Return Migration, Human Capital Accumulation and the Brain Drain*

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Abstract

In this paper we present a model that explains migrations as decisions that respond to where human capital can be acquired more efficiently, and where the return to human capital is highest. The basic framework is a dynamic Roy model in which a worker possesses two distinct skills that can be augmented by learning by doing. There are different implicit price, in different countries and different rates of skill accumulation. Our analysis contributes to the literature on the selection of immigrants and return migrants, by offering a richer framework that may help to accommodate selections of emigrants and return migrants that are not immediately compatible with the one-dimensional skill model. Our analysis has also implications for the debate on brain drain and brain gain. In the two skills model presented here, return migration can lead to a mitigation of the brain drain, or even the creation of a "brain gain", where those who return bring the home country augmented local skills.

Key Words: Return migration, human capital accumulation, comparative advantage, brain drain
JEL Classification: J3, J6, F2.

1 Introduction

Mobility of workers across national borders responds not only to the return to skills, but also to the opportunity and efficiency of skill acquisition. Efficiency considerations suggest that skills should be acquired where the cost is low and applied where the reward is high. This last aspect has been largely overlooked in the literature that analyzes the causes and forms of migration. Thus, individuals may choose to acquire abroad skills that are highly rewarded in their home country and produced cheaply elsewhere. Student migrations are an example, with some countries having established themselves as learning centers that provide educational services above those demanded domestically.1 The focus of

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1 Recent papers that discuss movement of students are Rosenzweig (2006) and Kennan (2009). The first paper discusses international mobility, and the second mobility across US
this paper is on learning on the job, whereby immigrants augment their skills by acquiring work experience in different countries. There is evidence that, for migrants who returned to their home country, work experience acquired abroad enhances earnings by more than work experience acquired in the home country. Reinhold and Thom (2009) analyze earnings of Mexican emigrants who returned from the U.S. They find that, for these immigrants, the labour market experience accumulated in the US increases earnings by twice the amount than experience accumulated in Mexico. Papers by Barret and O’Connel (2000) and Lara (2006) report similar findings for Ireland and migrants who returned to Eastern Europe from Western European countries. Co, Gang and Yun (2000) report a wage premium for having been abroad for female return migrants to Hungary.

Movement of individuals across national borders to acquire skills where they can be acquired more efficiently, and to sell these skills where their return is highest leads to forms of migration that are different from the classic permanent migration type, inducing return migration and chain migrations. At the same time, these movements shift skills from one country to another, with implications for aggregate human capital formation and growth. In particular, brain gain can occur if returning immigrants acquire abroad skills that are valuable in the home country.

In this paper we present a model that explains migrations as decisions that respond to where human capital can be acquired more efficiently and where the return to human capital is highest. The basic framework is one in which a worker possesses two distinct skills that can be augmented by learning by doing. These skills command a different implicit price in different countries. The rate of human capital accumulation is also different in different countries. Thus, a person may move to a country where her skills grow fast and then apply these skills in a different country where these skills command a high price. In this regard, there is an important difference between human and physical or financial assets. Human capital cannot be separated from its owner and he/she must move in order to exploit differences in returns in different locations.

An early paper that discusses higher return in the home country to skills acquired in the host country as a motive that triggers return migration is Dustmann (1994, 1995). Other papers that analyze this motive are Borjas and Bratsberg (1996), Santos and Postel-Vinay (2003) and Mayr and Peri (2008). These models assume that individual skills are one-dimensional. In the single skill model, individuals move based on the prices of this skill in the two countries. If the price is higher in the receiving country, some highly skilled workers will move. If one adds learning abroad, some of those who moved will return.
but those will be the least skilled among the emigrants. Conversely, if the price of the single skill is lower abroad, low skilled workers will emigrate and among these immigrants the most skilled will return. Although, a stronger home component may be acquired by staying abroad for some "learning" period. In either case, return migration amplifies the wage differences between natives and immigrants in the receiving country, provided that the ability distribution is the same in the source country and the receiving country.

The two skills model that we discuss is a generalization of the one skill model of return migration. Allowing comparative advantage to play a role, we obtain that among the stayers there are some who are more able (in the sense of having a larger endowment of both skills) than some of the movers. At the same time, there may be some movers who are more skilled than some of the stayers. In both comparisons, those who stay have a relatively high component of the skill that is more highly valued at the home country and those who move have a relatively high component of the skill that is more highly valued at the host country. By the same logic, the selection of return migrants may exacerbate or alleviate the impact of migrant selection for the initial out-migration for both emigration- and immigration country. In these regards, the multi-dimensional skill distribution adds a richer set of implications than the model by Borjas and Bratsberg (1996).

Our framework can accommodate flexible migration patterns, including return- and chain migrations. Recent studies show that return migration is an important phenomenon. For instance, of the foreign born population that immigrated to the UK in the 1990’s, and that has remained for at least the first year after immigration, about 40% had left the UK after another 5 years (see Dustmann and Weiss, 2007). Bijwaard (2008) reports that of those arriving to the Netherlands about 40% have left the country within seven years. A recent OECD publication (OECD 2008, Table III.1) reports similar out-migration rates for other countries: The average out-migration rate after 5 years ranges from 28% for the Netherlands to 60% for Ireland. More relevant for this paper are the figures on

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2 Borjas and Bratsberg (1996) assume that learning abroad raises local earning by a fixed proportion, irrespective of the duration of the stay abroad. Stark et al. (1998) present a learning model that also creates selective return migration. Immigrants are initially paid the average return to skills of their group; as employers obtain more information, they will pay according to individual skills, which may lead to a return migration of those immigrants who are less productive. In Borjas and Bratsberg’s framework, this is captured by shocks to earnings after emigration.

3 Borjas (1987) and Gould and Moav (2008) use a two skill Roy model to explain emigration patterns. However, they do not address learning and return migration.

