreign technologies, as the main driving force of economic development. I provide a detailed analysis of the incentives of firms to adopt foreign technologies and explore the interaction between migration and the adoption of foreign technologies. I show that this interaction has important implications and generates rich dynamics for the sending country. In particular, I show that in an economy exposed to migration, initial conditions can be important and migration could lead to either virtuous or vicious circles and poverty traps. Countries with a low level of technological development may end up in a development trap, where a low level of development results in low wage rates and consequently high migration rates. High migration in general equilibrium generates less demand for the adoption of leading technologies, reducing incentives of the firms to invest into new technologies, which in turn generates low output and low wages and even higher migration in subsequent periods. Potentially, the country diverges from the world's growth path and ends up being emptied out. In contrast, countries with relatively high levels of development experience virtuous circles with low migration, high investment incentives and adoption of new technologies, and higher economic growth.

Thus, the model, studied in this paper reveals the complexity of the migration issue. It predicts the possibility of multiple steady states and poverty traps. This possibility of two different steady states and evolution paths is consistent with two different patterns of international migration observed in the real world. On the one hand, there is low migration from lower income countries in the European Union, even in the presence of substantial wage differentials. In contrast, one also finds high migration and extreme cases of depopulated regions and ghost towns in parts of Mexico, Central Asia and Russian Siberia.

From the welfare perspective, it is clear that migrants enjoy higher wages and living standards in the destination country and benefit from migration. Most migrants not only receive considerably higher income but also might have access to better education and healthcare services, and have better prospects for their children. Therefore, if by the wave of a magic wand everybody could move out from a poor to a rich country, then everybody would gain. However, if moving everybody out is not possible within the lifetimes of generations of people, then along the transition path in a trapped economy we may observe lower and decreasing relative wages and consumption, and deterioration of living standards of those left behind. What is worth stressing about this result is that this kind of poverty trap with migration is possible even with the possibility of transfer of foreign technologies, and for an economy that was converging to the world's growth rate without migration.

Another contribution of the paper is the analysis of remittances. Although there is an extensive theoretical and empirical literature on remittances on the micro level, the analysis of long-run macroeconomic implications of remittances have been limited ([28]). This paper contributes by incorporating altruistic remittances into the endogenous growth model. Following the literature on bequest motives, I model remittances as a result of "joy-of-giving" preferences of migrants and consider the joint implications of migration and remittances. I show that altruistic remittances dampen the negative impact of migration. They remove the limiting case of emptying out of the economy and reduce the chances of the economy to end up in the poverty trap.

While mainly focused on the issues of migration and remittances, this paper also contributes to the literature on growth and poverty traps by looking at an additional force that might in extreme cases affect convergence, international labor mobility. The results of the paper suggest that emigration could become another source of divergence and poverty traps.

The remainder of the paper is organized as follows. The next section describes the basic setup of the model of a small open economy with endogenous migration and remittances, and that grows by adopting foreign technologies. To get better insight into the interaction between migration and technology adoption, Section 3 abstracts from the effect of remittances and shows that the evolution of the economy with migration is history-dependent and can lead to vicious and virtuous circles and poverty traps . Section 4 looks at steady state and dynamic impact of remittances on the economy. Section 5 concludes.

1.2 The Model

1.2.1 General Description

On the preferences side, I study endogenous migration decision in the context of the overlapping generation model. As in [16], all else being equal people are home biased, *i.e.* they prefer to live in their home country. They migrate if utility from the excess income they receive abroad outweighs this additional utility they receive due to home preference. Migrants are altruistic and care about the relatives left behind. The altruistic remittances are the result of "joy of giving" preferences. On the production side, following [6], I consider a developing country, with the level of technology behind the world's level of technology. The world level of technology grows at the constant rate g. There is a possibility of technology transfer, the possibility of growth by implementing new technologies that have been discovered elsewhere. However, the transfer of technology is costly. The developing country cannot just take and implement foreign technologies off the shelf. The transfer of technology and the resulting growth requires resources. The availability of these resources affects the country's "absorptive capacity".

1.2.2 Households

There is an overlapping generations of individuals. Each person lives for two periods. In period one people work, earn income, consume and save. In period two they retire, consume all their savings and leave no bequest. In period one people also decide to work in their home country or to migrate abroad. For simplicity, I assume that having departed, emigrants do not return. In general all other things being equal, individuals prefer to live in their home country. Following [16], this is captured by preference parameter θ. If people live in the home country $\theta \geq 1$, and if they migrate and live abroad $\theta = 1$. Therefore, utility of an individual drops when he migrates. This decrease in the utility captures the non-monetary costs of migration, including the psychological and emotional costs of being separated from families and friends, and the cost of adjusting to the new social and cultural environment. Individuals differ in their preferences for living in their home country. $\theta \in [1, \infty)$ is treated as a random variable with Pareto distribution with the following probability density function:

$$f(\theta) = \begin{cases} \epsilon/\theta^{\epsilon+1} & for\ \theta > 1 \\ 0 & for\ \theta = 1 \end{cases} \tag{1.1}$$

In addition, migrants are assumed to care about their relatives left behind and send remittances back home. Utility of an individual i born at period t if he lives in the home country is:

$$U^h_{i,t} = \ln(\theta_i c^h_{i,t}) + \beta \ln(\theta_i c^h_{i,t+1}) \tag{1.2}$$

where h stands for home, β represents subjective discount factor, c_t is consumption of individual when a worker, and c_{t+1} is consumption, when he retires.

Individuals at home maximize the above utility subject to the following budget constraints:

In period t:

$$c^h_{i,t} + s^h_{i,t} = w^h_{i,t} + \tau^h_{i,t} + \pi^h_{i,t} \tag{1.3}$$

In period $t+1$:

$$c^h_{i,t+1} = (1+r)s^h_{i,t} + \tau^h_{i,t+1} \tag{1.4}$$

where w is the wage, $\pi_t$is firms' profits distributed back to individuals, which will be specified later. s_t is savings and τ^q_t is remittances, r is the world's interest rate (this is a small open economy model with capital mobility and trade in final goods).

Let's denote total present discounted value of income received at home as

$I^h_{i,t} \equiv \left(w^h_{i,t} + \tau^h_{i,t} + \frac{\tau^h_{i,t+1}}{1+r} + \pi^h_{i,t} \right)$, then the optimal levels of consumption each period if a person decides to stay at home are: $c^h_{i,t} = \frac{1}{1+\beta} I^h_{i,t}$, $c^h_{i,t+1} = \frac{\beta(1+r)}{1+\beta} I^h_{i,t}$ and the indirect utility function of staying at home is:

$$V_i^h = \ln\left(\theta_i^{1+\beta}\left(\frac{1}{1+\beta}\right)^{1+\beta}(\beta(1+r))^{\beta} I_{i,t}^h\right)$$

Remittances received by each person in the home country is $\tau_t^h \geq 0$. Migrants send remittances to those left in the home country. To capture altruistic motives of migrants to remit, I use the "joy of giving" preferences, according to which migrants simply enjoy giving away money to people in living in their country of birth. This form of altruistic preferences is used in the growth and development literature to capture altruistic intergenerational bequest motives (see for example [17]) . Thus, the utility of the migrant is:

$$U_{i,t}^f = (1-\delta)(\ln c_{i,t}^f + \beta \ln c_{i,t+1}^f) + \delta(\ln \tau_{i,t} + \beta \ln \tau_{i,t+1}) \tag{1.5}$$

Migrants do not own firms abroad and at home and do not receive any profits. The budget constraints of the migrant each period are:

In period t:

$$c_{i,t}^f + s_{i,t}^f = w_{i,t}^f - \tau_{i,t}^f \tag{1.6}$$

In period $t+1$:

$$c_{i,t+1}^f = (1+r)s_{i,t}^f - \tau_{i,t+1}^f \tag{1.7}$$

where f stands for foreign, τ_i^f is remittances sent by each migrant.

The migrant chooses the levels of consumption $c_{i,t}^f$, $c_{i,t+1}^f$, and remittances $\tau_{i,t}^f$, $\tau_{i,t+1}^f$ each period so as to maximize utility function (1.5) subject to the budget constraints (1.6) and (1.7). Hence, the optimal levels of migrant's consumption and remittances are: $c_{i,t}^f = \frac{1-\delta}{1+\beta} w_{i,t}^f$, $c_{i,t+1}^f = \frac{\beta(1+r)(1-\delta)}{1+\beta} w_{i,t}^f$, $\tau_{i,t}^f = \frac{\delta w_{i,t}^f}{1+\beta}$, $\tau_{i,t+1}^f = \frac{\delta\beta(1+r)}{1+\beta} w_{i,t}^f$. It should be noted that, given the form of altruistic preferences above, remittances are proportional to the wage rate abroad. That is, migrants remit a constant fraction of the their wage income. Substituting the optimal levels of consumption and remittances into the utility function gives the following indirect utility function for migrants:

$$V_i^f = \ln\left(\left(w_{i,t}^f\right)^{1+\beta}(\beta(1+r))^{\beta}\left(\frac{1}{\beta+1}\right)^{1+\beta}\left((1-\delta)^{1-\delta}\delta^{\delta}\right)^{1+\beta}\right)$$

People will stay at home if the utility from staying at home is greater than the utility from migrating $V_i^h > V_i^f$. It follows from comparing the two indirect utility functions that people will stay at home if:

$$\theta_i > \frac{(1-\delta)^{1-\delta}\delta^{\delta}w_{i,t}^f}{I_{i,t}^h} \tag{1.8}$$

Given the Pareto distribution of random variable θ, probability that θ is greater than some number θ^* is $P(\theta > \theta^*) = \theta^{*-\epsilon}$. Denoting the proportion of population migrated abroad as m_t ($m_t \in [0,1]$), it follows that the fraction of population that will stay at home is:

$$1 - m_t = Prob\left(\theta > \frac{(1-\delta)^{1-\delta}\delta^{\delta}w_t^f}{I_t^h}\right) = \left[\frac{I_t^h}{(1-\delta)^{1-\delta}\delta^{\delta}w_t^f}\right]^{\epsilon} \tag{1.9}$$

It should be noted that ϵ is the parameter of the preference for the country of birth. For the given ratio of incomes received in the two countries, the higher the ϵ the more people decide to migrate. One can think of ϵ as the parameter representing inherited deep roots, characteristics of the attachment of a nation's citizens to their country of birth. The higher the ϵ, the less people are attached to their homeland. In addition, ϵ could be thought as living conditions in the country (including political stability, peace, democracy, and rule of law) that could influence people's preferences for their home country. If the country is politically unstable, then all else being equal ϵ might be higher

I assume that remittances are equally divided among the individuals of the same generation at home. If $\tau_t^f = \frac{\delta w_t^f}{1+\beta}$ and $\tau_{t+1}^f = \frac{\delta\beta(1+r)w_t^f}{1+\beta}$ are remittances sent by each migrant of generation t, then the present discounted value of remittance income received by an individual in the home country in period t is $\frac{m_t}{1-m_t}\delta w_t^f$. Then the total income received at home is: $I_t^h = w_t + \frac{m_t}{1-m_t}\delta w_t^f + \pi_t$. Therefore, the migration equation can be written as:

$$1 - m_t = \left[\frac{w_t + \frac{m_t}{1-m_t}\delta w_t^f + \pi_t}{(1-\delta)^{1-\delta}\delta^{\delta} w_t^f}\right]^{\epsilon} \tag{1.10}$$

1.2.3 Final goods sector

A final good, Y, is produced competitively. It can be consumed, used as an input into research, and also used as an input into the production of intermediate goods. It is produced using labor and a continuum of specialized intermediate goods according to the production function:

$$Y_t = ((1-m_t)L)^{1-\alpha} \int_0^1 A_t(i)^{1-\alpha} x_t(i)^{\alpha} di \tag{1.11}$$

where $x_t(i)$ is the input of the latest version of the intermediate good i and $A_t(i)$ is the productivity parameter associated with it. L is the total population and m_t is the fraction of people migrated abroad.

The price of each intermediate good equals its marginal product:

$$p_t(i) = \alpha(L(1-m_t))^{1-\alpha} \left(\frac{x_t(i)}{A_t(i)}\right)^{\alpha-1} \tag{1.12}$$

1.2.4 Intermediate goods sector

In each intermediate good sectors, firms can adopt the world's frontier technology. The probability of success in adoption in the intermediate goods sector is $\mu_t(i)$. If an entrepreneur succeeds he gets to implement the world's frontier technology A_t^f. That is:

$$A_t(i) = \begin{cases} A_t^f & \text{with probability } \mu_t(i) \\ A_{t-1}(i) & \text{with probability } 1 - \mu_t(i) \end{cases}$$

If an entrepreneur succeeds, he can produce any amount of intermediate good at the cost of one unit of final good per unit of intermediate good. In addition, there are also other producers who can produce copies of this intermediate good, but at a higher unit cost of $\chi > 1$. Thus, in sectors in which an adoption has just occurred, the incumbent is the sole producer and charges the price of χ. The monopoly rent of the incumbent is assumed to last for one period only, after, which everybody can produce intermediate goods of the same quality. In non-innovating sectors, production takes place under perfect competition, with the price equal to the unit cost of each competitive producer χ. Thus, given that $p_t(i) = \chi$ the quantity demanded of the intermediate good i will be:

$$x_t(i) = \left(\frac{\alpha}{\chi}\right)^{\frac{1}{1-\alpha}} A_t(i)L(1 - m_t) \tag{1.13}$$

The profit of an incumbent will be:

$$\pi_t(i) = (p_t(i) - 1)x_t(i) = (\chi - 1)\left(\frac{\alpha}{\chi}\right)^{\frac{1}{1-\alpha}} L(1 - m_t)A_t^f \equiv \bar{\pi}(1 - m_t)A_t^f \tag{1.14}$$

where $\overline{\pi} \equiv (\chi - 1)\left(\frac{\alpha}{\chi}\right)^{\frac{1}{1-\alpha}} L$ is a constant

Therefore, profit of the entrepreneur depends negatively on migration. The intuition is that high migration rate means less labor will be available tomorrow to convert the latest adopted ideas and blueprints into final consumable goods.

In what follows, I assume that the growth of the world's frontier is driven by quality improving innovations (not imitation). The frontier economy is in the steady state with a balanced constant growth rate of g. In this steady state, wages, profits, and output in the final good and intermediate good sectors are proportional to the frontier technology level A^f. In particular, I define the wage rate in the foreign economy as proportional to the technology level with factor of proportionality $\bar{w}^f = constant$, that is the foreign wage rate is equal to $w_t^f = \bar{w}^f A_t^f$.

1.2.5 Adoption process

The technology transfer or the adoption of the world's frontier technology is costly. The probability of success in adoption $\mu_t(i) \in [0, 1]$ depends on the amount of resources invested into research. In each sector in order to successfully adopt the technology with probability $\mu_t(i)$, it is necessary to invest Φ_t amount of the final good. The cost function for adoption is increasing and convex and is given by:

$$\Phi_t(i) = \lambda \mu_t^\gamma(i) A_{t+1}^f$$

where and the parameters $\gamma > 1$, and $\lambda > 0$. As in [6] the cost is proportional to the frontier technology, A_{t+1}^f, *i. e.* it is assumed that the further ahead the frontier moves the more difficult it becomes to adopt it.

In case of successful adoption the entrepreneur receives profit $\pi_{t+1}(i)$ next period. The cost $\lambda \mu_t^\gamma(i) A_{t+1}^f$, however, has to be paid up front, one period in advance. The success in adoption is random and comes with probability $\mu_t(i)$. Therefore, profit of the entrepreneur is:

$$\mu_t(i)\pi_{t+1}(i) - (1+r)\lambda\mu_t^{\gamma}(i)A_{t+1}^{f} \tag{1.15}$$

where r is the interest rate.

1.2.6 Equilibrium

I assume there is a free entry into the research sector in equilibrium. Substituting for profits from equation 1.14 into (1.15), and setting the result equal to 0 gives the equilibrium probability of adoption:

$$\mu_t(i) = \left(\frac{\bar{\pi}}{(1+r)\lambda}\right)^{\frac{1}{\gamma-1}} (1 - m_{t+1})^{\frac{1}{\gamma-1}} \tag{1.16}$$

It should be noted that the equation above establishes symmetry across intermediate good sectors. The resulting equilibrium probability of adoption is the same for all sectors ($\mu_t(i) = \mu_t$, for all i). Therefore, the equilibrium average level of productivity in the country, $A_t = \int_0^1 A_t(i)di$, is given by:

$$A_{t+1} = \mu_t \bar{A}_{t+1} + (1 - \mu_t)A_t \tag{1.17}$$

That is, the productivity equals to the frontier productivity in the fraction μ_t of sectors that were successful in the adoption process, but remains at the previous level of productivity in the $1 - \mu_t$ sectors that were not successful.