4 A related issue is the ability of the one skill model to explain emigration patterns. While some earlier work finds limited evidence for a negative relationship between the source country’s income inequality and emigrant wages, as predicted by the one-skill model (e.g., Cobb-Clark 1993), others find no relationship between inequality and the degree of selection (e.g., Feliciano, 2005 and Orrenius and Zavodny, 2005). Belot and Hatton (2008) examine immigrants in 29 countries from 80 origin countries and find little evidence that is compatible with the predictions of the one-skill model. Chicquiar and Hanson (2005) find evidence against the "negative selection" one should expect on the basis of the one skill model. The empirical findings seem compatible with the one skill model only upon introducing additional assumptions, such as a decline in migration costs with education.
return migration from developed to developing countries. Of those immigrants from Mexico who resided in the US in 1995, 3.7 percent had returned in 2000. However, the numbers are unequally distributed across education groups: While only 1.6% of those with an intermediate level of education had returned, 4.3% and 5% of the low and highly educated returned. The study reports similar U-shaped patterns for return migration from the US to Argentina and Brazil. Further, such return pattern is not restricted to the US: migrants to Spain and who returned to their home countries Chile, Brazil, Argentina and Mexico are also more frequent among the low- and highly educated.

Our model has also implications for the debate on brain drain and brain gain. In an early paper, Kwok and Leland (1982) describe brain drain as a (permanent) outflow of skilled workers. The model discussed by Borjas and Bratsberg (1996) adds an additional dimension to this: A brain drain issue arises when the price of skills is higher abroad, and may be amplified by those who return being the less able among those who left. In the two skills model presented here, the brain drain is mitigated because those who return come with augmented local skills that are more applicable in the home country. If the proportion of those who return is large enough, aggregate output and even output per capita may increase, implying a brain gain.5 We also show that by imposing entry standards based on skills that are tailored to the host country, the potential brain gain is reduced because some of those who would return with augmented local skills are barred from skill acquisition abroad.6 We discuss these issues in the context of a dynamic Roy model, in which skills vary over time. In contrast to the static Roy model, in which alternatives are characterized by the prices of skills only, our model specifies each alternative in terms of price and learning opportunities. Such a model can generate planned mobility even under conditions of certainty.7

After introducing the main features of our model, our analysis below proceeds in the following two steps: First, of those who have emigrated who shall return and when. Then, based on the anticipated return decision, who shall emigrate and when. We show that these decisions depend crucially on the extent of transferability of work experience acquired abroad to the home country. Specifically, if one can more efficiently augment abroad the skills that are highly valued

5The one skill model implies that those who return are less skilled (both in terms of local and external output) than those who stay abroad and, therefore, a brain gain is less likely.
6Some of the more recent literature suggests the possibility of out-migration generating an additional incentive to invest in human capital; in the case that out-migration is restricted, this may then mitigate the brain drain, or even turn it into a brain gain. See Mountford (1997) Docquier and Rapoport (1997), Stark et al. (1998) and Vidal (1998) for models that are based on this idea, with homogeneous and heterogeneous labor. Beine, Docquier and Rapoport (2001) provide empirical evidence that is compatible with a brain gain occurring. Mayr and Peri (2008) extend this framework by allowing for return migration. They assume complementarity between schooling acquired at home and work experience acquired abroad. This creates an incentive for return migration, and a potential for a brain gain.
7Our paper builds on the following papers. Learning as a joint production was first introduced by Rosen (1972a, 1972b). Willis and Rosen (1979), Borjas (1987) and Heckman and Honore (1990) discuss the two skill Roy model. Jovanovic and Nyarko (1997) consider learning in stepping stone occupations.
in the home country, this motivates both emigration and return migration. We then discuss the potential brain gain associated with return migration. We discuss these issues focusing only on investment considerations. Other reasons for return migration and their implications, such as consumption preferences, retirement, and purchasing power differences are discussed elsewhere (Dustmann, 1995 and Dustmann and Kirchkamp, 2002). Business cycle effects are discussed in Mandelman and Zlade (2008).

2 Earning, Learning and Prices

2.1 Skills and human capital

Human capital is an aggregate that summarizes individual skills in terms of productive capacity.\footnote{A human capital model with multiple skills was first considered by Welch (1969). Heckman et al. (2006) use a two skill model to explain schooling and wages and provide evidence for the importance of both cognitive and non-cognitive skills for such outcomes.} Different skills are rewarded differentially in different countries. We assume the connection between individual skills and productive capacity may be represented as

$$\ln K_j(t) = \sum_s \theta_{sj} S_s(t),$$

where $K_j(t)$ is the productive capacity of a person if he works in country $j$ at time $t$, $S_s(t)$ is the quantity of skill $s$ possessed by the individual at time $t$ and $\theta_{sj}$ is a non-negative parameter that represents the contribution of skill $s$ to production in country $j$. This specification implies complementarity of skills in generating the human capital relevant to different countries.

To simplify the exposition, we consider the case of only two countries, the receiving country and the country of origin, denoted by $a$ and $b$, respectively, and two skills, denoted by 1 and 2. Each person is characterized as a bundle of two latent skills and in each country there is some bivariate distribution of these skills in the population.\footnote{Individual skills cannot be unbundled from the worker and sold to different employers. For simplicity, we abstract here from the occupational assignment within countries and essentially assume one occupation in each country.} For any fixed prices of skills, one can use a linear transformation to translate the latent skills $S_1$ and $S_2$ that a worker possesses to the potential productive capacities of the worker in each of the two countries, $\ln K_a$ and $\ln K_b$. We can thus describe a worker by the pair $(K_a(t), K_b(t))$ instead of a pair of latent skills $(S_1(t), S_2(t))$ and, under some conditions, identify the distribution of skills (see Heckman and Honore, 1990).\footnote{The maintained assumption here is that skills can be measured in some standard units that are common to all countries. The coefficients $\theta_{sj}$ can then be recovered, in principle, from data on earnings (preferably of the same individuals), the duration of stay in the two countries and the choices made by different potential immigrants.}

Skills are initially endowed and can then be augmented by acquiring work experience. We consider here a "learning by doing" technology, whereby work in
country $j$ augments skill $s$ at a constant rate $\gamma_{sj}$ per unit of time worked. Note the joint production feature of this technology; working in any one country $j$ augments two skills that are potentially useful in both countries. However, experience accumulated in country $j$ may be more relevant to some particular skill and the same skills may be valued differently in the two countries. In this way, we obtain that work experience is transferable but not necessarily general.

We assume that skill 1 is more valuable in the receiving country (country $a$) than in the home country (country $b$) while skill 2 is more valuable in country $b$ than in country $a$. That is,

$$\theta_{1a} > \theta_{1b}, \quad \theta_{2b} > \theta_{2a}. \tag{2}$$

We also assume that skill 1 is accumulated at a faster rate than skill 2 in the receiving country, while skill 2 is accumulated more quickly than skill 1 in the country of origin. That is,

$$\gamma_{1a} > \gamma_{2a}, \quad \gamma_{2b} > \gamma_{1b}. \tag{3}$$

Together, these two assumptions distinguish the two countries in terms of the skills that are used and generated there. Think of country $a$ to be more modern (developed) than country $b$ and suppose that skill 1 represents "managerial" or "intellectual" skills and skill 2 represents "work" or "physical" skills. Then, one may expect that managerial skills have a higher relative price in the developed country and also that work experience in the developed country will augment this skill at a higher rate. In contrast, physical skills may be relatively more valuable in country $b$ and also augmented there at a faster rate.

We assume that $\gamma_{sj}$ and $\theta_{sj}$ are all constant parameters and that time flows continuously. Then, a person who works in country $a$ accumulates local human capital at a rate

$$\dot{K_a} = \theta_{1a}\gamma_{1a} + \theta_{2a}\gamma_{2a} \equiv g_{aa}, \tag{4}$$

and foreign human capital at a rate

$$\dot{K_b} = \theta_{1b}\gamma_{1a} + \theta_{2b}\gamma_{2a} \equiv g_{ba}. \tag{5}$$

Similarly, a person who works in country $b$ accumulates local human capital at a rate

$$\dot{K_b} = \theta_{1b}\gamma_{1b} + \theta_{2b}\gamma_{2b} \equiv g_{bb}, \tag{6}$$

and foreign human capital at a rate

$$\dot{K_a} = \theta_{1a}\gamma_{1b} + \theta_{2a}\gamma_{2b} \equiv g_{ab}. \tag{7}$$
As seen, the growth in local and foreign human capital for workers in each of the two countries depends on both the prices and learning rates of the two skills. Because prices of skills and the learning rates of each skill differ between the two countries, the rates of change in human capital that are applicable locally or abroad can differ.

2.2 Assumptions

For simplicity, we assume certainty, infinitely long lived agents, and a fixed interest rate $r$. We further assume that learning can take place only for a finite period of time $T$. When an agent reaches that critical age his human capital remains constant for the rest of his/her life, which captures the idea that learning capacity declines with age.$^{11}$ This assumption implies substitution between learning at home and abroad. The more time a person learns in the home country, the less time is left for learning abroad. Finally, we ignore costs of mobility and non wage rewards that of course can be important in practice. We do so to focus on the learning issues which have not been investigated much in the literature.$^{12}$

In this paper, we shall mainly focus on the degree to which experience acquired in the host country, $a$, influences the earning capacity that an immigrant would have if he/she returns to the home country, $b$. We allow country $a$ to be a learning center in the sense that experience acquired there can augment earning capacity locally and in other countries in a substantive way. In particular, we shall consider the case

$$g_{ba} > g_{aa} > g_{bb} \quad (8)$$

which means that experience acquired in the host country, $a$, can augment the human capital that is applicable to the home country, $b$, by more than it augments the human capital that is applicable to the host country and also by more than one can obtain by staying in the home country. In contrast, country $b$ is not a learning center. We thus assume throughout that

$$g_{ab} < g_{bb} < g_{aa} \quad (9)$$

and

$$g_{ab} < r < g_{ba}. \quad (10)$$

Assumption (9) states that experience acquired in country $b$ has only a moderate effect on earning capacity, locally and abroad. Assumption (10) adds that under these circumstances it is unprofitable to delay a move from country $b$ to country $a$, because the growth rate in the human capital applicable to country

$^{11}$Empirically, most of the wage growth that can be attributed to work experience takes place over the first ten years of the work career (see Rubinstein and Weiss, 2007).

$^{12}$Selective out-migration and return migration can be influenced by the costs of mobility, especially if these costs differ by level of schooling (see Chiquiar and Hanson, 2005). Grogger and Hanson (2008) estimate the costs of moving across different countries and report fairly large costs.
a, while staying in b, is below the interest rate. On the other hand, it may be profitable to delay the move back from country a to country b, because the growth rate in human capital that is applicable to country b, while staying in a, exceeds the interest rate. Together, assumptions (8), (9) and (10) allow us to consider emigration and return migration flows that are one directional from the developing country b to the developed country a and back, but not the other way around. Of course, the model is general enough to accommodate flows in both directions and delayed migration, but we shall suppress these possibilities here.

2.3 Transferability

Regarding the effect of learning in country a on the earning capacity in country b, we distinguish three basic cases.

1) **Partial transferability** of experience, \( g_{ba} < g_{bb} \), which means that, by staying in the home country, b, one can augment the human capital that is applicable to the home country by more than if work experience is acquired abroad in country a. Furthermore, having assumed that \( g_{ab} < g_{aa} \), we also have that \( g_{ba} < g_{aa} \). That is, experience acquired in the host country augments the human capital applicable to the host country, \( K_a \), by more than it augments the human capital that is applicable to the home country, \( K_b \).

2) **Strong transferability**, \( g_{ba} > g_{aa} \), which means that experience acquired in the host country augments the human capital applicable to that country, \( K_a \), by less than it augments the human capital that is applicable to the home country, \( K_b \). Furthermore, having assumed that \( g_{bb} < g_{aa} \), we also have that \( g_{ba} > g_{bb} \). That is, experience acquired in the host country augments the human capital applicable to the home country, \( K_b \), by more than one would obtain by acquiring work experience in the home country.

3) **Super transferability**, \( g_{ba} > g_{aa} \) (and thus \( g_{ba} > g_{bb} \)) and also \( g_{ba} - g_{bb} > r \). In this special case of strong transferability, the learning effects are sufficiently strong to guarantee that, irrespective of the individual’s initial skills, learning abroad dominates learning in the home country.

These definitions do not apply directly to transferability of skills or productive capacity but rather to the role of work experience in each country to augment skills that have different values in different countries. The worker can always keep the skills that are embodied in him/her but because these skills are valued differently in different countries, each person has two different earnings capacities, one for each country. The question then is how work experience in a given country influences these two earnings capacities. It can be shown that all the cases described above can be satisfied by appropriate choices of the basic parameters of the model, that is, the four growth rates and the four prices of skills in the two countries. 13This richness of possibilities arises because the

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13For instance, for \( 4% < r < 12% \), the parameters below satisfy super transferability.