The country's normalized productivity (or it is also called the country's proximity to frontier or the inverse of the country's distance to frontier) defined as $a_t \equiv A_t/\bar{A}_t$ evolves according to:

$$a_{t+1} = \mu_t + \frac{1-\mu_t}{1+g} a_t \tag{1.18}$$

Substituting equation (1.13), into (1.11), gives the amount of the final good produced:

$$Y_t = \left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}} A_t L(1-m_t) \tag{1.19}$$

Since the final goods sector is competitive, the wage rate equals marginal product of labor, and is given by:

$$w_t = (1-\alpha)\frac{Y_t}{L(1-m_t)} = (1-\alpha)\left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}} A_t = \bar{w}A_t \tag{1.20}$$

where $\bar{w} = (1-\alpha)\left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}}$

Finally, substituting the wage equation (1.20) into equation (1.10) gives the following migration equation:

$$1 - m_t = \left[k_r a_t + \left(\frac{\delta}{1-\delta}\right)\frac{m_t}{1-m_t}\right]^{\epsilon} \tag{1.21}$$

$k_r = \frac{\bar{w}}{(1-\delta)^{1-\delta}\delta^{\delta}\bar{w}^f}$ is a constant.

The equilibrium in the economy is characterized by three equations: an equation for the probability of adoption (1.16), the law of motion of the relative technology (1.18), and the migration equation (1.21), in three unknowns: relative technology a_t, probability of adoption μ_t and migration rate m_t.

The first equation, the equation determining the probability of adoption, relates the probability of success in the adoption process today to the migration rate tomorrow. Investments that research firms make today into adopting new ideas, technologies, and blue-prints depend on the anticipated profits that they will get tomorrow, which in turn depend on the rate of migration tomorrow. The higher the rate of migration, the less labor will be available tomorrow to convert the latest adopted ideas and blue prints into final consumable goods. If the migration rate is high, foreseeing high migration tomorrow, firms will invest less today, which leads to the lower probability of adopting new technologies (or lower adoption rate) tomorrow. Similar to Schumpeterian models of endogenous growth ([5]) or two period OLG models of money ([20]) this equation is forward looking so that the probability of adoption of new technologies in any period depends on the expected rate of migration next period.

The third equation, the migration equation, relates migration rate, remittances and the level of relative technology in the country. Higher relative technology level implies lower income differentials between the migrant sending country and the frontier economy, and therefore lower migration rate. Therefore, from the migration side of the story, one of the major driving forces of migration is the country's relative level of technology. In addition, the second part of the sum, the term $\left(\frac{\delta}{1-\delta}\right)\frac{m_t}{1-m_t}$ captures the effect of remittances. Remittances go up with the degree of altruism of migrants, δ. Also, as a result of the "joy of giving" preferences of migrants, remittances are proportional to the wage rate abroad[2], and consequently, increase with the wage level abroad and with the number of migrants.

Finally, the second equation, the law of motion of relative technology, links the technology level tomorrow with the technology level today and with the probability of adoption. These three equations capture the dynamic relationship between migration, technological development and economic growth.

This dynamic feedback loop between migration of a significant proportion of specialized professionals and economic development is especially important for small developing countries with scarce human resources as the following examples indicate.

Perhaps the most striking facts documented in the migration literature are emigration of healthcare professionals. For example, [32], points out that Grenada had

[2] The "joy of giving" preferences were used to capture the important altruistic nature of remittances and yet keep the model tractable. Remittances might also decline with the number of migrants if we look at individual families, since the more members of the family move out, the less people the migrants will need to care about, and the less remittances they will send.

to train 22 doctors to keep just one. One-half of the graduates of South African medical schools have emigrated to industrial countries ([26]). However, significant out-migration does not have to be migration of doctors or the future Nobel Prize winners. There are less documented but also important cases of significant out-migration of other professionals like engineers, craftsmen, teachers, plumbers and architects. Hundreds of thousands of school teachers from Former Soviet Union countries in Central Asia left their jobs to work in Russia and other higher income countries of the region. As a result, today Kyrgyzstan and other countries of Central Asia report significant shortages of school teachers and deterioration of education of their children. As another example, Poland after becoming a member of the European Union in 2004 has been experiencing massive out-migration of labor. The country has been experiencing a critical shortage of welders and shipbuilders for its shipping industry. Migration created a labor shortage so severe that due to the lack of manpower in the construction industry, the city of Warsaw may not be able to spend the money that is due to begin arriving from the European Union for projects like improving roads and the water supply. The same has been true for the Kyrgyz Republic. With almost one fifth of the country's five million population having migrated, it did not have enough of its own manpower for major road construction connecting the southern part of the country with the north. [1] cites one government official in Central Asia as saying that - even if industrial plants were to resume production, there would be no qualified workers to operate them. It should be noted this is not the consequence of lack of education, because Central Asia had enough engineers, and once there were working industrial plants and people operating these plants.

1.3 Equilibrium with no remittances

In this section, I study the case of migration with no remittances. In the case of no remittances, the migration equation reduces to:

$$1 - m_t = \left(\frac{w_t}{w_t^f}\right)^{\epsilon} = \left(\frac{\bar{w}}{\bar{w}^f}\right)^{\epsilon} a_t^{\epsilon}$$

Combining this equation with the equation (1.16) gives the probability of adoption as a function of distance to frontier is:

$$\mu_t = \bar{\mu} a_{t+1}^{\frac{\epsilon}{\gamma-1}}$$

where $\bar{\mu} = \left(\frac{\bar{\pi}}{(1+r)\lambda}\left(\frac{\bar{w}}{\bar{w}^f}\right)^{\epsilon}\right)^{\frac{1}{\gamma-1}}$. Since both the probability of adoption $\mu \in [0,1]$, and technology gap $a \in [0,1]$, I assume that the parameter $\bar{\mu} \leq 1$.

Then the law of motion for the distance to frontier is:

$$a_{t+1} = \bar{\mu} a_{t+1}^{\frac{\epsilon}{\gamma-1}} + \frac{1 - \bar{\mu} a_{t+1}^{\frac{\epsilon}{\gamma-1}}}{1+g} a_t \tag{1.22}$$

Therefore, the dynamics of the economy are characterized by the evolution of the proximity to frontier measure. Given the initial value a_0 equation, (1.22) describes the subsequent possible evolutions of the equilibrium sequences of the proximity to frontier $\{a_t\}_{t=0}^{\infty}$.

1.3.1 Steady state analysis

I now characterize steady state equilibria of the economy. A steady state equilibrium is the stationary level of the proximity to frontier a such that the following condition holds (which is derived by imposing $a_t = a_{t+1}$ in the equation (1.22)):

$$a = \bar{\mu} a^{\frac{\epsilon}{\gamma-1}} + \frac{1 - \bar{\mu} a^{\frac{\epsilon}{\gamma-1}}}{1+g} a$$

Clearly $a = 0$ is one steady state. In the rest of this section I will refer to other non-zero steady state equilibria. For $a \neq 0$, after dividing both sides of the equation by a and rearranging terms I obtain the following condition:

$$- a^{\frac{\epsilon}{\gamma-1}} + (1+g)a^{\frac{\epsilon}{\gamma-1}-1} = \frac{g}{\bar{\mu}} \tag{1.23}$$

This equation implicitly defines the steady state value of proximity to frontier as a function of the growth rate of the frontier technology, the degree of labor mobility, and the parameters of the adoption and production processes.

For the following analysis it is useful to define a function:

$$F(a) \equiv -a^{\frac{\epsilon}{\gamma-1}} + (1+g)a^{\frac{\epsilon}{\gamma-1}-1}$$

Proposition 1. *If $\epsilon < \gamma - 1$, then for $a \in (0,1)$ $F'(a) < 0$, and there exists a unique steady state equilibrium.*

Proof. I look for the solution for the following equation:

$$F(a) \equiv -a^{\frac{\epsilon}{\gamma-1}} + (1+g)a^{\frac{\epsilon}{\gamma-1}-1} = \frac{g}{\bar{\mu}}$$

If $\epsilon < \gamma - 1$, then $F(0) = +\infty$, $F(1) = g$. The derivative of the function F is $F'(a) = a^{\frac{\epsilon}{\gamma-1}-2}\left(-\frac{\epsilon}{\gamma-1}a + (1+g)\left(\frac{\epsilon}{\gamma-1} - 1\right)\right)$. The function is increasing (that is $F'(a) > 0$) if $a < (1+g)\left(\frac{\epsilon}{\gamma-1} - 1\right)\frac{\gamma-1}{\epsilon} \equiv a^*$. Note that since $\epsilon < \gamma - 1$, $a^* < 0$, therefore for positive values of a, $F(a)$ is monotonically decreasing.

The function is sketched on Figure 1.1. Since $\bar{\mu} \leq 1$, $g/\bar{\mu} > g$, for $a \in (0,1]$ the function $F(a)$ intersects the $g/\bar{\mu}$ line. In addition, because of monotonicity there is a unique intersection.

□

If people's home preferences are high enough, then the effect of migration on the economy is low and the economy resembles an economy without migration. Similar

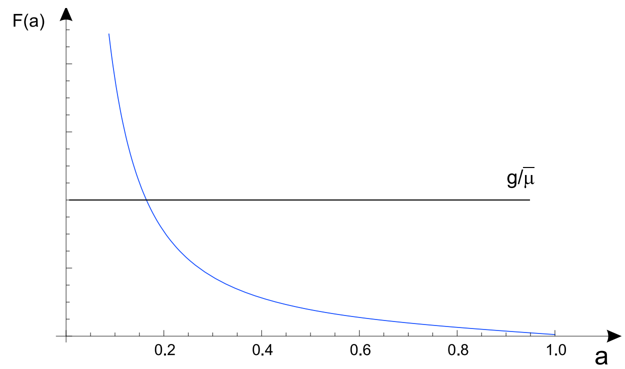

FIGURE 1.1: Steady state, $\epsilon < \gamma - 1$

to this closed economy case, there is a unique steady state equilibrium in which the country grows at the frontier growth rate but with lower levels of consumption and output per capita.

On the other hand, if people's home preferences are low, then the effect of migration dominates, which leads to either divergence in the growth rate with no non-zero steady state or multiply steady states.

The following lemma gives the properties of the function $F(a)$ when $\epsilon > \gamma - 1$. The graph of the function $F(a)$ when $\epsilon > \gamma - 1$ is shown on Figure 1.2.

Lemma 2. *If $\epsilon > \gamma - 1$, then*

- *$F(a)$ is increasing if $a < a^* \equiv \frac{(1+g)(\epsilon-(\gamma-1))}{\epsilon} > 0$ and decreasing if $a > a^*$.*
- *$F(0) = 0$, and $F(1) = g$*

Proof. The function $F(a)$ is increasing if $F'(a) = a^{\frac{\epsilon}{\gamma-1}-2}\left(-\frac{\epsilon}{\gamma-1}a + (1+g)\left(\frac{\epsilon}{\gamma-1} - 1\right)\right) > 0$. That is, it is increasing if $a < (1+g)\left(\frac{\epsilon}{\gamma-1} - 1\right)\frac{\gamma-1}{\epsilon} = \frac{(1+g)(\epsilon-(\gamma-1))}{\epsilon} \equiv a^*$, it attains its maximun at $F(a^*)$ and is decreasing if $a > a^*$. Since $\epsilon < \gamma - 1$, then $a^* > 0$.

□

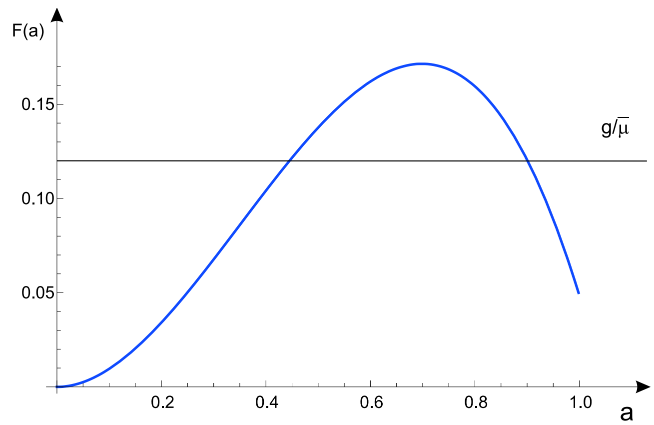

FIGURE 1.2: Steady States, $\epsilon > \gamma - 1$

Proposition 3. *Suppose $\epsilon > \gamma - 1$. Let $\gamma - 1 < \epsilon_1 < (\gamma - 1)\left(1 + \frac{1}{g}\right)$ (which is a function of g, $\bar{\mu}$,γ) be the smallest of the solutions to $F(a^*) = \frac{g}{\bar{\mu}}$, then*

- *If $\epsilon > \epsilon_1$, then there is no steady state equilibrium.*
- *If $\gamma - 1 < \epsilon < \epsilon_1$, then there are 2 steady state equilibria.*

Proof. Let $\epsilon > \gamma - 1$. The question we are interested in concerns for $a \in (0, 1)$, how many times the function $F(a)$ intersects the horizontal line $\frac{g}{\bar{\mu}}$. If $\epsilon > \gamma - 1$, $F(0) = 0$ and since $\bar{\mu} \leq 1$, $F(1) = g \leq \frac{g}{\bar{\mu}}$.

Note that the maximum is attained outside of the domain we are interested, that is $a^* \equiv (1 + g)\left(1 - \frac{\gamma-1}{\epsilon}\right) > 1$ if $\epsilon > (\gamma - 1)\left(1 + \frac{1}{g}\right)$.

Suppose that $\epsilon < (\gamma - 1)\left(1 + \frac{1}{g}\right)$(the maximum is attained within the domain $(0, 1)$), then first note that the maximum of function F, $F(a^*)$, for this case is decreasing in ϵ. To see this, use the envelope theorem to find:

$$\begin{aligned} \frac{dF(a^*)}{d(\epsilon)} &= \frac{\partial F(a)}{\partial(\epsilon)}\Big|_{a=a^*} = \frac{(a^*)^{\frac{\epsilon}{\gamma-1}} \ln a^*}{\gamma-1}\left(-1 + (1+g)(a^*)^{-1}\right) = \\ &= \frac{(a^*)^{\frac{\epsilon}{\gamma-1}} \ln a^*}{\epsilon-(\gamma-1)} < 0 \end{aligned}$$

since $a^* < 1$, $\ln a^* < 0$.

If $\epsilon \to \gamma - 1$, then $F(a^*) \to (1+g)$. As ϵ increases from its minimum value $\gamma - 1$, the maximum of the function $F(a)$, $F(a^*)$, goes down and the argmax a^* goes up, until $\epsilon = (\gamma - 1)\left(1 + \frac{1}{g}\right)$, in which case $a^* = 1$ and $F(a^*) = g$. Since $g \leq \frac{g}{\bar{\mu}}$, there exists an $\epsilon \in \left(\gamma - 1;\ (\gamma - 1)(1 + \frac{1}{g})\right)$ that is the solution to $F(a^*) = \frac{g}{\bar{\mu}}$. Let ϵ_2 be that solution. Then since the maximum is decreasing in ϵ it is clear that if $\epsilon > \epsilon_1$, then there is no non-zero steady state equilibrium. Conversely, if $\epsilon < \epsilon_1$, then there are 2 steady state equilibria.

□

The proposition states that there is an intermediate value of the preference for the home country: if people's home preferences are too low, than no matter how close the wage differentials are if there is a free labor mobility everybody eventually moves out. However, if people's home preferences are in the intermediate range ($\gamma - 1 < \epsilon < \min\{\epsilon_1, \epsilon_2\}$), then there are 2 possible non-zero steady state equilibria and what happens in equilibrium is state dependent. In this intermediate range of home preferences, the dynamics of the economy are different, and depend on the country's proximity to frontier as we see in the next section.

1.3.2 Dynamic equilibria

In the previous section I have looked at the steady states of the economy and established the possibility of multiple non-zero steady state equilibria, depending on the magnitude of the people's preferences for their country of birth. This section turns to analyzing the dynamics of the economy. It derives the properties of the dynamical system that governs the evolution of the economy and determines the stability of different steady state equilibria. The dynamics of the economy with no remittances are determined by the evolution of the proximity to frontier, which is governed by the first order nonlinear difference equation (1.22).

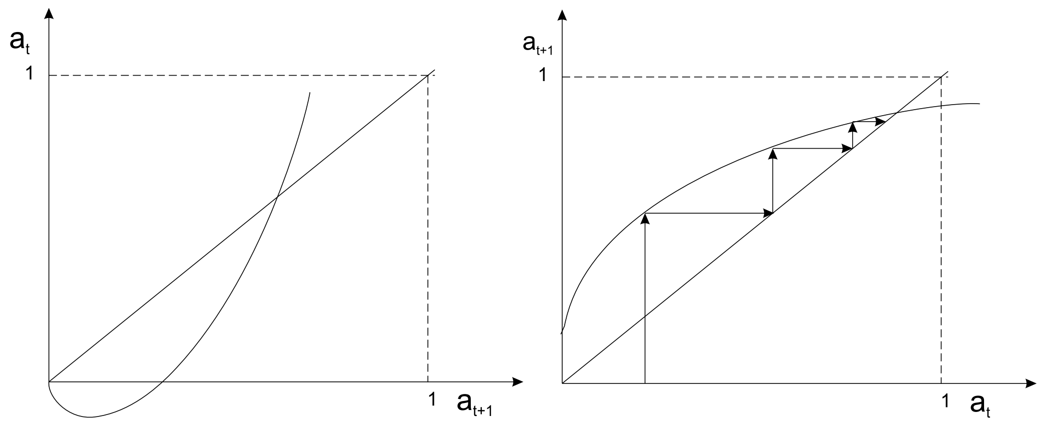

FIGURE 1.3: Law of motion of the proximity to frontier: forward and backward dynamics, $\epsilon < \gamma - 1$

Although the natural dynamics of the economy are backward looking, it is useful to rearrange this equation and work with the following forward looking form:

$$a_t = \Gamma(a_{t+1}) \equiv (1+g)\left(1 + \frac{a_{t+1} - 1}{1 - \bar{\mu} a_{t+1}^{\frac{\epsilon}{\gamma-1}}}\right) \tag{1.24}$$

Based on the results from the previous section, I analyze the dynamics of the economy for three different cases corresponding to three different ranges of ϵ: low $(\epsilon < \gamma - 1)$, intermediate $(\gamma - 1 < \epsilon < \epsilon_1)$ and high $(\epsilon > \epsilon_1)$.

In the first case, high degree of people's home preferences/low ϵ, the following proposition can be formulated.

Proposition 4. *If $\epsilon < \gamma - 1$ then $\Gamma'(0) \to -\infty$. For $a > 0$ there is a unique stable nonzero steady state, in which the country's growth rate equals the world's frontier growth rate.*

Proof. In this prove I skip the subscript $t+1$. Note that $\Gamma(0) = 0$, $\Gamma(1) = 1 + g$

The derivative of function Γ is:

$$\Gamma'(a) = (1+g)\frac{1-\bar{\mu}a^{\frac{\epsilon}{\gamma-1}} - \frac{\epsilon}{\gamma-1}\bar{\mu}a^{\frac{\epsilon}{\gamma-1}-1}(1-a)}{(1-\bar{\mu}a^{\frac{\epsilon}{\gamma-1}})^2} \tag{1.25}$$

If $\epsilon < \gamma - 1$ then $\Gamma'(0) = -\infty$. The graph of function $\Gamma(a)$ is sketched on Figure 1.3.2. As established in Proposition 1, when $\epsilon < \gamma - 1$, there is a unique nonzero steady state equilibrium.To see formally that the nonzero steady state is stable, note that in the steady state: $a = \bar{\mu}a^{\frac{\epsilon}{\gamma-1}} + \frac{1-\bar{\mu}a^{\frac{\epsilon}{\gamma-1}}}{1+g}a \Longleftrightarrow \bar{\mu}a^{\frac{\epsilon}{\gamma-1}} = \frac{ga}{1+g-a}$. Substituting this into (1.25) gives:

$$\begin{aligned} \Gamma'(a)|_{\Gamma(a)=a} &= \frac{(1+g)(1+g-a)^2}{((1+g)(1-a))^2}\frac{(1-a)(\gamma-1+g(\gamma-1-\epsilon))}{(1+g-a)(\gamma-1)} \\ &= \frac{(1+g-a)((1+g)(\gamma-1)-g\epsilon)}{(\gamma-1)(1+g)(1-a)} \end{aligned}$$

Then

$$\begin{aligned} \Gamma'(a)|_{\Gamma(a)=a} - 1 &= \frac{(1-a+g)((1+g)(\gamma-1)-g\epsilon)}{(\gamma-1)(1+g)(1-a)} - 1 = \frac{g((1+g)(\gamma-1)-g\epsilon)-(1-a)g\epsilon}{(\gamma-1)(1+g)(1-a)} \\ &= \frac{g((1+g)(\gamma-1-\epsilon)+a\epsilon)}{(\gamma-a)(1+g)(1-a)} > 0 \end{aligned}$$

□

This proposition says that if the degree of people's home preferences if high enough relative , the country is able to retain its population

Proposition 5. *If $\gamma - 1 < \epsilon < \epsilon_2$, then $\Gamma'(0) = 1 + g > 1$ and the steady state $a = 0$ is unstable in the forward dynamics of equation (1.24), and therefore it is stable in the backward dynamics. In addition, there are two more steady state equilibria a_l and a_h (with $a_l < a_h$).*

Countries with $a < a_l$ will diverge from the world's growth rate and will be eventually emptied out. Countries with $a > a_1$will reach the steady state $a = a_h$, in which the growth rate of the economy is equal to the world's growth rate.

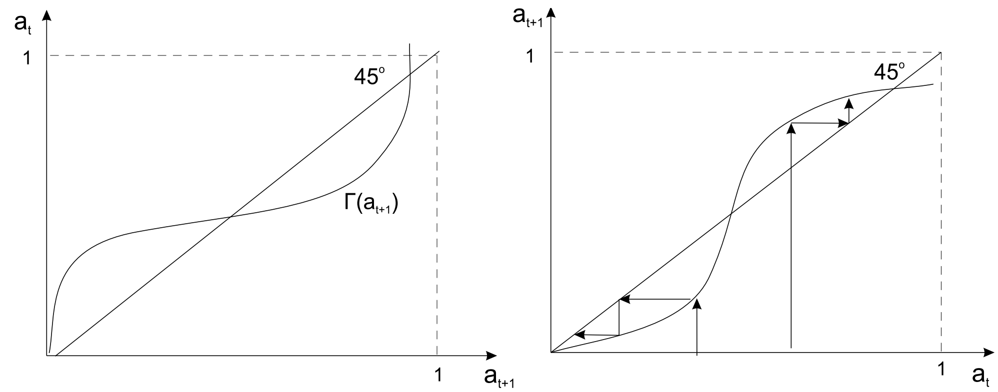

FIGURE 1.4: Law of motion of the proximity to frontier: forward and backward dynamics, $\gamma - 1 < \epsilon < \epsilon_2$

Proof. In order to characterize these steady states, I next show that for $\epsilon > \gamma - 1$ and $a \in (0,1)$ the function $\Gamma(a)$ is increasing in a. To show that $\Gamma'(a) > 0$, we need to show that $1 - \bar{\mu}a^{\frac{\epsilon}{\gamma-1}} - \frac{\epsilon}{\gamma-1}\bar{\mu}a^{\frac{\epsilon}{\gamma-1}-1}(1-a) > 0 \Longleftrightarrow a^{\frac{\epsilon}{\gamma-1}} + \frac{\epsilon}{\gamma-1}a^{\frac{\epsilon}{\gamma-1}-1}(1-a) < \frac{1}{\bar{\mu}}$.

Define $\Upsilon(a) \equiv a^{\frac{\epsilon}{\gamma-1}} + \frac{\epsilon}{\gamma-1}a^{\frac{\epsilon}{\gamma-1}-1}(1-a)$. To see that $\Upsilon(a) < \frac{1}{\bar{\mu}}$, first note that$\Upsilon(0) = 0$, $\Upsilon(1) = 1 < \frac{1}{\bar{\mu}}$(since $\bar{\mu} < 1$) then note that

$$\Upsilon'(a) = \frac{\epsilon}{\gamma-1}\left(\frac{\epsilon-(\gamma-1)}{\gamma-1}\right)(1-a)a^{\frac{\epsilon}{\gamma-1}-2} > 0.$$

The results of the proposition follow from the fact that the function $\Gamma(a)$ is increasing, it intersects the 45 degree line 3 times (including 0), and $\Gamma'(0) > 1$.

□

The proposition says that with an intermediate level of home preferences, the dynamics of the economy open to migration depend on the proximity of the country to technological frontier. Countries with a relatively high level of technological development experience virtuous circles. Higher level of technology and higher wage rates lead to the lower income differentials and lower migration. Low migration and availability of sufficient manpower to transform adopted ideas into final consumable goods keeps sufficient incentives to invest in new technologies which in turn leads to the higher growth rate and low migration next period. Thus, the model generates and helps to explain the case of migration in European Union. Researchers studying labor migration in Europe observe that migration from lower income to higher income countries is low notwithstanding sizeable wage gains from migration. [8] points out that the increased emigration from Portugal and Spain to other higher income European countries stopped shortly after full labor mobility was allowed in spite of the large wage gains (from 30 to 77 percent) from migration. This model suggests that there are two factors that explain why labor does not migrate from poor to rich countries in Europe. First, people in Europe have relatively deep roots, for them the psychological cost of migration is high. Second, the technological gap between countries in the European Union is relatively low. In terms of the notation used in the model, the proximity to frontier in Southern Europe is greater then a_l, so that the countries reach their high stable steady state equilibrium with low migration.

In contrast, countries sufficiently far from the technological frontier may experience vicious circles. The low level of technological development in these countries leads to high wage differences compared to wage rates in the frontier economy, which leads to high migration rates, which in turn decreases the demand for intermediate goods and profits from the adoption of leading technological practices. This in turn generates lower investments and an even lower relative level of technological development next period. Thus, the model suggests that for low income countries, migration might become a source of a poverty trap.

The real world counterparts of this case are ghost towns and depopulated regions. Although countries do not disappear due to legal regulations, communities do. For example, emigration to the United States has resulted in depopulation of regions in central Mexico. [18] describes Cerrito del Agua (a town in the central Mexican state Zacatecas), which has left with population of only 3,000 people, has no paved roads either leading to it or within it. No restaurants, no movie theaters, no shopping

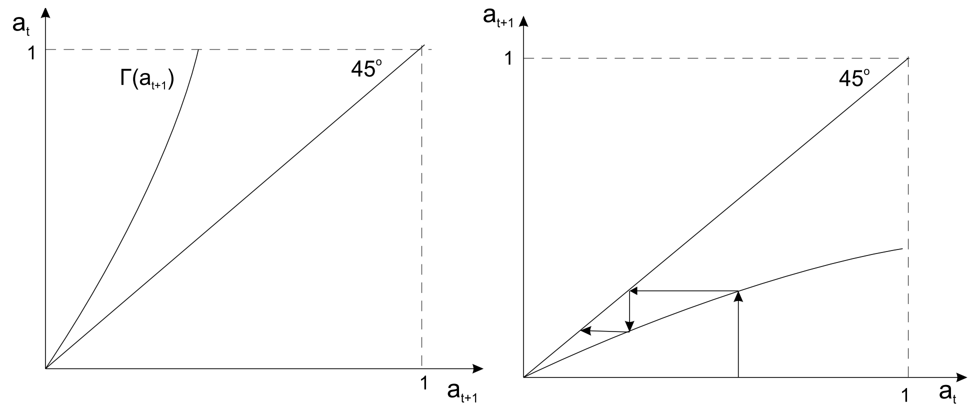

FIGURE 1.5: Law of motion of the proximity to frontier: forward and backward dynamics, $\epsilon > \epsilon_2$

malls. In fact, Cerrito del Agua has no middle schools, high schools or colleges; no cell phone service, no hospital. Its surrounding fields are dry and untended. The streets are empty. Depopulation is not unique to the Mexican case. Many towns and villages in Central Asia today are populated mostly by elderly and children after experiencing drastic migration of working age population. [2] gives an example of Ak-Tyuz village, the small village in the north of Kyrgyzstan, which has become a ghost village today, losing around 90% of its population. Today there are only 691 persons living in the village, half of this population are elderly. Russia's Siberia and Far East regions are another example of migration and depopulation. As described in [1] due to migration, and also a fall in birth rates this part of Russia has experienced rapid decline of its population at the rate of about 200,000-300,000 people per year since 1991. Hundreds of villages and small towns in this region have lost up to 50 percent of population. For example, Susumanskiy region in Magadan oblast has lost 70 percent of its population between 1991 and 2007, going from 50000 people in 1991 to less than 14000 in 2007.

Proposition 6. *If* [3] $\epsilon > \epsilon_2$ *then* $\Gamma'(0) > 1$ *and the steady state* $a = 0$ *is unstable in*

[3] $\epsilon_2 > \gamma - 1$ is defined in Proposition 3

the forward dynamics of equation (1.24), and therefore it is stable in the backward dynamics. Moreover, there is no other steady state equilibria, and $a = 0$ *is globally stable. With this level of home preferences free labor mobility will eventually empty out the economy.*

Proof. Proof follows from $\Gamma'(0) = 1 + g > 1$, and the fact that in this case there are no nonzero steady state equilibria (see Proposition (3))

□

This last case considers extremely high migration rates. People in this case mainly compare income differentials to make a migration decision. They are not attached to their home country. In such a case, migration unambiguously leads to emptying out of the economy.

1.4 Equilibrium with remittances

Remittances today have become an important source of external funding for developing countries. Exceeding official development aid, they are the second largest source of income after FDI. In spite of their importance the macroeconomic implications of remittances within a systematic theoretical framework are limited. Therefore, in this section, I look at the implications of remittances.

With remittances, the migration decision is governed by the following equation:

$$1 - m_t = \left[\frac{\bar{w}}{(1-\delta)^{1-\delta}\delta^{\delta}\bar{w}^f} a_t + \underbrace{\left(\frac{\delta}{1-\delta}\right)\frac{m_t}{1-m_t}}_{\text{effect of remittances}} \right] \tag{1.26}$$

Here, the second part of the sum $\left(\frac{\delta}{1-\delta}\right)\frac{m_t}{1-m_t}$ reflects the additional effect from remittances. Under perfect foresight equilibrium, people make the decision to migrate by comparing the relative wage income that they will receive at home relative to abroad (the first part of the sum) and the additional income that they get from remittances, where remittance income increases with the number of migrants and with the degree of altruism of the migrants. For a given level of relative technology and wage differentials, the higher the degree of altruism of migrants, the higher the remittance income received and the more people will decide to stay in the home country.

One important consequence of having altruistic remittances is the observation that the point $a = 0$ is no longer an equilibrium. When $a \to 0$,

$$1 - m_t = \left[\left(\frac{\delta}{1-\delta} \right) \frac{m_t}{1 - m_t} \right]^{\epsilon}$$

We can see from the equation above that, due to remittances, there still will be people left in the home county, that is even if $a \to 0$, $1 - m_t > 0$. Due to altruistic remittances, the country will share the benefits of the technological advances developed elsewhere, not only through technology adoption, but also through increased income and funds that people get in the form of remittances. The country will be able to retain some proportion of its population. Therefore, the case of emptying out of the economy is not a possibility with remittances. With altruistic remittances, the economy converges in the long-run to the growth rate of the world's economy.

I next examine the level effects of migration with remittances by looking at how migration with remittances affects country's technological gap.

The dynamical system describing the economy's evolution path is governed by the system of 2 difference equations, the migration equation and the following law of motion of the proximity to frontier:

$$a_{t+1} = \bar{\mu}_r (1 - m_{t+1})^{\frac{1}{\gamma - 1}} + \frac{1 - \bar{\mu}_r (1 - m_{t+1})^{\frac{1}{\gamma - 1}}}{1 + g} a_t$$

where $\bar{\mu}_r = \left(\frac{\bar{\pi}}{(1+r)\lambda}\right)^{\frac{1}{\gamma-1}}$

Given the level of relative technology today, people anticipate their wage rates at home and abroad and make their migration decisions. Therefore, the dynamic equilibrium sequences of migration rate $\{m\}_{t=0}^{\infty}$, and the proximity to frontier $\{a\}_{t=0}^{\infty}$ are determined.

1.4.1 Steady state analysis with remittances

In the steady state from the law of motion for the proximity to frontier:

$$\bar{\mu}_r(1-m)^{\frac{1}{\gamma-1}} = \frac{\bar{\mu}_r(1-m)^{\frac{1}{\gamma-1}} + g}{1+g} a$$

From the migration equation:

$$a = \frac{1}{k_r}\left((1-m)^{\frac{1}{\epsilon}} - \frac{\delta}{1-\delta}\frac{m}{1-m}\right)$$

where $k_r = \frac{\bar{w}}{(1-\delta)^{1-\delta}\delta^{\delta}\bar{w}^{f}} < 1$. I will assume $k_r < 1$.