<table>
<thead>
<tr>
<th>country</th>
<th>( \theta_1 )</th>
<th>( \theta_2 )</th>
<th>( \gamma_1 )</th>
<th>( \gamma_2 )</th>
<th>( g_a )</th>
<th>( g_b )</th>
</tr>
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<td>a</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>b</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
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rates of augmentation of the earning capacity in each of the two countries are different combinations of the skill acquisition rates and prices. For instance, even though emigrants from the home country acquire skill 1 at a faster rate than skill 2 in the receiving country \((\gamma_{1a} > \gamma_{2a})\) and the value of this skill is higher there \((\theta_{1a} > \theta_{1b})\), it is still possible that the human capital applicable to the home country, \(K_b\), grows in the host country at a faster rate than the human capital that is applicable to the host country, \(K_a\). By (4) to (7), \(g_{ba}\) and \(g_{aa}\) are weighted averages of the same growth rates of skills, i.e., the growth rate of skill 1 in country \(a\), \(\gamma_{1a}\), and the growth rate of skill 2 in country \(a\), \(\gamma_{2a}\). However, the weights given to these common factors are the different prices of the two skills in the two countries. Thus, \(g_{ba}\) exceeds \(g_{aa}\) if

\[
\gamma_{2a}(\theta_{2b} - \theta_{2a}) > \gamma_{1a}(\theta_{1a} - \theta_{1b}),
\]

which means the difference across countries in the prices of skill 2, \(\theta_{2b} - \theta_{2a}\), is sufficiently large relative to the price difference across countries in the prices of skill 1, \(\theta_{1a} - \theta_{1b}\), to offset the impact of the higher rate of learning of skill 1 in country \(a\), \(\gamma_{1a}\), compared to the learning rate of skill 2 in country \(a\), \(\gamma_{2a}\).

### 2.4 Rental rate of human capital and its adaptation

Firms in each country reward individual skills indirectly by renting human capital at the market-determined rental rate, \(R_j\), implying that a worker with a given bundle of skills earns in country \(j\) at time \(t\)

\[
w_j(t) = R_j \exp(\sum_s \theta_{sj} S_s(t)).
\]

Thus, the parameter \(\theta_{sj}\) is proportional to the increase in earning capacity associated with a unit increase in skill \(s\) if the individual works in country \(j\). Having assumed that \(\theta_{sj}\) is independent of the quantity of skill \(s\) possessed by the individual, these coefficients may be viewed as the implicit "price" (or "rate of return") of skill \(s\) in country \(j\). We assume that the rental rate for human capital in the receiving country, \(R_a\), exceeds the rental rate that human capital receives in country \(b\), \(R_b\). This difference in rental rates can be sustained if country \(a\) has a superior technology and immigration into the receiving country is regulated and only some of those who wish to enter are allowed in.

For several reasons, it is likely that immigrants who enter the receiving country do not immediately receive the same rental rate for their human capital as natives. First, it takes time for immigrants to find a suitable job that matches their skills in the receiving country. Second, employers may be uncertain or prejudiced about the immigrants’ quality and may update their beliefs based on observed performance. Finally, immigrants may need time to learn the local language and labor market institutions. To describe these processes, we adopt the following functional form

\[
\tilde{R}_a(t-\tau) = e^{-\lambda(t-\tau)} R_b + (1 - e^{-\lambda(t-\tau)}) R_a,
\]

9
where $\tilde{R}_a$ is the rental rate for human capital that immigrants receive in country $a$, and $\tau$ is the time of entry into the new country.\textsuperscript{14} That is, the rental rate that an immigrant from country $b$ receives in country $a$ is a weighted average of the rental rate in the country of origin, $R_b$, and the rental rate in the receiving country $R_a$. Initially, immigrants receive the same rental rate as abroad, $R_b$, but as they spend more time in the host country, the rental rate rises and approaches the rental rate of natives, $R_a$. The parameter $\lambda > 0$ controls the speed of adjustment, given by

$$\frac{d\tilde{R}_a(t - \tau)}{d(t - \tau)} = \lambda[R_a - R_b]e^{-\lambda(t - \tau)} = \lambda(R_a - \tilde{R}_a(t - \tau)).$$

(14)

With this specification, the gap in the rental rates of natives and immigrants narrows at a decreasing rate.

By the same logic, the rental rate that potential immigrants from country $a$ to country $b$ would receive in country $b$ would be lower than that of natives, $R_b$. Our model which allows for the case $g_{ba} > g_{aa}$ and provides incentives for return migration of natives from the home country may also create incentives for some natives of the host country to emigrate from country $a$ to country $b$. To simplify, we assume away such emigration by setting the rental rate in country $b$ for immigrants from country $a$ to zero.

We conduct the analysis in three steps, working backwards. We first examine the return decision of immigrants who are already in the receiving country and investigate who shall return to the home country and when. Based on the results of this last stage, we examine the timing of emigration from the home country and show that emigration is never postponed. Finally, based on these two considerations, we discuss who shall emigrate. In each stage, we consider the three alternatives defined above: partial transferability, strong transferability and super transferability. The last section of the paper contains the implications of our analysis for the brain drain (gain) problem.

Before we embark into the analysis, let us state our main results:

**Proposition 1** In all three considered cases, all workers that wish to emigrate from the home country to the host country will do it immediately at time $0$.

**Proposition 2** Under partial transferability, some workers will stay in the home country and all those who choose to emigrate will never return to the home country. Workers with relatively high initial endowment of skill $g_2$ (that is more valued in home country, $b$) are more likely to stay in the home country.

\textsuperscript{14}There is evidence that immigrants "downgrade" considerably upon arrival, due to the inability to transfer existing skills to the labour market of the host country. Eckstein and Weiss (2004) have estimated the parameters of equation (13) and show that immigrants from the former USSR to Israel, although being highly skilled, have initially wages that are far below those of natives with comparable skills. Dustmann, Frattini and Hall (2009) show that new immigrants to the UK from Eastern Europe, despite having much higher levels of education than natives, start off with wages far lower than those of natives with comparable levels of education, but wages grow subsequently much faster than those of natives.
Proposition 3 Under strong transferability, some workers will stay in the home country, some of those who choose to emigrate will return at or prior to the end of the learning period, $T$, and some will never return to the home country. Workers with relatively high initial endowment of skill 2 are more likely to stay in the home country, those with an intermediate level of skill 2 will emigrate and return to the home country, while those with relatively high initial endowment of skill 1 will emigrate and never return.