Combining these two equations and rearranging terms I get an equation that determines the steady state migration rate as a function of technological and behavioral parameters of the economy:

$$\left(\bar{\mu}_r(1-m)^{\frac{1}{\gamma-1}} + g\right)\left((1-m)^{\frac{1}{\epsilon}-\frac{1}{\gamma-1}} - \frac{\delta}{1-\delta}\frac{m}{(1-m)^{1+\frac{1}{\gamma-1}}}\right) = \bar{\mu}_r(1+g)k_r$$

This can be rewritten in terms of the proportion of population left in the home country $l \equiv 1-m$. The terms then can be rearranged as follows in order to disentangle the effect of remittances:

$$F_r(l) \equiv \underbrace{\left(\bar{\mu}_r l^{\frac{1}{\gamma-1}} + g\right) l^{\frac{1}{\epsilon}-\frac{1}{\gamma-1}}}_{\text{without remittances}} \underbrace{- \frac{\delta}{1-\delta}(1-l)\left(gl^{-1} + \bar{\mu}_r l^{-1-\frac{1}{\gamma-1}}\right)}_{\text{effect of remittances}} = \bar{\mu}_r(1+g)k_r$$

The first term on the right-hand side is the part with no remittances: this case has been analyzed in the previous sections of the paper. The latter term is the effect of remittances. Note that the last term is increasing in l. Differentiating with respect to l,

$$F_r'(l) = \left(\frac{1}{\epsilon} - \frac{1}{\gamma-1}\right) l^{\frac{1}{\epsilon}-\frac{1}{\gamma-1}-1}\left(\bar{\mu}_r l^{\frac{1}{\gamma-1}} + g\right) + \frac{1}{\gamma-1}\bar{\mu}_r l^{\frac{1}{\epsilon}-1} + \\ + \underbrace{\frac{\delta}{1-\delta}\left(gl^{-1} + \bar{\mu}_r l^{-1-\frac{1}{\gamma-1}}\right) + \frac{\delta}{1-\delta}(1-l)\left(gl^{-2} + \left(1 + \frac{1}{\gamma-1}\right)\bar{\mu}_r l^{-2-\frac{1}{\gamma-1}}\right)}_{+} \tag{1.27}$$

If $\epsilon < \gamma - 1$ then $F_r(l)$ is increasing in l. $\lim_{l\to 0} F_r(l) = -\infty$ $F(1) = \bar{\mu}_r + g > \bar{\mu}_r(1+g)k_r$. There is a unique steady state, in which the economy grows at the world's growth rate. If people's home preferences are high enough, that is people have sufficiently deep roots to stay in the home country even if they receive much lower wages at home than abroad, then having altruistic migrants and additional income in the form of remittances certainly will stimulate even more people to stay in the home country. For $\epsilon < \gamma - 1$ this generates enough incentives for the firms to invest into new technologies and the economy will move toward the unique steady state.

If $\epsilon > \gamma - 1$, $\lim_{l\to 0} F_r(l) = -\infty$, $F(1) = \bar{\mu}_r + g > \bar{\mu}_r(1+g)k_r$, therefore by continuity there exists a steady state, but again as in the case of no remittances, it may not be unique. An odd number of equilibria are possible in this case. The derivative could be either positive or negative, depending on which effect dominates:

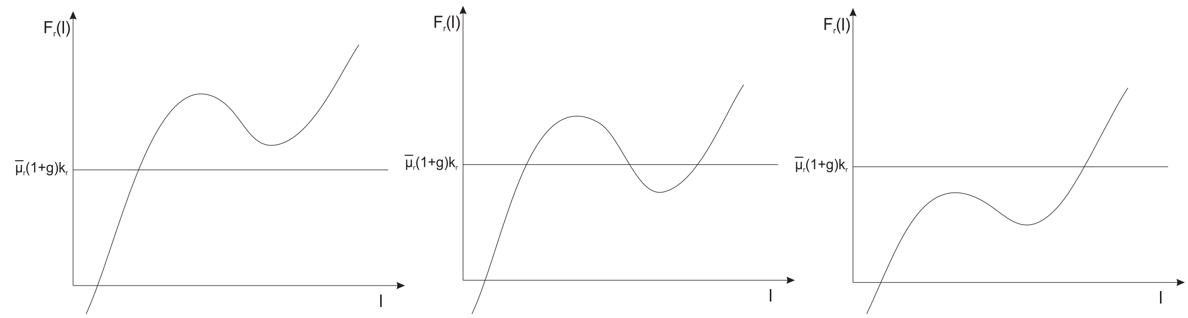

FIGURE 1.6: Steady states: unique low, multiple and unique high

$$F_r'(l) = \underbrace{\left(\frac{1}{\epsilon} - \frac{1}{\gamma-1}\right) l^{\frac{1}{\epsilon}-\frac{1}{\gamma-1}-1} \left(\bar{\mu}_r l^{\frac{1}{\gamma-1}} + g\right)}_{-} + \underbrace{\frac{1}{\gamma-1}\bar{\mu}_r l^{\frac{1}{\epsilon}-1}}_{+} +$$

$$+ \underbrace{\frac{\delta}{1-\delta}\left(\bar{\mu}_r l^{-1} + g l^{-1-\frac{1}{\gamma-1}}\right) + \frac{\delta}{1-\delta}(1-l)\left(\bar{\mu}_r l^{-2} + \left(1 + \frac{1}{\gamma-1}\right) g l^{-2-\frac{1}{\gamma-1}}\right)}_{+} \tag{1.28}$$

For sufficiently low levels of $l \rightarrow 0$, the last term, the effect of remittances, dominates and the function will be increasing in l. In general, by adding remittances we make the derivative less negative.

Three cases are possible depending on the parameter values. If the degree of altruism of migrants δ and consequently remittances are sufficiently low, and people's home preferences are also sufficiently low (that is, ϵ is sufficiently high), then the economy ends up in a unique low steady state equilibrium. For the intermediate values of δ and ϵ, multiple equilibria are possible. If δ is high enough, and ϵ is low enough then a unique high steady state equilibrium is achieved.

Having feedback from migrants and more remittances decreases the chances of the economy of ending up in a poverty trap or in a low level equilibrium. It should be noted that the poverty trap with remittances is different from the poverty trap without remittances. With no remittances, the economy diverges from the world's growth rate and eventually ends up being emptied out. In contrast, with remittances it grows at the world's growth rate. However, its relative level of technology and relative output level will be lower.

1.4.2 Dynamical system with remittances

$$a_t = (1+g)\left[1 + \frac{a_{t+1} - 1}{1 - \bar{\mu}_r(1 - m_{t+1})^{\frac{1}{\gamma-1}}}\right] \tag{1.29}$$

$$1 - m_t = \left[k_r a_t + \left(\frac{\delta}{1-\delta}\right)\frac{m_t}{1-m_t}\right]^{\epsilon} \tag{1.30}$$

The second equation implicitly determines the rate of migration as a function of proximity to frontier. Migration rate is decreasing in a_t as expected. Countries with higher technological development have lower wage differentials and holding everything else constant, lower migration. We can solve the equation (1.30) for a_t:

$$a_t = \frac{1}{k_r}\left((1 - m_t)^{\frac{1}{\epsilon}} - \frac{\delta}{1-\delta}\frac{m_t}{1-m_t}\right)$$

Differentiating this with respect to a_t yields:

$$m'(a) = -\frac{k_r}{\frac{1}{\epsilon}(1 - m(a))^{\frac{1}{\epsilon}-1} + \underbrace{\frac{\delta}{1-\delta}(1 - m(a))^{-2}}_{\text{effect of remittances}}} < 0$$

Note that since equation (1.30), defined for the period $t+1$, implicitly determines m_{t+1} as a function of a_{t+1}, we substitute $m(a_{t+1})$ in to (1.29) to get

$$a_t = \Gamma(a_{t+1}) \equiv (1+g)\left[1 + \frac{a_{t+1} - 1}{1 - \bar{\mu}_r(1 - m(a_{t+1}))^{\frac{1}{\gamma-1}}}\right]$$

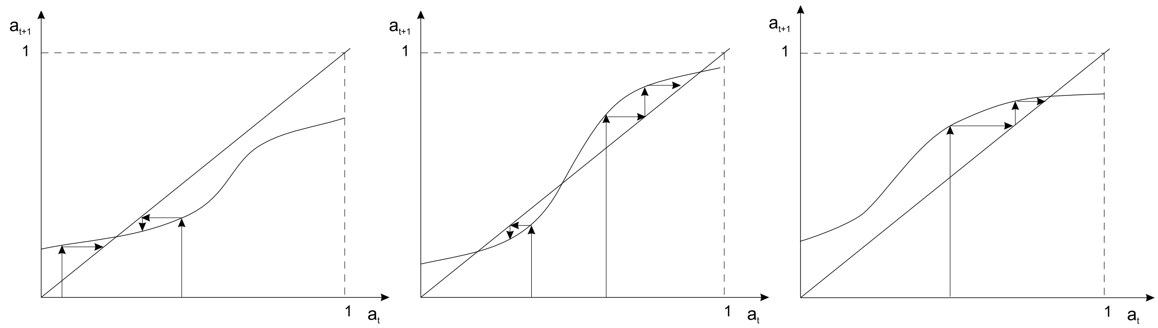

FIGURE 1.7: Dynamics with remittances: 1) low δ and high ϵ; 2) intermediate δ and ϵ; 3)high δ and low ϵ

This first-order nonlinear difference equation determines the dynamic equilibrium sequence of the proximity to frontier$\{a_t\}_{t=0}^{\infty}$, where the one-period ahead migration rate $m(a_{t+1})$ is implicitly defined by equation (1.30).

$\Gamma(0) = (1+g)\left[1 - \frac{1}{1-\bar{\mu}_r(1-m(0))^{\frac{1}{\gamma-1}}}\right] < 0$, $\Gamma(1) = 1+g > 1$, and the derivative is:

$$\Gamma'(a) = \frac{1+g}{\left(1-\bar{\mu}_r(1-m(a_{t+1}))^{\frac{1}{\gamma-1}}\right)^2}$$

$$\times \left[1-\bar{\mu}_r(1-m(a_{t+1}))^{\frac{1}{\gamma-1}} - (1-a_{t+1})\frac{\bar{\mu}_r}{\gamma-1}(1-m(a_{t+1}))^{\frac{1}{\gamma-1}-1}\times\right.$$

$$\left.\times\frac{k_r}{\frac{1}{\epsilon}(1-m(a))^{\frac{1}{\epsilon}-1} + \underbrace{\frac{\delta}{1-\delta}(1-m(a))^{-2}}_{\text{effect of remittances}}}\right]$$

Note that the derivative is increasing in the degree of altruism of migrants δ, meaning that adding remittances makes the derivative "more positive".

1.5 Conclusion

In this paper in order to study the long-run impact of emigration and remittances on a small open developing country, I have introduced endogenous migration decision and altruistic remittances into Schumpeterian growth model with technology transfer. I have characterized the steady states and dynamic paths of this economy and determined the conditions under which migration leads to multiple equilibria.

The results suggest that due to a dynamic feedback loop between migration, remittances and technology transfer the out-migration can lead to vicious and virtuous circles and to a poverty trap. Depending on the degree of people's mobility, low income countries exposed to migration might end up in a development trap. Low wage rates in these countries lead to high migration, which in turn reduces the incentives of the firms to invest into frontier technologies. Low investments result in low technology level, lower relative output and lower wages, and even higher migration next period. Potentially, this could lead to long-run divergence and emptying out of the country. Thus, the paper argues that while in the era of globalization migration to developed countries opens up better prospects and higher income for migrants themselves, the adverse impact of such movements on economic development of the countries behind merit attention.

In addition, the paper shows that having feedback from migrants in the form of remittances is important. Altruistic remittances help to reduce the negative impact of migration. In a small open economy, remittances allow people share the benefits of technological development around the world, which reduces a country's chances of ending up in a poverty trap and removes the possibility of the limiting case of divergence in growth and fully emptying out of the economy.

There are several interesting directions for future research. First, people's preferences for their country of birth and consequently their decision to emigrate might depend on a country's social and political environment. In particular, political instability, corruption, violation of human rights might trigger high emigration. The basic model I considered in the paper could be extended by linking the desire to emigrate due to these political economy issues. Second, micro evidence suggests that in addition to altruistic motives, remittances could be the result of other motives such as strategic, insurance, and exchange motives (for details see [28]) . The model then could be used to look and compare the implications of different remittance motives.

2

Migration and Remittances Under Financial Market Imperfections

2.1 Introduction

Remittances have become an increasingly important source of external funding for developing countries. They are now the second largest source of external funding after FDI, exceeding official development assistance. Despite the considerable size of migration and remittances both in absolute and relative terms and their importance for developing counties, the literature on long-run effects of migration and remittances is very limited. The analysis of the macroeconomic impact of remittances seem largely fragmented. Remittances have not been fully analyzed in a general equilibrium endogenous growth framework. The existing macroeconomic models focus mainly on international capital mobility. The macroeconomic literature on remittances and migration on the other hand is fragmented and looks at separate sectors or uses Keynesian, or Mundel-Fleming types of models with no solid microeconomic foundation.

This paper introduces migration and remittances into an endogenous growth model with financial market imperfections and analyzes the impact of migration and remittances on the long-run output level and growth of the remittance-receiving country. The combined impact of migration and remittances on the economy of the remittance-receiving country is not clear cut. On the one hand, due to migration developing countries lose an important source of economic growth: their qualified labor force. On the other hand, altruistic remittances of skilled emigrants increase the welfare of remaining residents, ease their financial constraints, and create possibilities for investment and growth. Therefore, how migration and remittances affect the growth rate of the economy depends on the relative size of migration versus remittances, depends on how far the economy is from the technological frontier, the extent of the financial constraint of the economy and whether and what part of remittances are used for consumption or investment purposes.

These links between migration, remittances and growth are related to two lines of literature in the endogenous growth theory: the literature on education and growth and the literature on financial development and growth. The literature on education and growth emphasizes the importance of education as a source of economic growth. [10] and [33] point out that human capital is an important determinant of growth. They also stress that the stock of human capital, not the rate of change, matters for growth. [33] also point out that in order to grow by imitating foreign technologies developing countries need educated labor force, not necessarily highly educated labor force as in the case of innovation, but people with secondary and higher education. In line with this strand of literature, emigration of people with higher and secondary education from developing countries decreases the stock of qualified labor force and can have a negative impact on economic growth of these countries. The literature on financial development and growth provides a substantial body of evidence that financial development is an important source for economic growth. For example, [25] find a strong robust effect of financial development on economic growth in the cross section of 71 countries. [6] extend previous work to study the issue of financial development and convergence, and show both theoretically and empirically that the lack of financial development prevents some countries to converge to the growth rate of the global technology frontier. In line with this strand of literature, remittances, if used for investment purposes, could be a substitute for financial development and ease the financial constraints faced by developing countries and therefore contribute to economic growth. Exploiting these links between migration and remittances to the growth literature, I study different effects of migration and remittances on growth and convergence depending on county's distance to technological frontier, its level of financial development, and relative sizes of migration and remittances. I derive the conditions under which migration and remittances can have positive or negative impacts on the country's growth and convergence. I show that the results depend on the degree of the country's financial development and its distance to the technological frontier. Importantly, I show that if the financial constraint is strong, so that the economy is diverging from the world's growth path, then migration and remittances can have growth effects and can increase the steady state growth rate of the country as well as the likelihood that the country will converge to the world's growth path.

2.2 Literature review

Theoretical literature on macroeconomics of remittances

Although there is an extending volume of empirical literature on remittances, the theoretical literature on the macroeconomic impact of remittances and migration seems to be very limited. [28] give an overview of existing theoretical and empirical literature on remittances both on macro and micro level. Most of the papers on the macro level cited in this overview are empirical papers.

[27] looks at remittances as a tool that alleviates liquidity constraints and promotes self-employment in developing countries. The paper builds a simple overlapping generations model of one-period-lived individuals, who can be employed, become an entrepreneur, or can migrate. The agents at the end of their life bequeath a fraction of their wealth to their children. The individuals face financial constraints if they want to become entrepreneurs. That is, for most of them the initial wealth they inherited from the previous generation is lower than the start-up cost of becoming an entrepreneur. Using this model, the author explores how migration allows shifting the economy from the underdevelopment trap to an efficient long-run equilibrium.

[15] study the joint effect of brain drain and remittances on the average level of human capital of the remaining people at home. These authors also look at remittances as a tool that alleviates liquidity constraint and promotes education in developing countries. The authors consider an overlapping generation of individuals who live for 2 periods. In period 1, individuals decide to invest in education or not to invest. Education is costly, but returns to education exceed cost of education. In the second period educated individuals can migrate. Education is both a necessary and sufficient condition for migration. By migrating, educated individuals get an even higher price for education; that is, the return to education abroad is higher than return to education at home. Education is always beneficial; however, people face a liquidity constraint. Lower and middle income class people cannot afford education and consequently not able to migrate. The positive side of migration is that migrants remit a constant fraction of their income back home. These remittances alleviate liquidity constraints as a result higher share of population has access to education. The authors explore conditions under which the beneficial effect of remittances dominates the detrimental effect of the brain drain.

Related endogenous growth literature

The current Schumpeterian growth literature emphasizes the low level of financial development and liquidity constraint as one of the reasons for poor countries to diverge from the world growth frontier. As [6] point out, financial constraints prevent poor countries from adapting new technologies that were discovered elsewhere. Financial constraints do not allow poor countries to use the possibility of international technology transfer and to take advantage of technological ”backwardness”. [6] study how the liquidity constraint affects the long-run growth and convergence. In addition to financial constraints, their model has two key components that make financial constraints an important impediment to growth. First, technology transfer is costly; the receiving country can not just take the foreign technology of the shelf. It has to make investments in order to master the world technology and to adapt it to the local environment. Second, the more advanced is the global technology, the more difficult it is to master it and the higher investment is required in order to keep imitating at the same pace as before.