Proposition 4 Under super transferability, all workers wish to emigrate. Some of those who wish to emigrate will return and all those who wish to return will do so at the same time, $T$. Others will stay in the host country. Workers with relatively high initial endowment of skill 1 are more likely to stay in the host country.

We remark that the results summarized above are robust to changes of our assumptions. To address this issue, we have examined an alternative model with the following features: Concave learning curves, with no limit on the duration of learning, except for a finite life. Skills are substitutes rather than complements. Equal and constant rental rates of human capital in the two countries. The details of this analysis are available upon request. We show there that the key findings of our paper are invariant to these changes. The main driving force of in both versions of the model is that the rate of learning from experience differs across countries in a systematic way. Thus, if one can learn skills that are relevant to the home country more effectively abroad, this motivates emigration and return migration. In contrast, if what one learns in each country is more applicable in that country, people will emigrate but not return. The advantage of the piecewise linear learning structure that is adopted here is that, with relatively few parameters, we can generate a rich set of immigration and selectivity patterns, calculate explicitly the expected earnings in terms of the basic parameters and identify the potential sources of brain gain.

The growth rate of skill $s$ in country $j$ at time $t$ is
\[ \dot{S}_s(t) = \gamma_{sj} h'(t), \]
where $h(t)$ is common to all countries and skills. This "learning curve" is assumed to satisfy:
- $h(0) = 0, h'(t) > 0, h''(t) < 0, h'(0) = \infty$.

Also, because skills are substitutes,
\[ K_j(t) = \sum_s \theta_{sj} S_s(t) = K_j(0) + h(t) \sum_s \theta_{sj} \gamma_{sj} = K_j(0) + h(t) g_{jj}, \]
where $g_{ij}$ are the same constants as in this paper.
3 The Return Decision

3.1 The costs and benefits of delayed return

Imagine an immigrant who moved from country $b$ to $a$ at time $\tau$ and considers whether to return to the home country at time $\varepsilon$, where $\tau < \varepsilon < T$. Conditional on entry at $\tau$, the present value (evaluated at the time of entry $\tau$) of staying at country $a$ for a period $\varepsilon - \tau$ and then moving back to country $b$ at time $\varepsilon$ is

\[
V(\varepsilon, \tau) = K_a(\tau) \int_{\tau}^{\varepsilon} e^{(g_a-r)(t-\tau)} \bar{R}_a(t-\tau) dt + R_b K_b(\tau) e^{g_b(\varepsilon-\tau)} \int_{\tau}^{T} e^{g_b(t-\varepsilon)-r(t-\tau)} dt + e^{g_b(T-\varepsilon)} \frac{e^{-r(T-\tau)}}{r}, \tag{15}
\]

where $K_a(\tau)$ and $K_b(\tau)$ are the amounts of human capital applicable to countries $a$ and $b$, respectively, that the worker has upon arrival to the host country at time $\tau$.

Differentiating with respect to $\varepsilon$, we get

\[
V'_\varepsilon(\varepsilon, \tau) = K_a(\tau) e^{(g_a-r)(\varepsilon-\tau)} \bar{R}_a(\varepsilon - \tau) - R_b K_b(\tau) e^{(g_a-r)(\varepsilon-\tau)}
+ (g_a - g_b) R_b K_b(\tau) e^{g_b(\varepsilon-\tau)} \int_{\varepsilon}^{T} e^{g_b(t-\varepsilon)-r(t-\tau)} dt + e^{g_b(T-\varepsilon)} \frac{e^{-r(T-\tau)}}{r}, \tag{16}
\]

The first term on the RHS of (16) is the marginal gain from postponing the return to the home country in terms of the current earnings in the receiving country. The second term is the marginal cost of delay in terms of the current earnings one may receive upon returning to the home country. The last term is the marginal effect of postponement on life time earnings following the return to the home country which can be positive or negative, depending on the acquisition rates of the human capital that is applicable to the home country, $K_b$, in the two countries. If $g_a > g_b$ (that is local human capital is more efficiently acquired abroad) then a delay raises the amount of $K_b$ that a returning immigrant can acquire during the learning period $T$ and can then use in country $b$. Conversely, if $g_a < g_b$, a delayed return is costly in terms of acquiring additional local capital during the remainder of the learning period from $\varepsilon$ to $T$.

We can rewrite

\[
V'_\varepsilon(\varepsilon, \tau) = K_a(\tau) e^{(g_a-r)(\varepsilon-\tau)} \{ \bar{R}_a(\varepsilon - \tau) - R_b K_b(\tau) e^{(g_a-r)(\varepsilon-\tau)} C(\varepsilon) \}, \tag{17}
\]

12
\[
C(\varepsilon) = 1 - ((g_{ba} - g_{bb})e^{r(T - \varepsilon)} \int_{\varepsilon}^{T} e^{g_{ha}(t-\varepsilon)-r(t-\varepsilon)} dt + e^{g_{hb}(T-\varepsilon)} e^{-r(T-\varepsilon)} r) \\
= 1 - (g_{ba} - g_{bb}) \left[ \int_{0}^{T-\varepsilon} e^{(g_{ha}-r)t} dt + e^{(g_{ha}-r)(T-\varepsilon)} \right]
\]

(18)

is the marginal cost of delay per unit of human capital that is applicable to the home country, \(K_b\). The derivative of this cost with respect to \(\varepsilon\) is given by

\[
C'(\varepsilon) = e^{(g_{ha}-r)(T-\varepsilon)} (g_{ha} - g_{hb}) \frac{g_{bb}}{r}.
\]

(19)

It follows that if \(g_{ba} > g_{bb}\) then \(C(\varepsilon)\) rises in \(\varepsilon\), reaching a maximum of

\[
1 - \frac{g_{ba} - g_{bb}}{r}
\]

at \(\varepsilon = T\). Conversely, if \(g_{ba} < g_{bb}\) then \(C(\varepsilon)\) declines in \(\varepsilon\), reaching a minimum of

\[
1 - \frac{g_{ba} - g_{bb}}{r}
\]

at \(\varepsilon = T\).

We can now summarize the main forces that affect the return decisions. The rising rental rate for human capital in the host country provides an incentive to delay the return. When experience accumulated in the host country raises the human capital applicable to the home country at a faster rate than it raises the human capital applicable to the host country, i.e. \(g_{ba} > g_{aa}\), delay becomes more costly because the only way to use the higher earning capacity in the home country is to move there. However, when experience accumulated in the host country raises the human capital applicable to the home country at a faster rate than experience in the home country raises local human capital, i.e. \(g_{ba} > g_{bb}\), there is an incentive to delay the return until \(T\) because the learning period is finite and, conditioned on return, learning abroad is more productive. The interest rate also plays a role because, to the extent that investment abroad is productive, one would prefer to receive these benefits sooner rather than later. For this reason, some individuals may prefer to return home prior to \(T\), even though \(g_{ba} > g_{bb}\). However, as we shall show, when \(g_{ba} - g_{bb} > r\), all immigrants will spend the whole learning period \(T\) in the host country and then some of them will return home.

Because learning cannot continue beyond time \(T\), there is a discontinuity in the marginal cost of delaying the return at \(T\). For \(\varepsilon > T\), we have that the present value of earnings from \(T\) on (evaluated at \(\tau\)) are,

\[
V(\varepsilon, \tau) = K_a(T) \int_{\varepsilon}^{T} e^{-r(t-\varepsilon)} \tilde{R}_a(t-\tau) dt + R_0 K_b(T) \int_{\varepsilon}^{\infty} e^{-r(t-\varepsilon)} dt,
\]

(20)
\[ V_\varepsilon(\varepsilon, \tau) = K_\alpha(T)e^{-r(\varepsilon-\tau)}[\bar{R}_\alpha(\varepsilon-\tau) - \frac{K_b(T)}{K_a(T)}]. \]  

(21)

Hence, approaching \( T \) from above we get in the limit

\[ V_\varepsilon(T, \tau) = K_\alpha(T)e^{-r(T-\tau)}[\bar{R}_\alpha(T-\tau) - \frac{K_b(T)}{K_a(T)}]. \]  

(22)

However, from (16) we see that by approaching \( T \) from below we get in the limit

\[ V_\varepsilon(T, \tau) = K_\alpha(T)e^{-r(T-\tau)}\{\bar{R}_\alpha(T-\tau) - \frac{K_b(T)}{K_a(T)}[1 - \frac{g_{ba} - g_{bb}}{r}]\}. \]  

(23)

Thus, if

\[ \frac{g_{ba} - g_{bb}}{r} > 0, \]

the marginal cost of delay jumps up and \( V_\varepsilon(T, \tau) \) jumps down at \( T \) while if

\[ \frac{g_{ba} - g_{bb}}{r} < 0, \]

the marginal cost of delay jumps down and \( V_\varepsilon(T, \tau) \) jumps up at \( T \).

Only if

\[ 0 = \frac{g_{ba} - g_{bb}}{r}, \]

we have continuity. The intuition is that if \( g_{ba} > g_{bb} \) then for \( \varepsilon < T \), the human capital applicable in country \( b \) grows faster in country \( a \). So delaying the return is less costly than for \( \varepsilon > T \) when growth stops. Conversely, if \( g_{ba} < g_{bb} \) then for \( \varepsilon < T \), the human capital applicable in country \( b \) grows more slowly in country \( a \). So delaying the return is more costly than for \( \varepsilon > T \) when growth stops.

Note, finally, that for

\[ \frac{g_{ba} - g_{bb}}{r} > 1, \]

the marginal cost when coming from below is negative for all \( \varepsilon \) in the range \( \tau \leq \varepsilon \leq T \).

While the marginal benefit from delay at point in time, \( \bar{R}_\alpha(\varepsilon-\tau) \), is common to all immigrants, the marginal cost, \( \frac{K_b(T)}{K_a(T)}(g_{ba} - g_{bb})C(\varepsilon) \), depends on the initial endowments that immigrants possess upon entry into the host country. An increase in the ratio \( \Omega(\tau) \equiv \frac{K_b(\tau)}{K_a(\tau)} \) shifts the marginal costs curve upwards, because then the foregone earnings at home while learning abroad are higher at any point in time.

3.2 Determination of the return time

We can now describe the determination of the return time, \( \varepsilon \), based on the marginal costs that emerge under different degrees of transferability. Due to the discontinuity in the marginal cost function, we consider separately two cases, the case in which \( \tau \leq \varepsilon \leq T \) and the case in which \( \varepsilon > T \).
3.2.1 Return at or before $T$

**Partial transferability** In this case, $g_{aa} > g_{bb}$, which implies that, during the learning period, $T$, the ratio $\frac{K_b(t)}{K_a(t)}$ declines with the duration of stay in the host country and, therefore, the costs of delayed return decline. That is, moving back to the home country becomes less attractive if the emigrant has already stayed in the host country for a while. This is illustrated in Figure 1. The rising concave curve represents the rental rate that immigrants receive in country $a$, $\dot{R}_a(\varepsilon - \tau)$, which is the *marginal gain* from delaying the return to the home country. The downward sloping curve represents the *marginal cost* in terms of forgone earnings in the home country associated with a delayed return. The intersection of these marginal gain and marginal cost curves determines the duration of stay in the host country that satisfies the first order condition, $V_\varepsilon(\varepsilon, \tau) = 0$. However, as seen in the Figure 1, the second order condition is not satisfied at this point. Moving a bit to the right the incentive to stay longer increases and moving a bit to the left the incentive to stay is reduced. This is indicated by the arrows in Figure 1. Thus, irrespective of their initial endowments, all workers will either stay in the home country or emigrate to the host country and never return. This result is the same as the occupational specialization results under partial transferability obtained by Weiss (1971).