As in [28] and [15], I look at remittances as a tool that alleviates financial constraints. However, I explore another channel, through which remittances and migration can potentially affect growth, namely the channel of international transfer of technology.

[14]. In contrast to other macro level studies of remittances, which look at remittances as exogenous transfers, this paper considers a unified framework with both causes and effects of remittances. The authors model remittances as altruistic transfers in a sense that the utility of the migrant depends on the utility of the family members left behind. Under such setting the authors argue that remittances may lead to moral hazard. Recipients can decrease their labor force participation, reduce labor effort, or invest in risky projects. Using a panel of data for 113 developing countries, [14] find that remittances are countercyclical and have a negative effect on economic growth.

However, there are also empirical papers that find positive impact of remittances on economic growth. [19] use a large sample of cross-country data, and look at the interaction between remittances and financial development and its impact on economic growth. They explore the hypothesis that remittances in developing countries can substitute for the lack of financial development. They argue that potential entrepreneurs can use remittances whenever the financial system does not help them invest into productive activity due to high interest rates or lack of collateral. Empirical results of this paper suggest that remittances have compensated for a bad financial system and promoted growth in financially less developed countries.

[21] study the effect of brain drain on economic growth and human capital formation by looking at the cross country evidence and estimating growth and human capital equations. They find that countries that are subject to high levels of brain drain have lower level of human capital and lower growth rates. They consider two possible ways by which migration could effect growth: direct (remittances, FDI and trade linkages, return migration) and through the impact on human capital (which itself could be both negative and positive).

2.3 Model Description

2.3.1 General Description

As in [6], I consider a developing country, with the level of technology behind the world's level of technology $\bar{A}$. The world level of technology growth at the constant rate g. There is a possibility of technology transfer, the possibility of growth by implementing new technologies that have been discovered elsewhere. However, the transfer of technology is costly. The developing country cannot just take and implement the foreign technologies off the shelf. The transfer of technology and the resulting growth requires resources. The availability of these resources affects the country's "absorptive capacity".

Migration is modeled as an exogenous one-time decrease in the labor supply and remittances enter as transfers to the households. Thus, the total labor L in this economy can work in the final goods sector and can migrate to another country L_M. Suppose, for now, that migration is exogenous, and some fixed L_M migrates. These people send some fraction γ of their labor income back home. Thus, remittances, $T_t = \gamma w_{Mt} L_M$, enter as an additional income in the budget constraint of the remaining people. The wage rate of those who migrate equals the world's wage rate adjusted by the sending country's distance to technological frontier $w_{Mt} = a_t \bar{w}_t$, where w_{Mt} is the wage rate of migrants, and $\bar{w}_t > w_t$ is the world's wage rate. This reflects the fact that migrants from low income countries receive relatively lower wages, compared to migrants from technologically advanced countries.

As in [6], it is also assumed that because of the low level of financial development and (low wealth) the inventors in the country are financially constrained. So, the remittances from abroad can help to ease this financial constraint.

2.3.2 Final goods sector

A final good Y in the country is produced competitively and can be used for consumption, as an input in research, and also as an input into the production of intermediate goods. It is produced using labor and a continuum of specialized intermediate goods according to the production function:

$$Y_t = (L - L_M)^{1-\alpha} \int_0^1 A_t(i)^{1-\alpha} x_t(i)^{\alpha} di \tag{2.1}$$

where $x_t(i)$ is the input of the latest version of the intermediate good i and $A_t(i)$ is the productivity parameter associated with it. L is the total population (labor is supplied inelastically) and L_M is number of people who have migrated abroad.

The price of each intermediate good equals its marginal product:

$$p_t(i) = \alpha(L - L_M)^{1-\alpha} \left(\frac{x_t(i)}{A_t(i)}\right)^{\alpha-1} \tag{2.2}$$

2.3.3 Intermediate goods sector

In each intermediate goods sector there is a possibility of imitation of the world's frontier technology. Suppose that the probability of success in imitation in the intermediate goods sector is $\mu_t(i)$. If an entrepreneur succeeds he gets to implement the world's frontier technology $\bar{A}_t$. That is:

$$A_t(i) = \begin{matrix} \bar{A}_t & \text{with probability } \mu_t(i) \\ A_{t-1}(i) & \text{with probability } 1 - \mu_t(i) \end{matrix} \tag{2.3}$$

If an entrepreneur succeeds, he can produce any amount of intermediate good at the cost of one unit of final good per unit of intermediate good. In addition there are also other producers that can produce copies of this intermediate good, but at a higher unit cost of $\chi > 1$. Thus, in sectors in which an innovation has just occurred, the incumbent is the sole producer and charges the price of χ. The monopoly rent of the incumbent is assumed to last for 1 period only, after, which imitation allows other individuals to produce intermediate goods of the same quality. In non-innovating sectors production takes place under perfect competition, with the price equal to the unit cost of each competitive producer χ. Thus, given that $p_t(i) = \chi$ the quantity demanded of the intermediate good i will be:

$$x_t(i) = \left(\frac{\alpha}{\chi}\right)^{\frac{1}{1-\alpha}} A_t(i)(L - L_M) \tag{2.4}$$

The profit of an incumbent will be:

$$\pi_t(i) = (p_t(i) - 1)x_t(i) = (\chi - 1)\left(\frac{\alpha}{\chi}\right)^{\frac{1}{1-\alpha}} (L - L_M)\bar{A}_t = \pi(L - L_M)\bar{A}_t \tag{2.5}$$

where $\pi = (\chi - 1)\left(\frac{\alpha}{\chi}\right)^{\frac{1}{1-\alpha}}$.

Substituting equation 4 into 1 gives the amount of the final good produced:

$$Y_t = \left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}} A_t(L - L_M) = DA_t(L - L_M) \tag{2.6}$$

where $D = \left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}}$ and A_t is the average level of productivity in the country, given by:

$$A_t = \int_0^1 A_t(i)di \tag{2.7}$$

In equilibrium the probability of innovation in each sector is $\mu_t(i) = \mu_t$ for all i and the average productivity has the following law of motion:

$$A_t = \mu_t \bar{A}_t + (1 - \mu_t)A_{t-1} \tag{2.8}$$

The the country's normalized productivity defined as $a_t = A_t/\bar{A}_t$ will evolve according to:

$$a_t = \mu_t + \frac{1 - \mu_t}{1 + g} a_{t-1} \tag{2.9}$$

a_t is the inverse measure of country's technology gap or so called distance to frontier.

Since the final goods sector is competitive the wage rate equals marginal product of labor:

$$w_t = (1 - \alpha)\frac{Y_t}{L - L_M} = (1 - \alpha)\left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}} A_t = BA_t \tag{2.10}$$

where $B = (1 - \alpha)\left(\frac{\alpha}{\chi}\right)^{\frac{\alpha}{1-\alpha}}$

2.3.4 Innovation

The technology transfer or the imitation of the world's frontier technology is costly. The probability of success in imitation μ_t depends on the amount of resources invested in to research. Investments in research are made in units of final output. The production function for imitation is given by

$$\mu_t = f\left(\frac{N_{t-1}}{\bar{A}_t}\right) \tag{2.11}$$

where $f' > 0, f'' < 0, f(0) = 0$, and N_{t-1} is the amount of investment into research in terms of final output made in the previous period. The division by frontier level of technology $\bar{A}_t$ means that the further ahead the frontier moves the more difficult it is to imitate it. The cost function can be expressed as:

$$N_{t-1} = \bar{A}_t f^{-1}(\mu_t) = \bar{A}_t n(\mu_t) \tag{2.12}$$

The entrepreneurs will maximize the following expected payoff from imitation with respect to μ_t:

$$\beta\mu_t\pi_t - N_{t-1} = \beta\mu_t\pi(L - L_M)\bar{A}_t - n(\mu_t)\bar{A}_t \tag{2.13}$$

subject to the credit constraint.

2.3.5 Equilibrium with no credit constraints: level effects of migration and remittances

Suppose that there is no credit constraint and entrepreneurs can borrow unlimited amounts at the interest rate $r = \beta^{-1} - 1$ from the rest of the economy. Then the marginal rate of return to research should be equal to marginal cost of research:

$$n'(\mu_t) = \beta\pi(L - L_M) \tag{2.14}$$

Thus, the solution to this equation, μ^*, is constant over time. It depends on the number of people in the economy. If migration L_M goes up, the probability of success in research goes down. The lower the labor, the lower the demand for intermediate goods for a given price χ, and the lower the profits of entrepreneurs, which gives less incentives to invest into research and imitate.

The investment into research is given by:

$$N_{t-1} = n(\mu^*)\bar{A}_t = n^*\bar{A}_t \tag{2.15}$$

which gives the following law of motion for the county's technology gap:

$$a_t = \mu^* + \frac{1-\mu^*}{1+g}a_{t-1} = F_1(a_{t-1}) \tag{2.16}$$

which converges in the long-run to the steady state value of:

$$a^* = \frac{(1+g)\mu^*}{g+\mu^*} \tag{2.17}$$

Thus, increased migration increases the technology gap of the country.

Output of the final goods sector will be:

$$Y_t = D(L - L_M)a^*\bar{A}_t \tag{2.18}$$

The general good output will decline after labor migration both from direct effect of decreased labor input and indirect effect of low innovation. However, in the steady state, the effect of migration on final goods output is the level effect only, and the growth rate of output in the steady state will follow the world's growth rate g.

Households receive income from 3 different sources: wages, profits and remittances. As described above, remittances are given by:

$$T_t = \gamma \bar{w}_t L_M a_t \tag{2.19}$$

Assuming that world's wage rate, $\bar{w}$, is derived from similar processes as in home country with possibly different parameter values $\bar{w} = (1-\bar{\alpha})\left(\frac{\bar{\alpha}}{\bar{\chi}}\right)^{\frac{\bar{\alpha}}{1-\bar{\alpha}}}$ and remittances are equal to:

$$T_t = \gamma(1-\bar{\alpha})\left(\frac{\bar{\alpha}}{\bar{\chi}}\right)^{\frac{\bar{\alpha}}{1-\bar{\alpha}}} \bar{A}_t L_M = \gamma \bar{B} \bar{A}_t L_M a_t \tag{2.20}$$

where $\bar{B} = (1-\bar{\alpha})\left(\frac{\bar{\alpha}}{\bar{\chi}}\right)^{\frac{\bar{\alpha}}{1-\bar{\alpha}}}$

Let $\tau_t = T/(L-L_M)$ be remittances per capita.

Then per-capita income of remaining residents is given by:

$$I_t^* = w_t + \tau_t + \frac{\pi_t}{L-L_M} = \left[Ba^* + \mu^*\pi + \gamma\bar{B}\frac{L_M}{L-L_M}a^*\right]\bar{A}_t \tag{2.21}$$

Remittances increase per-capita steady state income, on the other hand migration decreases per-capita steady state income through its effects on profits and wages.

The net impact of migration and remittances on per-capita income is ambiguous depending on which effect dominates. If migration is high relative to the size of remittances, then the net impact is negative. If, on the other hand, remittances are high due to the highly altruistic nature of migrants or large technology gap, which results in a large differential in the wage rates between the sending and receiving countries, then the remittance effect dominates, resulting in higher per-capita income. In this respect, south-north migration or migration between technologically distant countries is more likely to result in a positive impact of migration on per-capita income.

2.3.6 *Credit constraints and growth effects*

Following [6] I assume that the credit markets are imperfect. Suppose that imitations are undertaken by entrepreneurs who have access to wage income w_t and remittances τ_t. In order to undertake research investment each entrepreneur borrows $N_t - w_t - \tau_t$. The conditions of the loan are as follows: the entrepreneur pays the loan plus interest to the lender if the project is successful; he does not pay anything if the project is not successful. That is, the expected payment on the loan in the next period is $\mu(N_t - w_t - \tau_t)R$, where μ is the probability of success and R is the interest factor on the loan. Suppose now that credit markets are imperfect and entrepreneurs can avoid repaying their debt by hiding the success of their imitation at a cost cN_t, which is paid upfront. The entrepreneur will not hide the success of his project if the following incentive compatibility constraint (ICC) holds:

$$cN_t \geq \mu(N_t - w_t - \tau_t)R \tag{2.22}$$

The lenders in this economy are the other people, who can lend at the expected rate of return r. Therefore, in equilibrium, the following arbitrage condition should hold:

$$\mu R = 1 + r \tag{2.23}$$

Substituting the arbitrage condition into ICC:

$$cN_t \geq (1 + r)(N_t - w_t - \tau_t) \tag{2.24}$$

gives the following ICC:

$$N_t \leq \frac{1 + r}{1 + r - c}(w_t + \tau_t) \tag{2.25}$$

If the optimal equilibrium solution with no constraints violates the ICC, then the ICC is binding in equilibrium. Thus the ICC binds if:

$$n^*\bar{A}_{t+1} \geq \frac{1+r}{1+r-c}\left(BA_t + \gamma\bar{B}\bar{A}_t\frac{L_M}{L-L_M}a_t\right) \tag{2.26}$$

Dividing both sides by $\bar{A}_t$ gives:

$$n^* \geq \frac{1+r}{(1+r-c)(1+g)}\left(B + \gamma\bar{B}\frac{L_M}{L-L_M}\right)a_t \tag{2.27}$$

Let us denote $\omega(c, L_M, \gamma) = \frac{1+r}{(1+r-c)(1+g)}\left(B + \gamma\bar{B}\frac{L_M}{L-L_M}\right)$. $\omega(c, L_M, \gamma)$ is an increasing function of migration, and an indicator of financial development.

Then the inequality above can be written as:

$$a_t \leq \frac{n^*}{\omega(c, L_M, \gamma)} \tag{2.28}$$

Thus, the ICC constraint is binding if the economy is too far behind the technology frontier. In this case research and imitation requires large amount of resources. Consequently, entrepreneurs need large amounts of loans to invest into research and have higher incentive to hide the success of their research. What remittances do is that they extend the set of technology gaps at which ICC is not binding. Higher levels of remittances help to ease financial constraint and allow countries that are further away from the the technology frontier grow at the world's growth rate.

If the ICC constraint is binding then each entrepreneur will spend the maximum possible on technology, the amount that satisfies constraint (2.28) with equality:

$$n_t = \frac{1+r}{(1+g)(1+r-c)}\left(B + \gamma\bar{B}\frac{L_M}{L-L_M}\right)a_t = \omega(L_M, \gamma, c)a_t \tag{2.29}$$

Given, this amount of investment n_t, the probability of the innovation is $\mu_{t+1} = f(n_t) = f(\omega(L_M, \gamma, c)a_t)$, where f is an increasing and concave function and takes values between 0 and 1.

The low of motion of the technology distance then is:

$$a_{t+1} = \mu_{t+1} + \frac{1-\mu_{t+1}}{1+g}a_t = f(\omega(L_M, \gamma, c)a_t) + \frac{1 - f(\omega(L_M, \gamma, c)a_t)}{1+g}a_t = F_2(a_t) \tag{2.30}$$

Since the function F_2 is increasing in $\mu = f(\omega(L_M, \gamma, c)a_t)$ and the function f is increasing in a_t, then F_2 is an increasing function of a_t. Also, since the first derivative of F_2 is decreasing in a_t; $F_2'(a) = \omega f'(\omega a)\left(1 - \frac{a}{1+g}\right) + \frac{1}{1+g}(1 - f(\omega a))$. F_2 is a concave function of a_t. Also note that at $a_t = 0$, $F_2(0) = 0$.

The function F_2 is also increasing in L_M. Increased migration and, consequently, a higher level of remittances relaxes the financial constraint and shifts the F_2 curve up. This effect of relaxing financial constraint is similar to the effect of financial development. However, in contrast to the case of financial development, remittances are tied to migration, and as a result are accompanied by the loss of human capital. This effect on the graph is captured by shifting down the unconstrained $F_1(a_t)$ line.

Depending on the strength of financial constraint there are the following three cases to consider.

Case 1: Convergence in growth rate with negative level effect of migration and remittances

If a country has a well developed financial system so that it is not financially constrained in the steady state, then the negative impact of migration dominates the positive impact of remittances. Migration leads to a lower level of steady state GDP per capita.

Higher migration results in lower equilibrium probability of innovation μ^*, which shifts the unconstrained $F_1(a_t)$ line down.