**Strong transferability** In this case, $g_{ba} > g_{bb} > 0$ and $g_{ba} > g_{aa}$ which implies that, during the learning period, $T$, the ratio $\Omega(t) \equiv \frac{K_b(t)}{K_a(t)}$ rises with the duration of stay in the host country. Therefore, the cost of a delayed return rise with the duration of stay in the host country. That is, moving back to the home country becomes more attractive if the emigrant has already stayed in the host country for a while. This is illustrated in Figure 2. In this case, if an intersection exists for $\varepsilon$, such that $\tau < \varepsilon < T$, it satisfies the second order conditions. Therefore, an optimal solution may exist such that an immigrant who entered the receiving country will later choose to return to the home country. This happens because, during the stay abroad, his human capital applicable to the home country, $K_b$, rises in the receiving country at a faster rate than the human capital that is applicable to the receiving country, $K_a$. Examining Figure 2, it is seen that immigrants with a higher $\Omega(\tau)$ will leave sooner after arrival (i.e., $\varepsilon - \tau$ declines) because the foregone earnings at home while learning abroad are higher for them. For sufficiently low $\Omega(\tau)$, the cost function will shift down and the intersection will occur in the range in which $\varepsilon > T$.

**Super transferability** In this case, we have $g_{ba} - g_{bb} > r$ in addition to $g_{ba} > g_{aa}$ and $g_{ba} > g_{bb}$, which strengthens the motivation to acquire learning abroad. In fact, the marginal costs of delay in terms of forgone earnings in the home country become negative for all $\varepsilon < T$, irrespective of the initial skill endowments. Because of the positive benefits from delayed return associated with the rising rental rate, $\dot{R}_a(\varepsilon - \tau)$, all immigrants will stay until $T$. Then, those with relatively high $\Omega(\tau)$ return to the home country and those with
relatively low $\Omega(\tau)$ will stay forever in the host country. This case is illustrated in Figure 3.

### 3.2.2 Return after $T$

Would the immigrant stay after the completion of the learning period and return later at some time? To check that, consider an immigrant who wants to extend his stay beyond $T$ and then returns to the home country at some time $\epsilon > T$.

The present value of life time earnings from $T$ on, evaluated at $T$, are

$$V(\epsilon, T) = K_a(T) \int_{T}^{\epsilon} e^{-r(t-T)} \tilde{R}_a(t - \tau) dt + R_b K_b(T)e^{-r(\epsilon-T)} \frac{1}{r}. \quad (24)$$

Hence,

$$V_\epsilon(\epsilon, T) = K_a(T)e^{-r(\epsilon-T)} \tilde{R}_a(\epsilon - \tau) - R_b K_b(T)e^{-r(\epsilon-T)}$$

$$= e^{-r(\epsilon-T)}[K_a(T)\tilde{R}_a(\epsilon - \tau) - R_b K_b(T)], \quad (25)$$

and

$$V_{\epsilon\epsilon}(\epsilon, T) = -r V_\epsilon(\epsilon, T) + e^{-r(\epsilon-T)} K_a(T) \lambda[R_a - \tilde{R}_a(\epsilon - \tau)]. \quad (26)$$

Because the rental rate that immigrants receive in the host country, $\tilde{R}_a(\epsilon - \tau)$, is always below the rental rate that natives receive, $R_a$, we obtain that $V_\epsilon(\epsilon, T) = 0 \Rightarrow V_{\epsilon\epsilon}(\epsilon, T) > 0$ for any finite $\epsilon$. Hence, there is no internal solution for $\epsilon$ that exceeds $T$ and a potential immigrant would either leave at $T$ (or earlier) or stay in the host country forever, depending upon where the present value of subsequent earnings is higher. This rule applies whether or not the marginal cost curve intersects the marginal benefit curve in the region $\epsilon > T$.

### 4 The Emigration Decision

Under the assumptions of the model, it never pays to delay the emigration decision. Note, first, that we only need to concern ourselves with the case in which $\tau < T$. Would the immigrant move at a $\tau$ such that $\tau > T$? In this case, as shown before, he/she will either move back to the home country instantaneously (which is equivalent to staying in the home country) or stay at the host country forever. In the latter case, the expected life time earnings would be

$$W(\tau) = R_b[K_b(0) \int_{0}^{T} e^{(g_b+r)t} dt + K_b(T) \int_{T}^{\tau} e^{-r t} dt] + K_a(T) \int_{\tau}^{\infty} e^{-r t} \tilde{R}_a(t - \tau) dt,$$

with a derivative

$$W'(\tau) = e^{-r \tau} \{R_b K_b(T) - r K_a(T) \int_{0}^{\infty} e^{-r t} \tilde{R}_a(t) dt\}. \quad (28)$$

16
The sign of $W'(\tau)$ is seen to be independent of $\tau$ and, therefore, the immigrant will either never leave (if $W'(\tau) > 0$) or leave immediately at $T$ if (if $W'(\tau) < 0$).

We can further show that, for an immigrant who plans to leave the source country $b$ at $\tau = T$ and stay there, it is always preferable to leave somewhat earlier. To see this, examine the life time value of a plan for which the exit time $\tau$ occurs slightly before $T$. Then

$$W(\tau) = R_b K_b(0) \int_0^\tau e^{(g_{ab} - r)t} dt + K_a(0) e^{(g_{ab} - r)\tau} \int_0^{T - \tau} e^{(g_{aa} - r)t} \bar{R}_a(t) dt$$

$$+ K_a(0) e^{g_{ab} \tau + g_{aa} (T - \tau) - r \tau} \int_0^{T - \tau} e^{-rt} \bar{R}_a(t) dt$$

and

$$W'(T) = e^{-rT} \{ R_b K_b(T) + (g_{ab} - g_{aa} - r) K_a(T) \int_0^\infty e^{-rt} \bar{R}_a(t) dt \}.$$  \hspace{1cm} (29)

Now, if the immigrant emigrates at $T$, it must be the case that the present value of life time earnings (evaluated at $T$) are higher at country $a$

$$\frac{R_b K_a(T)}{r} < K_a(T) \int_0^\infty e^{-rt} \bar{R}_a(t) dt.$$  \hspace{1cm} (31)

Also, under our asymmetry assumption (9), one acquires $K_a$ in the home country at a lower rate than in the host country, $g_{ab} < g_{aa}$. Therefore, $W'(T) < 0$. In other words, if a worker plans a "final" move to country $a$ he would increase the amount of $K_a(T)$ that will be used for the remainder of the work life by moving slightly earlier than the end of the learning period, $T$. We can also show (see Appendix) that an interior solution with respect to $\tau$ does not exist in the range $0 < \tau < T$. Hence, given that $W'(T) < 0$, the only corner solution is at $\tau = 0$. The basic intuition is that if the immigrant plans to stay in the host country then, by leaving early, one can increase the amount of $K_a$ that will be used in the host country. Similarly, if the immigrant plans to return to the home country then, by leaving early, one can increase the amount of $K_b$ that will be used in the home country. In either case, the limited learning period is used more efficiently by an early exit.