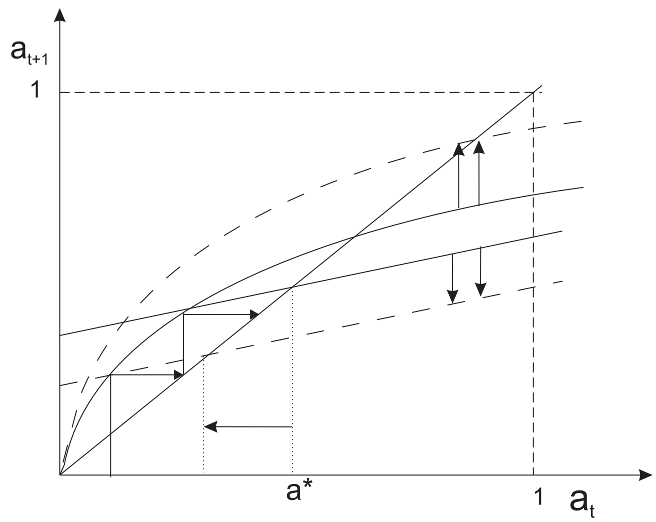

FIGURE 2.1: A country with high level of financial development and negative level effect of migration and remittances

$$a_{t+1} = \mu^* + \frac{1-\mu^*}{1+g} a_t = F_1(a_t) \tag{2.31}$$

Higher remittances from migration, on the other hand, relax the financial constraint and shift the $F_2(a_t)$ line up, since

$$\frac{\partial F_2}{\partial L_M} = \left(1 - \frac{a}{1+g}\right) \frac{\partial f(\omega(L_M, \gamma, c) a_t)}{\partial L_M} > 0$$

Proposition 7. *If*

$$\frac{n^*}{a^*} \leq \omega(L_M, \gamma, c)$$

then a_t will asymptotically converge to the unconstrained steady state and higher migration and remittances lead to a lower level of relative GDP per capita in the steady state.

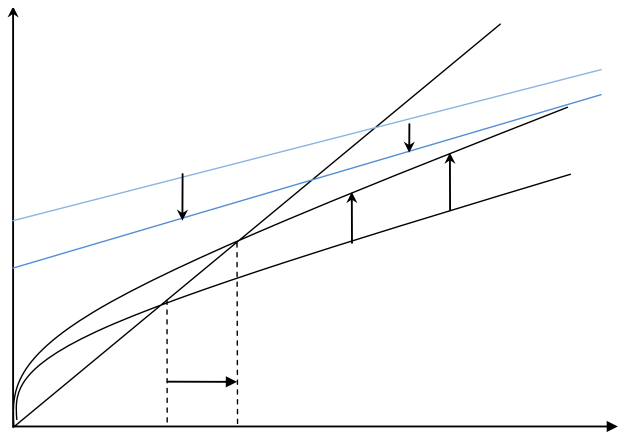

FIGURE 2.2: A country with low level of financial development and positive level effect of migration and remittances

Case 2: Convergence in the growth rate and positive level effect of migration and remittances

If a country's financial development is relatively low and financial constraint is binding in the steady state, but the country converges to the frontier growth rate, then positive impact from higher remittances dominates the negative impact of migration. Migration and remittances have positive level effect on the steady state relative GDP per capita.

Proposition 8. *If*

$$\frac{1}{f'(0)}\frac{g}{1+g} \leq \omega(L_M, \gamma, c) < \frac{n^*}{a^*}$$

then a_t converges to its constrained steady state value and up to the certain point migration and remittances have positive level effect on the relative GDP per capita in the steady state.

It should be noted, however, that because of the tradeoff from loss of human capital, the achieved relative GDP per capita is always less than the original unconstrained relative per capital GDP.

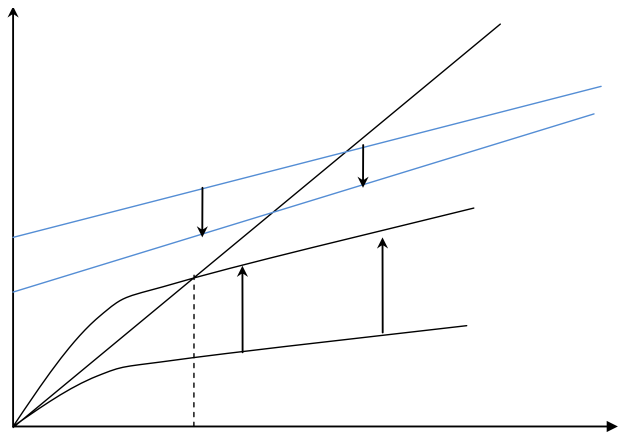

FIGURE 2.3: A country with low level of financial development and positive growth effect of migration and remittances

Case 3: Divergence in the growth rate and growth effect of remittances

If the slope of F_2 line at 0 is less than 1, then the country fails to converge to the frontier growth rate. The slope of F_2 at 0 is

$$F_2'(0) = \omega(L_M, \gamma, c)f'(0) + \frac{1}{1+g}$$

.

Since $f'(0) > 0$ and $\omega(L_M, \gamma, c)$ is increasing in its arguments, higher migration and consequently remittances increase the slope of the F_2 curve at 0. Therefore, in a country in which financial constraint is leading to the divergence from the world's growth rate, migration and remittances increase the growth rate of the economy and can potentially lead to the convergence to the frontier growth rate. This is stated in the following proposition.

Proposition 9. *If the following condition holds:*

$$\omega(L_M, \gamma, c) < \frac{1}{f'(0)}\frac{g}{1+g}$$

then there is a divergence in the growth rate and an increase in migration and remittances has positive growth effects.

Thus, depending on the strength of financial constraint there are three cases with different effects of migration and remittances. 1) The first case is when the country has a relatively better developed financial system. The financial constraint is not binding at the steady state and the country converges to the frontier growth rate on its own. Then, the negative effect from migration dominates the positive effect of remittances. Therefore, migration and remittances decrease the steady state level of per-capita GDP relative to the frontier. 2) The second case is when the financial constraint is stronger. It is binding at the steady state, but the country still converges to the frontier growth rate. In this case, migration and remittances increase the level of steady state relative GDP per capita. However, because of the tradeoff from loss of human capital, the achieved relative GDP per capita is always less then the original unconstrained relative per capita GDP. 3) Finally, if a country faces severe financial constraint, such that its steady state growth rate fails to converge to the frontier growth rate, then remittances can have growth effects and can increase the steady state growth rate of the country and the likelihood that the country will converge to the frontier growth rate.

2.4 Empirical Test

The purpose of this section is to run a cross-country growth regression, which in addition to the other growth determinants includes data on migration, remittances and financial development and interaction terms of these variables.

The following growth regression is estimated:

$$g_i = \beta_0 + \beta_f F_i + \beta_y y_i + \beta_{fy} F_i y_i + \beta_r Rem_i + \beta_m hMH_i + \beta_m lML_i \beta_{rmh} Rem_i MH_i + \beta_{rf} F_i Rem_i + \epsilon_i \tag{2.32}$$

where g_i is the average growth rate of per-capita GDP, F_i is the average level of financial development, y_i is the initial log of GDP per capita (1960 is taken as initial year). Rem_i is the ratio of remittances to GDP, MH_i is the emigration rate of high and medium skilled workers for the year 2000, defined as a stock of working-aged individuals with higher or secondary education born in country i and living in OECD countries in percentage of the high or medium skilled labor force in country i. ML_i is the emigration rate of low skilled workers.

Data on remittances

For remittances I plan to use World Bank's data on remittances from the World Development Indicators database. The earliest remittances data available are from 1970. I use the remittances to GDP ratio.

Data on financial development

[25] construct measures of financial intermediation for 71 countries over the period 1960-1995. The same data are used by [6]. There are three indicators of financial intermediary development in the database: Liquid Liabilities, Commercial-Central Bank and Private Credit. Liquid Liabilities equals liabilities of the financial system (currency plus demand and interest-bearing liabilities of banks and nonbank financial intermediaries divided by GDP). Commercial-Central Bank equals the ratio of commercial bank assets divided by commercial bank plus central bank assets. Private credit equals the value of credits by financial intermediaries to the private sector divided by GDP. The database also contains data on legal origins, which is a set of zero-one variables, indicating whether the country's legal system is based on French, English, German or Scandinavian traditions. As in [25], variables on legal origin are used as instruments for financial development.

Data on migration

For migration data I plan to use International Migration Database by Educational Attainment (1990-2000) by Docquier and Marfouk. This database contains emigration stocks for 174 origin countries in 1990 and for 195 countries in 2000. Based on the census data for all OECD countries the authors count as migrants all working-aged (25 and older) foreign-born individuals living in an OECD country. Migrants are broken down into 3 categories according to their education level: high-skilled, medium-skilled and low-skilled. The database contains emigration stocks by educational attainment from all countries of the world for 2 years: 1990 and 2000. The data set also contains emigration rates by educational attainment: the raw emigration numbers evaluated in percentage of the total labor force born in the sending country(including the migrants themselves).

Results

Since financial development variable maybe endogenous, it can a result of economic growth rather than its underlying cause, I use legal origin variables and their interaction with the initial output to instrument for financial development.

Tables 1 and 2 below give the regression results for 2 measures of financial development respectively: Private Credit and Liquid Liabilities. The results show that remittances taken separately have positive and significant impact on economic growth, migration of people with higher and secondary education is negatively correlated with economic growth, but migration of low skilled workers is positively correlated with growth. The coefficients on both types of migration are significant at the 1 percent significance level. As in [6], financial development interacted with the initial output has a negative significant effect on growth, meaning that convergence depends positively financial development.

Also, although not significant, interaction of remittances with financial development has negative impact on growth in both regressions, indicating that remittances could be a substitute for financial development. As described in the theoretical section, the higher the level of financial development and the less credit constrained are the agents in the economy, the lower the impact of remittances on economic growth. However, if the financial constraints in the economy are high, then remittances could be the only source of investment for the households and higher remittances could

Table 2.1: Results using Private Credit as a measure of financial development

Regressors	Coefficient	t-stat
Initial Output (1960)	0.8016*	1.85
Financial Development	0.2644***	2.84
Low-skilled Migration	16.4238***	3.65
High and Medium Skilled Migration	-2.6906***	-2.75
Remittances to GDP ratio	0.4177**	1.94
Financial development X Initial output	-0.2909***	-2.68
Remittances X Financial Development	-0.0039	-0.67
High Skilled Migration X Remittances	-0.4487*	-1.7

Table 2.2: Results using Liquid Liabilities as a measure of financial development

Regressors	Coefficient	t-stat
Initial Output (1960)	1.3348**	2.51
Financial Development	0.2887***	2.94
Low-skilled Migration	11.8680***	2.69
High and Medium Skilled Migration	-2.8554***	-3.16
Remittances to GDP ratio	0.4072*	1.86
Financial development X Initial output	-0.0324***	-2.72
Remittances X Financial Development	-0.0047	-1.04
High Skilled Migration X Remittances	-0.3145	-1.31

stimulated economic growth.

Also, as the theoretical section predicts, the coefficient on the interaction of skilled migration and remittances is negative, indicating that the positive impact of remittances depends on the level of migration, the higher the rate of migration, the lower the positive impact of remittances.

2.5 Conclusion

This chapter looked at the migration and remittances under financial market imperfections. The effect of migration and remittances on the sending country in this case depends on the country's degree of financial development. migration and remittances

If a country has a relatively well developed financial system so that the financial constraint is not binding in the steady state, then migration leads to a lower level of steady state GDP per capita. On the other hand, if a country's financial development is relatively low and financial constraint is binding in the steady state, but the country converges to the frontier growth rate, then positive impact from higher remittances dominates the negative impact of migration. Migration and remittances have positive level effect on the steady state relative GDP per capita. Finally, if a country's financial constraint is leading to the divergence from the world's growth rate, migration and remittances increase the growth rate of the economy.

3

Private Transfers and International Remittances in Kyrgyzstan's Post Transition Environment: Results from a New Household Panel Dataset *(with C. Becker)*

3.1 Introduction

Remittances have become an important source of external funding for Kyrgyzstan. Remittance flows to Kyrgyzstan in recent years exceed the annual amounts of international aid and foreign direct investments ([22]). What is the impact of such transfers on the wellbeing of Kyrgyz households? Do remittances promote investments and economic growth, do they help to reduce poverty? The answer in the literature is not clear cut. While some studies argue that remittances only support immediate consumption needs of the receiving households and make no contribution to productive investment and growth, others argue that remittances can allow investments that would not have been otherwise possible due to financial constraints faced by households in developing countries. Studies find that remittances can contribute to higher investments both in physical and human capital. For example, [4] find that children from remittance receiving households are likely to stay at school and have better health indicators.

In relation to the impact of remittances on investment there is an interesting argument in [12] that some people migrate explicitly with an intention to earn enough money for domestic investment purposes. The factors contributing to such a choice are liquidity constraints, relatively low wage rates, high business start-up costs in the home country and much higher wages and income generating and savings potential abroad. In the case of Kyrgyzstan, from my personal observation, some people migrate temporarily to earn higher wages and to be able to afford their children's higher education. That is some migrate in order to invest in the human capital of their children.

Most of the existing studies on remittances however use cross-sectional data and can potentially suffer from the omitted-variable bias [1]. The possibility of omitted variable bias is great when looking at the effect of remittances on household outcomes, since remittances are necessarily tied to migration. The pool of migrants and consequently remittance senders, in turn, is not a random sample. Migrant families are usually systematically different from non-migrants. Therefore, any observed effect of migration or remittances on the household outcome might be the effect of the third factors, for example such household's characteristics as wealth, ability, education, entrepreneurial spirit and so on. If these household characteristics are unobservable and correlated with remittances then the OLS estimator would not be consistent. For example, more entrepreneurial and ambitious households might send members abroad and receive higher remittances and also have higher investment levels. Not controlling for the entrepreneurial spirit of the household results in an upward bias of the effect of remittances on investment in the OLS regression.

One way to address this potential omitted-variable-bias problem would be to

[1] with the exception of [35] which uses panel data from the Philippines

have a panel structure, which is the case in this study. In this study we exploit a new panel data for Kyrgyzstan to study the effect of remittances on 3 household outcomes as proxies: purchases of durable goods. With repeated observations for the same households that we have in the panel data it becomes possible to control for household specific effects that are unobserved but constant over time, and that might be correlated both with remittances and the outcome of interest. Hence, using panel data helps us to avoid omitted variable bias created by time-invariant unobservable omitted variables.

The rest of the paper is organized as follows. In section 2 we describe the data set and look at the descriptive statistics. Section 3 describes econometric methodology and the results of the estimation. Finally, section 4 concludes.

3.2 Data and Descriptive Statistics

This study uses panel data that has been created using Kyrgyz Integrated Household Survey (KIHS) data for 3 years, 2005-2007. The original number of households was 4803 for 2007, 4863 for 2006 and 4771 for 2005. The total number of the same households present in all 3 years is 2963.

This nationally representative survey contains detailed information on demographic characteristics, health and education of the households as well as expenditure and income information. Although in this study we use households as our unit of analysis, the panel was created both on the individual level and on the household level.[2]

The Income section of the KIHS data contains information on the transfers received by households. In particular it contains a question "What aid did you family

[2] KIHS survey was designed as a panel survey (with about 20 percent replacement rate each year), but no panel id on the individual level was created. We merged the households based on the following criteria: oblast, urban or rural location, and the date of birth of the household head. After merging the households, on the individual level individuals were merged based on the date of birth and the gender.

receive from your relatives and or acquaintances (in kind aid is also evaluated and added)". Thus, we have information on whether the household received a transfer and on the amount of the transfer. For 2005-2007 the survey breaks down transfers into transfers received from outside the territory of Kyrgyzstan and transfers within the country. We will use this information on outside transfers as remittances and look at the determinants of remittances and their impact on the households, in particular whether or not remittances affect the purchases of durable goods by the households. Unfortunately, the survey does not provide any other information on the sources of the transfers, or on the purposes of transfers. There is also no information on the amount of transfers sent by the households in the expenditure section of the survey.

The percentage of households receiving directly recorded remittances from abroad is only 5 percent. This number is very low. For comparison, [22] reports based on the nationally representative survey of 4200 households in 2006 that 15.8 percent of households in Kyrgyzstan received remittances from abroad, which is in our opinion closer to reality. The percentage of households receiving transfers in general (both from people within the country and abroad) is 41 percent, very high compared to remittances.

There are could be several explanations for this low remittance-receiving proportion of households. First, low quality data and misinterpretation of the survey question by respondents or even interviewers and coders are possibilities. Second, a large proportion of Kyrgyz migrants have left Kyrgyzstan together with their families. Russia gives Russian citizenship for people who want to live in Siberia and underpopulated Russian regions. Therefore, there will be no transfers if the whole family is migrated. Third, there are strong interfamilial linkages and connections among distant relatives in Kyrgyzstan. Remittances could be redistributed and hence reported in the survey as interhousehold transfers within the country.

All three years of the survey contain information on the households' possession of durable goods (including vehicles, personal computers, electronics, furniture, etc.) and when these durable goods were purchased. We generate a binary variable equal to one if the household has purchased at least one of these durable goods at the year when the remittances were made and zero otherwise.

We first look at the determinants of both interhousehold transfers in general and remittances in particular. Ideally, the determinants should include characteristics of the person sending the transfers. However, the survey does not contain any information on the senders. We look at the characteristics of the receivers that affect the probability of getting transfers (remittances). The dependent variable is a binary variable, indicating the fact that the household received transfers (remittances). It equals one if the amount of transfers (remittances) is positive and zero otherwise.

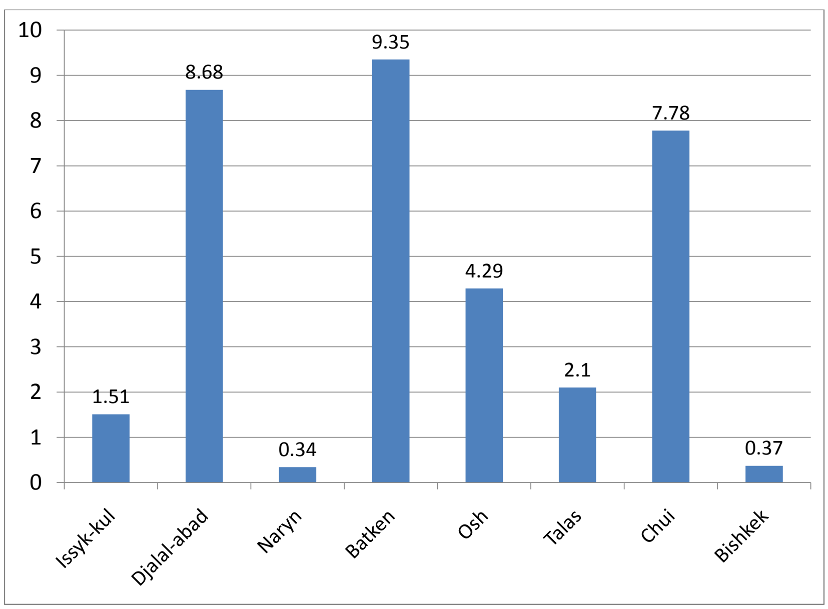

Figure 3.1: Percentage of Households Receiving Remittances by Oblast

There is a high variation in the number of households receiving remittances by oblasts. The percentage of households receiving remittances is relatively high in the southern region in Batken and Djalal-abad in particular, (9.4 and 8.7 respectively) and very low in Naryn and Bishkek (See Fig. 3.1).

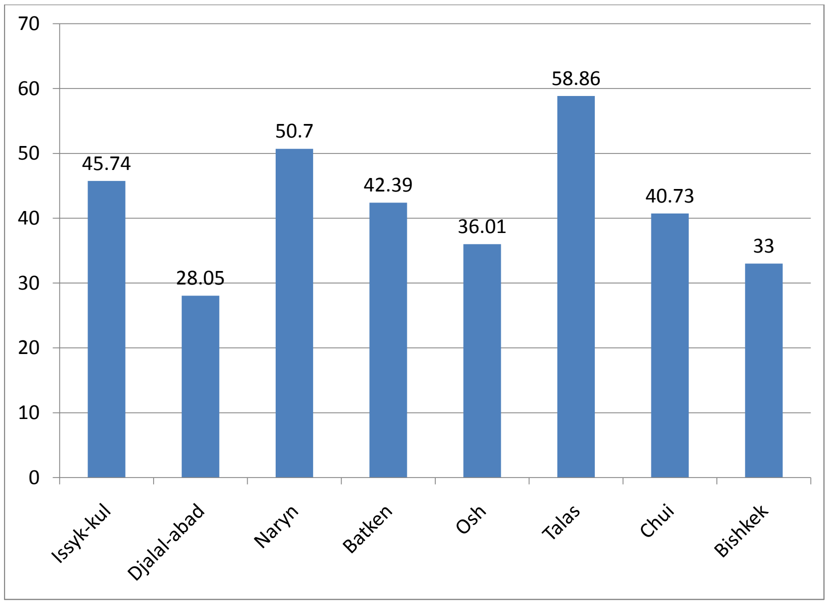

FIGURE 3.2: Percentage of Households Receiving Transfers by Oblast

Percentage of households receiving transfers also vary among oblasts: from 59 percent in Talas to 28 percent in Djalalabad. The regional pattern does not change much by year (See Fig. 3.2 and Fig. 3.3).

There is not much difference in transfer or remittance patterns in urban and rural areas (See Table 3.1). The regional differences come from differences among oblast and whether the household is located in Northern or Southern Kyrgyzstan. In general, the highest percentage of households receiving transfers is in the rural north, whereas the highest percentage of household receiving remittances is in the urban south. Transfers are received by 46 percent of rural northern households out by only

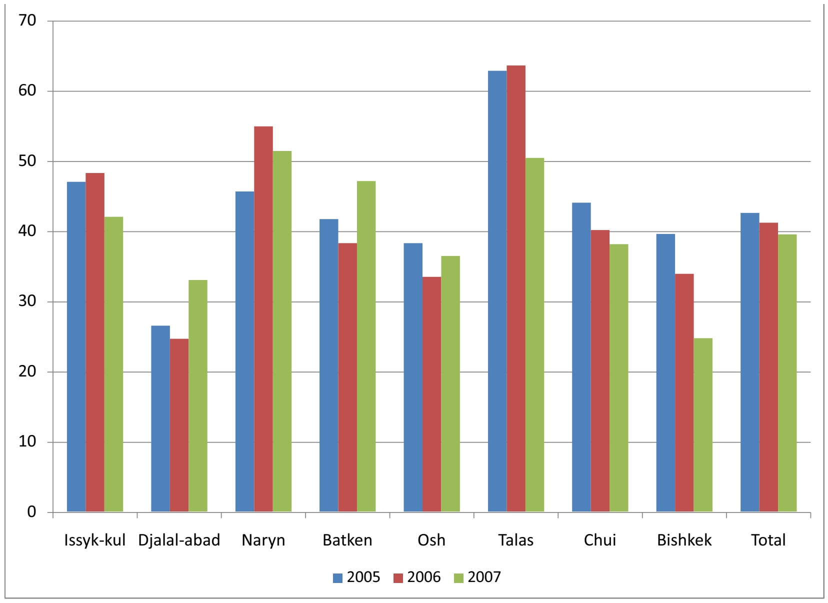

Figure 3.3: Percentage of Households Receiving Transfers by Oblast and Year

28 percent of rural southern households. Remittances are received by 8 percent of Urban-South households and only 1.9 percent of Urban-North households.

Table 3.1: Percentage of households receiving remittances and transfers by regions

Region	Households receiving Remittances	Households receiving Transfers
Urban-North	1.92	43.97
Rural-North	3.34	45.92
Urban-South	7.99	39.85
Rural-South	6.25	27.74
Urban	4.1	42.49
Rural	4.47	38.85

The variation of remittances by age of the household head is shown on Fig. 3.4. The probability of receiving remittances is higher for the households with older household heads. The age group of the household head with the highest percentage of households receiving transfers is from 61 to 70 years old.

Fig. 3.5 shows transfers by age group of the household head. It is interesting to

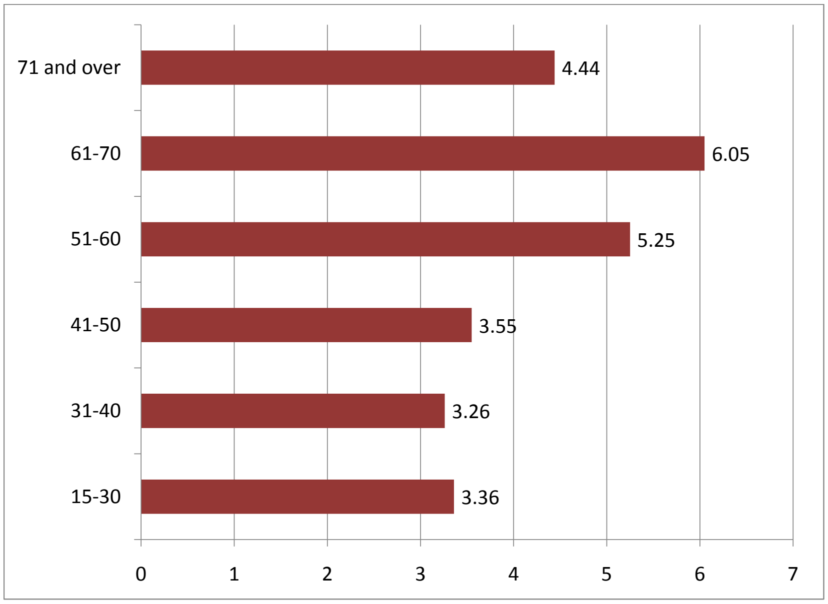

FIGURE 3.4: Percentage of Households Receiving Remittances by Age of Household Head

Table 3.2: Descriptive Statistics of the Sample based on the Receipt of Private Remittance and Receipt of Transfers

	Remittances			Transfers		
	No	Yes	All	No	Yes	All
Head female	0.35	0.47	0.36	0.30	0.40	0.34
Head married	0.63	0.57	0.63	0.64	0.54	0.60
% of individuals aged < 6	0.10	0.09	0.10	0.09	0.10	0.10
% of individuals aged 7-15	0.18	0.17	0.18	0.19	0.18	0.18
% of individuals aged < 18	0.35	0.32	0.35	0.35	0.34	0.35
% of elderly	0.17	0.23	0.17	0.16	0.19	0.17
% of working age individuals	0.48	0.45	0.48	0.49	0.47	0.48
Head age	50.30	53.03	50.42	50.67	50.05	50.42
Head with higher education	0.18	0.10	0.18	0.18	0.16	0.17

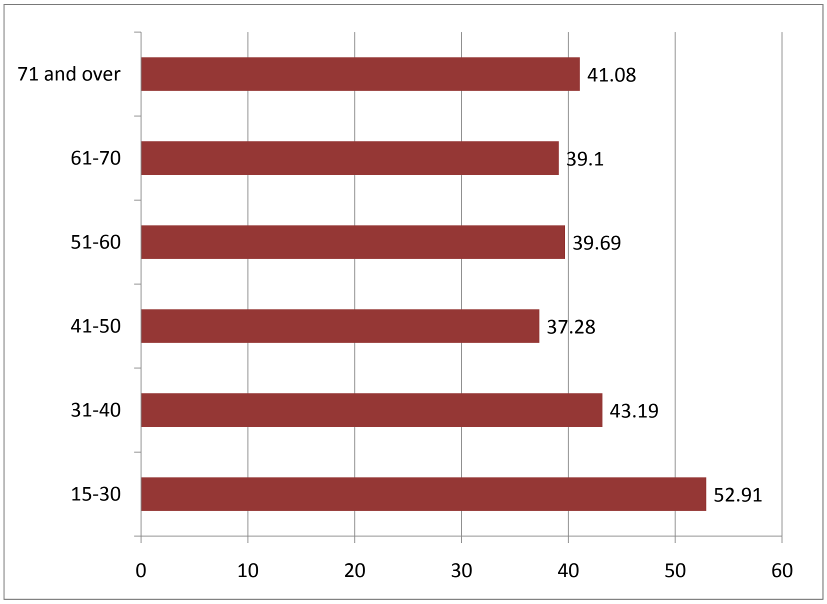

FIGURE 3.5: Percentage of Households Receiving Transfers by Age of Household Head

note that the age group with the highest percentage of households receiving transfers is the youngest group with age of the household head from 15 to 30. This age pattern suggests that private transfers could be facilitating human capital in Kyrgyzstan. This kind of pattern is observed in developed countries, whereas in developing countries the transfers flow from young to old.

Table. 3.2 provides some descriptive statistics of the data for households receiving and not receiving remittances and transfers. In general, transfers flow to vulnerable groups. For example, both remittances and transfers flow to female headed households. Percentage of households with female heads among households receiving remittances (transfers) is 47 percent (40 percent), whereas not receiving remittances (transfers) is 35 percent (30 percent). Also remittances and transfers are allocated to households with higher proportion of elderly members and allocated less to household with heads having higher education. All these observations suggest the altruistic nature of the private transfers in Kyrgyzstan.

It is also important to examine remittances in the context of income distribution of the households. Firstly, income or wealth of the households is one of the key selection dimensions into migrants and remittance recipients. Secondly, examining income distribution helps also to predict possible uses of remittances. If remittances mainly flow to households at the lower quintile of income distribution, then probably they are used for immediate consumption. Therefore, for the lower quintile groups remittances can have important welfare implications and can help to reduce poverty. On the other hand, if remittances are sent to households at the higher end of the income distribution then, presumably, these households use remittances for other purposes than basic necessities. It could be the case that remittances are used for investments in this case.

Table 3.3: Annual per capita income (soms per year)

	Obs	Mean	Std. Dev.	Min	Max
Income Per Capita	14286	13956.34	15114.94	52.67	519867.00
by year:					
2005	4758	11010.31	10587.47	105.00	228525.00
2006	4783	13771.22	15980.47	52.67	427968.00
2007	4745	17097.05	17306.32	100.00	519867.00
By oblast:					
Issyk-kul	1860	12404.08	13515.86	52.67	325761.70
Djalal-abad	1935	10706.34	8217.68	216.67	88700.00
Naryn	1487	10930.37	10153.83	237.50	110267.70
Batken	1460	13003.63	21355.11	140.00	427968.00
Osh	1919	13983.03	13867.76	105.00	215950.00
Talas	1564	9213.32	8110.40	375.00	82000.00
Chui	1882	17615.84	15872.42	100.00	248581.30
Bishkek	2179	21090.93	19380.60	2485.71	519867.00
By region:					
Urban	8762	16593.90	15945.69	116.67	519867.00
Rural	5524	9772.73	12610.68	52.67	332701.00

Table 3.3 shows income per capita levels for Kyrgyz households from the survey. The average annual income per capita over these 3 years was 13956 soms. As the data on income by oblasts shows the highest per capita income is in the capital city Bishkek, and the lowest income is in Talas oblast. Income of the urban households is 1.7 times higher than the income of the rural households.

Table 3.4: Annual per capita income by quintile(soms per year)

Quantile	Obs	Mean	Std. Dev.	Min	Max
2005					
1	958	2642.769	1005.654	105	4200
2	948	5527.606	772.3949	4205	6866.667
3	949	8494.83	964.2429	6870.8	10321.11
4	952	12552.53	1458.137	10325	15377.6
5	951	25871.2	15041.4	15382	228525
2006					
1	957	3281.622	1290.859	52.66667	5181
2	957	6794.466	917.7504	5196.667	8450
3	958	10296.74	1160.325	8451	12500
4	955	15683.97	2114.484	12506	20004
5	956	32826.87	27057.64	20034.67	427968
2007					
1	949	3888.027	1709.877	100	6581.8
2	951	8685.416	1211.074	6583.6	10675
3	947	13267.32	1585.507	10710	16215
4	949	20123.21	2487.958	16218.67	24861
5	949	39530.91	26691.69	24875	519867

The data by quintile (see Table 3.4) shows a high income dispersion. Average income per capita in the highest quintile of the income distribution is more than 10 times higher than income in the lowest quintile.

Examining remittances by income quintile shows that proportion of remittance-receiving households increases gradually from the lowest to the highest quintile in all years. For example in 2007, while only 2.85 percent of households receive remittances in the first quintile, 10.54 percent of households receive remittances in the fifths quintile. Therefore, the survey data suggest that migration might be costly and low income families cannot afford to send family members abroad. Also, remittances in Kyrgyzstan could be used not only to support basic consumption needs but for other purposes as well.

Table 3.5: Households receiving remittances and transfers (in percentage of total households in the quintile group)

Quantile	Households receiving remittances	Households receiving transfers
2005		
1	0.73	43.22
2	1.58	40.82
3	1.69	38.78
4	2.94	47.16
5	5.05	43.32
Total	2.4	42.66
2006		
1	0.31	43.47
2	2.3	39.08
3	3.24	39.98
4	7.12	41.57
5	8.37	43.62
Total	4.27	41.54
2007		
1	2.85	44.68
2	4.63	36.8
3	5.39	37.91
4	7.38	36.67
5	10.54	43.84
Total	6.15	39.98

Examining interhousehold transfers in general by income quintile does not show such a pattern. Transfers by quintile are u-shaped. Percentage of households receiving transfers is higher for the lowest quintile, decreases for the middle and increases again for the highest quintile. In should be noted that on average 41.4 percent of households received some transfers from their relatives and friends. Average proportion of households receiving remittances, on the other hand, is very, it is only 4.28 percent, which is very low in our view.

3.3 Econometric Methodology and Estimation Results

We look at the effect of remittances on purchases of durable goods. Using the panel data property and denoting u_i time invariant unobservable characteristics of the households we can write the following specification:

$$Y_{it} = \beta' X_{it} + \gamma R_{it} + u_i + \epsilon_{it} \tag{3.1}$$

Where Y_{it} is the fact of purchase of a durable good by household i at time t, R_{it} is dummy variable for receipt of remittances, and ϵ_{it} is an error term. X_{it} is a vector of characteristics of households. It includes logarithm of the per capita income of the household, dummy variable indicating whether the head has at leat secondary school education, household size, number of children under age 6, number of elderly members of the household, dummy variables if the head is married, divorced, widowed.

Durable good purchase is a binary variable equal 1 if there was a purchase of any durable good at the given year and 0 otherwise. Since the dependent variable is binary we use fixed effect conditional logit model developed in [13].

$$Prob(Y = 1 | \beta, X_{ti}, \gamma, R_{it}, u_i) = F(\beta' X_{it} + \gamma R_{it} + u_i) \tag{3.2}$$

where F is a logistic function, given by:

$$F(\beta' X_{it} + \gamma R_{it} + u_i) = \frac{e^{\beta' X_{it} + \gamma R_{it} + u_i}}{1 + e^{\beta' X_{it} + \gamma R_{it} + u_i}} \tag{3.3}$$

The main idea in [13] is to use only those observations in which the dependent variable switches its values and estimated a conditional logit. Because of the specifics of the logistic distribution the time invariant omitted variables disappear in this estimation.

Table 3.9 shows the estimation results for this conditional fixed effects logit model. The coefficient on remittances is positive and significant at the five percent level, suggesting that remittances affect purchases of durable goods. It should be noted that in the fixed effects logit model all households with unchanged outcome drop out from the estimation. The number of observations used in this model is 4206, which is substantially lower than the total sample size. These are the households who had changes in the indicator for purchases of durable goods.

The estimation results for the pooled logit model are given on Table 3.8). The coefficient on remittances is significant at the one percent level for the pooled logit. However, the Hausman test statistic leads to the rejection of the model without fixed effects.

3.4 Conclusion

In this paper using a new household level panel data we look at the patterns of remittances and interhousehold transfers in Kyrgyzstan and study their impact on the receiving households. We find that both remittances and transfers in general flow to female headed households, to households with higher proportion of elderly members, and also allocated less to household with heads having higher education. In addition, the importance of remittances and transfers as a source of household income differs geographically. Transfers in general are more important in the Northern regions, whereas remittances are more important in the Southern regions. Unlike internal transfers, international remittances in Kyrgyzstan flow to households with higher income level. This suggests that migration might be costly and low income families cannot afford to send family members abroad. Also, it suggests that remittances in Kyrgyzstan could be used not only to support basic consumption needs but for other

Table 3.6: Estimation results : Panel Conditional logit: Binary Dependent variable purchase of a durable good

Variable	**Coefficient**	**(Std. Err.)**
remit	0.401*	(0.182)
inc_pers	4.797†	(2.481)
household size	-0.162	(0.102)
child_7_15	-0.143	(0.091)
child_1	0.053	(0.120)
eld	0.066	(0.358)
married	0.107	(0.116)
diplom	0.063	(0.187)
work_age	0.019	(0.114)
eld_female	-0.434	(0.409)
age_ave	-0.020	(0.026)
age_oldest	0.027*	(0.014)
age_youngest	0.002	(0.013)
Head Married	0.553†	(0.283)
N	4206	
Log-likelihood	-1512.446	
$\chi^2_{(14)}$	30.883	

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

purposes, such as investments, as well. In fact, after exploiting the panel structure of the data and controlling for household specific fixed effects, we find that remittances have significant positive impact on purchases of durable goods.

Table 3.7: Estimation results : Pooled data logit: Binary Dependent variable purchase of a durable good

Variable	Coefficient	(Std. Err.)
remit	0.296**	(0.109)
inc_pers	13.999**	(1.841)
household size	-0.109**	(0.041)
child_7_15	0.049	(0.040)
child_1	0.139†	(0.073)
eld	0.171†	(0.103)
married	-0.013	(0.048)
diplom	0.047	(0.033)
work_age	0.146**	(0.048)
eld_female	-0.091	(0.127)
age_ave	-0.015	(0.010)
age_oldest	0.002	(0.005)
age_youngest	-0.013**	(0.005)
Head Married	0.330**	(0.093)
Intercept	-1.515**	(0.155)
N	14353	
Log-likelihood	-5955.551	
$\chi^2_{(14)}$	333.814	

Significance levels : † : 10%   ∗ : 5%   ∗∗ : 1%

Table 3.8: Estimation results for the effect of transfers: Panel Conditional logit: Binary Dependent variable purchase of a durable good

Variable	**Coefficient**	**(Std. Err.)**
trans	$0.143^{\dagger}$	(0.086)
inc_pers	5.475^{*}	(2.531)
household size	-0.164	(0.102)
child_7_15	-0.142	(0.092)
child_1	0.050	(0.121)
eld	0.094	(0.357)
married	0.116	(0.116)
diplom	0.070	(0.187)
work_age	0.011	(0.114)
eld_female	-0.474	(0.409)
age_ave	-0.019	(0.026)
age_oldest	0.029^{*}	(0.014)
age_youngest	0.001	(0.013)
Head Married	0.558^{*}	(0.283)
N	4206	
Log-likelihood	-1513.501	
$\chi^2_{(14)}$	28.772	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table 3.9: Estimation results for the effect of transfers: Pooled data logit: Binary Dependent variable purchase of a durable good

Variable	Coefficient	(Std. Err.)
trans	0.023	(0.049)
inc_pers	14.758**	(1.843)
household size	-0.108**	(0.041)
child_7_15	0.048	(0.040)
child_1	0.137†	(0.073)
eld	0.172†	(0.103)
married	-0.014	(0.048)
diplom	0.042	(0.033)
work_age	0.145**	(0.048)
eld_female	-0.093	(0.127)
age_ave	-0.015	(0.010)
age_oldest	0.002	(0.005)
age_youngest	-0.013**	(0.005)
Head Married	0.333**	(0.093)
Intercept	-1.532**	(0.159)

N	14353
Log-likelihood	-5958.937
$\chi^2_{(14)}$	327.042

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Appendix A

Appendix to Chapter 3

Table A.1: Descriptive Statistics of the Sample based on the Receipt of Private Transfers

Variable	All years			2005		
	No	Yes	All	No	Yes	All
Head Female	0.3	0.4	0.34	0.26	0.4	0.32
Head Married	0.64	0.54	0.6	0.63	0.51	0.58
% of individuals aged < 6	0.09	0.1	0.1	0.1	0.1	0.1
% of individuals aged 7-15	0.19	0.18	0.18	0.19	0.18	0.19
% of individuals aged < 18	0.35	0.34	0.35	0.36	0.34	0.35
% of elderly	0.16	0.19	0.17	0.16	0.18	0.17
% of working age individuals	0.49	0.47	0.48	0.49	0.47	0.48
Head Age	50.67	50.05	50.42	50.07	49.5	49.83
Head with higher education	0.18	0.16	0.17	0.18	0.16	0.17
Variable	2006			2007		
	No	Yes	All	No	Yes	All
Head Female	0.32	0.39	0.35	0.33	0.4	0.36
Head Married	0.65	0.55	0.61	0.64	0.55	0.6
% of individuals aged < 6	0.09	0.11	0.1	0.1	0.1	0.1
% of individuals aged 7-15	0.19	0.18	0.18	0.18	0.18	0.18
% of individuals aged < 18	0.35	0.35	0.35	0.34	0.34	0.34
% of elderly	0.17	0.18	0.17	0.17	0.2	0.18
% of working age individuals	0.48	0.47	0.48	0.49	0.46	0.48
Head Age	50.89	50.11	50.57	51.02	50.57	50.85
Head with higher education	0.18	0.16	0.17	0.19	0.15	0.18

Table A.2: Estimation results : Pooled data logit: Binary Dependent variable purchase of a durable good

Variable	**Coefficient**	**(Std. Err.)**
remit	0.291	(0.109)
inc_per	0.000	(0.000)
household size	-0.042	(0.025)
age in years	-0.002	(0.013)
Live together but not married	0.027	(0.181)
Divorced	-0.192	(0.130)
Live separately but not divorced	-0.160	(0.251)
Widower/widow	-0.259	(0.121)
Never has been married	-0.519	(0.192)
Household Head Female	-0.008	(0.084)
child_6	-0.026	(0.040)
eld	0.071	(0.075)
married	0.013	(0.049)
diplom	0.045	(0.033)
work_age	0.082	(0.039)
age_oldest	-0.005	(0.005)
age_youngest	-0.020	(0.002)
sqh_age	0.000	(0.000)
Intercept	-1.255	(0.313)

Table A.3: Estimation results : Panel Conditional logit: Binary Dependent variable purchase of a durable good

Variable	**Coefficient**	**(Std. Err.)**
remit	0.401	(0.182)
inc_per	0.000	(0.000)
household size	-0.176	(0.089)
age in years	-0.006	(0.015)
Live together but not married	-0.550	(0.476)
Divorced	-0.810	(0.460)
Live separately but not divorced	-0.383	(0.545)
Widower/widow	-0.333	(0.376)
Never has been married	-0.619	(0.574)
Household Head Female	-0.130	(0.221)
child_6	0.090	(0.111)
eld	-0.191	(0.236)
married	0.089	(0.118)
diplom	0.079	(0.187)
work_age	0.042	(0.112)
age_oldest	0.022	(0.015)
age_youngest	-0.005	(0.007)

Table A.4: List of variables used in the analysis

Variable Name	Description
Child_6	Number of children under age 6
child_7_15	Number of children aged 7-15
Child_18	Number of children aged <= 18
Eld	Number of Elderly Household members (> 54 for woman, and > 59 for man)
Hsize	Household size
Work_age	Number of working age household members (> 18 and <= 54 for woman, and > 18 and <= 59 for man)
Married	Number of married household members
Diplom	Number of household members with higher education
Age_oldest	Age of the oldest household member
age_youngest	Age of the youngest household member
age_ave	Average age of the household members
h_educ	Education of the household head:
	1 Higher
	2 Incomplete higher
	3 Special secondary
	4 Secondary vocational
	5 Secondary general
	6 Incomplete secondary
	7 Elementary
	8 No education
	9 Illiterate
	98 Age 0-6
H_mstat	Marital Status of the Household Head (Married, Live together but not married, Divorced, Live separately but not divorced, Widower/widow, Never has been married)
Dur	The fact of purchasing durable goods (including electronics, vehicles, furniture etc.)
	1 if households purchased at least one durable good at that year
Dur2	The fact of purchasing durable goods excluding furniture 1 if households purchased at least one durable good (excluding furniture) at that year
Moto	The fact of purchasing vehicles. 1 if households purchased at least one vehicle at that year
Comp_print	The fact of purchasing computers or printers
	1 if households purchased at least one computer or printer at that year
Trans	The fact of receiving transfers
	1 transfers > 0
Remit	The fact of receiving remittances
	1 remittances > 0
Inc_tot	Total income of the household (in soms annual)

Bibliography

[1] R Abazov. Current trends in migration in the commonwealth of independent states. Human Development Research Paper 36, United Nations Development Programme, 2009.

[2] Mehrigul Ablezova, Emil Nasritdinov, and Ruslan Rahimov. The impact of migration on elderly people. grandparent-headed households in kyrgyzstan. Social Research Center of American University in Central Asia, 2008.

[3] Daron Acemoglu, Philippe Aghion, and Fabrizio Zilibotti. Vertical integration and distance to frontier. *Journal of the European Economic Association*, 1(2-3):630–638, 04/05 2003.

[4] Pablo A. Acosta, Pablo R. Fajnzylber, and Humberto Lopez. The Impact of Remittances on Poverty and Human Capital: Evidence from Latin American Household Surveys. *SSRN eLibrary*, 2007.

[5] Philippe Aghion and Peter Howitt. A model of growth through creative destruction. *Econometrica*, 60(2):323–51, March 1992.

[6] Philippe Aghion, Peter Howitt, and David Mayer-Foulkes. The effect of financial development on convergence: Theory and evidence. *Quarterly Journal of Economics*, 120(1):173–222, 2005.

[7] Robert J. Barro and Xavier Sala-i Martin. *Economic Growth : Second Edition*. The MIT Press, October 2003.

[8] Catia Batista. Why doesn't labor flow from poor to rich countries? micro evidence from the european integration experience. Economics Series Working Papers 402, University of Oxford, Department of Economics, 2008.

[9] Michel Beine, Frederic Docquier, and Hillel Rapoport. Brain drain and ldcs' growth: Winners and losers. IZA Discussion Papers 819, Institute for the Study of Labor (IZA), July 2003.

[10] Jess Benhabib and Mark M. Spiegel. Human capital and technology diffusion. Technical report, 2002.

[11] Giuseppe Bertola. Models of economic integration and localized growth. CEPR Discussion Papers 651, C.E.P.R. Discussion Papers, March 1992.

[12] Richard Brown. Migrants' remittances, savings and invetment in the south pacific. *International Labor Review*, 133(3):347–367, 1994.

[13] Gary Chamberlain. Analysis of covariance with qualitative data. *The Review of Economic Studies*, 47(1):225–238, 1980.

[14] Ralph Chami, Samir Jahjah, and Connel Fullenkamp. Are immigrant remittance flows a source of capital for development. IMF Working Papers 03/189, International Monetary Fund, October 2003.

[15] Dilek Cinar and Frdric Docquier. Brain drain and remittances: Implications for the source country. *Brussels Economic Review/Cahiers Economiques de Bruxelles*, 47(1):103–118, 2004.

[16] Riccardo Faini. Increasing returns, migrations and convergence. *Journal of Development Economics*, 49(1):121–136, April 1996.

[17] Oded Galor and Omer Moav. Das human-kapital: A theory of the demise of the class structure. *Review of Economic Studies*, 73(1):85–117, 2006.

[18] John Gibler. Mexico's ghost towns: The other side of the immigration debate. May 2008.

[19] Paola Giuliano and Marta Ruiz-Arranz. Remittances, financial development, and growth. IZA Discussion Papers 2160, Institute for the Study of Labor (IZA), June 2006.

[20] Jean-Michel Grandmont. On endogenous competitive business cycles. *Econometrica*, 53(5):995–1045, 1985.

[21] Jos Luis Groizard and Joan Llull. Skilled migration and growth. testing brain drain and brain gain theories. Technical report, 2006.

[22] Shamsia Ibragimova, Temir Burzhubaev, and Adyljan Temirov. Country report on international migrants remittances and poverty in the kyrgyz republic. Technical assistance consultants report draft, Asian Development Bank, 2008.

[23] Paul Klein and Gustavo Ventura. Productivity differences and the dynamic effects of labour movements. *Journal of Monetary Economics*, 2009.

[24] Gemma Larramona and Marcos Sanso. Migration dynamics, growth and convergence. *Journal of Economic Dynamics and Control*, 30(11):2261 – 2279, 2006.

[25] Ross Levine, Norman Loayza, and Thorsten Beck. Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics*, 46(1):31–77, August 2000.

[26] Tikki Pang, Mary Ann Lansang, and Andy Haines. Brain drain and health professionals . *BMJ*, 324(7336):499–500, 2002.

[27] Hillel Rapoport. Migration, credit constraints and self-employment: A simple model of occupational choice, inequality and growth. *Economics Bulletin*, 15(7):1–5, 2002.

[28] Hillel Rapoport and Frederic Docquier. *The Economics of Migrants' Remittances*, volume 1 of *Handbook on the Economics of Giving, Reciprocity and Altruism*, chapter 17, pages 1135–1198. Elsevier, 2006.

[29] Dilip Ratha. Workers' remittances: an important and stable source of external development finance. 2003.

[30] James E. Rauch. Economic development, urban underemployment, and income inequality. *Canadian Journal of Economics*, 26(4):901–18, November 1993.

[31] Pietro Reichlin and Aldo Rustichini. Diverging patterns with endogenous labor migration. *Journal of Economic Dynamics and Control*, 22(5):703–728, May 1998.

[32] Stalker. *The Work of Strangers: A Survey of International Labour Migration*. International Labour Office, Geneva, 1994.

[33] Jerome Vandenbussche, Philippe Aghion, and Costas Meghir. Growth, distance to frontier and composition of human capital. *Journal of Economic Growth*, 11(2):97–127, June 2006.

[34] Jeffrey Williamson. *Inequality, poverty, and history*. Basil Blackwell, Cambridge, MA, 1991.

[35] Dean Yang. International migration, remittances and household investment: Evidence from philippine migrants' exchange rate shocks. *Economic Journal*, 118(528):591–630, 04 2008.

Biography

Nurgul Ukueva was born in Saint Petersburg, Russia, on June 9, 1977. She grew up in Bishkek, Kyrgyz Republic and graduated from a Physics and Mathematics High School 61 in Bishkek with the Gold Medal. She was a winner of the Mathematical Olympiads in Kyrgyzstan in 1992-1994 and received a Honors Certificate at the International Mathematical Olympiad in Hong Kong in 1994.

Nurgul received her undergraduate degree with honors, in Economics from Kyrgyz State University of Construction, Transportation and Architecture in 1999. In 1997 she was awarded a scholarship under Future Leaders Exchange Program of the United States Department of State and studied one year at Troy State University, USA. She earned her M.A. degree with honors, in Economics from Temple University in May 2004. Her studies at Temple University were financed by the Edmund S. Muskie Graduate Fellowship.

In 2004 Nurgul was admitted to the Economics Ph.D. program at Duke University. While at Duke she has received Japan-IMF Scholarship for Advanced Studies, 2004-2006, the Economic Department Tuition Scholarship from 2006 to 2010, summer Research Fellowship from the Graduate School of Duke University in the summers of 2006, 2007. Nurgul is planing on graduating from Duke University with doctorate degree in Economics in spring of 2010.