5 Who Returns and Who Leaves

We have shown that, in all the considered cases, immigrants who choose to emigrate will do it at time $\tau = 0$. It remains to determine who shall leave the home country, who shall stay in the host country and who shall return. In our
model, individuals with different initial endowments of the two skills, \( S_1(0) \) and \( S_2(0) \), make different emigration decisions that depend on the prices and the learning rates of the two skills in the host and the home countries. Generally, individuals with a \textit{relatively} higher endowment of the skill that has a higher value in the home country (skill 2) are more likely to stay in the home country and those individuals with a \textit{relatively} higher endowment of the skill that has a higher value in the host country (skill 1) are more likely to emigrate. However, the precise determination of these groups depends on whether emigrants plan to return or not and when. We shall, therefore, discuss separately the three basic cases outlined above.

5.1 Partial Transferability

Again, we begin with the simpler case of partial transferability. We have shown that, in such a case, an immigrant will either stay forever or leave immediately at time 0. The choice between these two alternatives is reduced to a comparison of the potential lifetime earnings in the two countries and a person will wish to emigrate to the receiving country immediately if

\[
R_b K_b(0) \left[ \int_0^T e^{(g_{ba} - r)t} dt + e^{(g_{ba} - r)T} \right] < K_a(0) \left[ \int_0^T e^{(g_{aa} - r)t} \tilde{R}_a(t) dt + e^{(g_{aa} - r)T} \int_0^\infty e^{-rt} \tilde{R}_a(t + T) dt \right].
\]

Recalling our definition, \( \Omega(t) \equiv \frac{K_a(t)}{K_b(t)} \), this comparison of present values can be rewritten in the form

\[
\Omega(0) < \frac{\int_0^T e^{(g_{ba} - r)t} \tilde{R}_a(t) dt + e^{(g_{ba} - r)T} \int_0^\infty e^{-rt} \tilde{R}_a(t + T) dt}{R_b \left[ \int_0^T e^{(g_{ba} - r)t} dt + e^{(g_{ba} - r)T} \right]} \equiv \Omega_p.
\]

Thus, there is some critical value of \( \Omega(0) \) denoted as \( \Omega_p \) that triggers emigration. We emphasize that \( \Omega_p \) (as well as the trigger values defined below) is not an additional independent parameter. Rather it is an endogenously determined function of the basic parameters that summarizes the impact of planned future immigration decisions on the present value of lifetime earnings that is associated with alternative current choices.

We can further reduce this relationship and rewrite (33) as

\[
S_2(0) < \frac{\ln \Omega_p}{\theta_{2b} - \theta_{2a}} + \frac{\theta_{1a} - \theta_{1b}}{\theta_{2b} - \theta_{2a}} S_1(0).
\]

Because \( \tilde{R}_a(t) > R_b \) and \( g_{aa} > g_{bb} \), the expected earnings per unit of initial human capital are higher in country \( a \) than in country \( b \) and, therefore, \( \ln \Omega_p > 0 \). Different individuals have different skills and the set of people that wish to emigrate is all those whose bundle of initial skills (a pair \( (S_1(0), S_2(0)) \) places
them below the bold line described in Figure 4. Because skill 1 has higher value in country \(a\), individuals with relatively higher endowment of that skill are more likely to emigrate. The slope of the boundary line is \(\frac{\theta_{1a} - \theta_{1b}}{\theta_{2b} - \theta_{2a}}\) which, under our assumptions, is positive but can be above or below 1. The graph is drawn for the case in which the prices of skill 2 differ across countries less than the prices of skill 1, \(\frac{\theta_{1a} - \theta_{1b}}{\theta_{2b} - \theta_{2a}} > 1\). This condition can be compared to the model with one skill, which is fixed over time, of Borjas and Bratsberg (1996) by examining the special case of perfect correlation between the two skills, \(S = S_1(0) = S_2(0)\). Then the condition \(\frac{\theta_{1a} - \theta_{1b}}{\theta_{2b} - \theta_{2a}} > 1\) implies that

\[
\frac{d\ln K_a}{dS} = \theta_{1a} + \theta_{2a} > \frac{d\ln K_b}{dS} = \theta_{1b} + \theta_{2b}, \tag{35}
\]

That is, a common increase in both skills raises log earnings in country \(a\) by more than it increases log of earnings in country \(b\). Hence, in the one skill model, individuals with low \(S\) would prefer to stay in the home country, while those with high \(S\) will emigrate. In the two dimensional case discussed here, the two skills are not perfectly correlated. Therefore, although \(\frac{\theta_{1a} - \theta_{1b}}{\theta_{2b} - \theta_{2a}} > 1\), some of those who choose to stay in the home country are more "able" (in the sense of having a higher endowment of both skills) than some of those who choose to emigrate. This is illustrated by points \(a\) and \(b\) in Figure 4. At the same time, some of those who choose to stay in the home country are less "able" (in the sense of having a lower endowment of both skills) than some of those who choose to emigrate. This is illustrated by points \(c\) and \(d\) in Figure 4. It is only if we restrict attention to comparison on the 45 degree line, that all the individuals who emigrate are more able than all the individuals who stay. In this regard, the two dimensional model provides a richer set of possibilities than the one dimensional model.

5.2 Strong Transferability

We now have \(g_{ba} > g_{aa} > g_{bb}\). In this case, some individuals may stay in the home country, some will return at some point between 0 and \(T\) and some will never return and stay in the host country for ever. Inspecting Figure 2, we see that workers for whom

\[
V \varepsilon(0, 0) = K_a(0)\{\tilde{R}_a(0) - R_b K_a(0) K_a(0) C(0)\} < 0, \tag{36}
\]

16 Partial transferability and condition (9) require

\[
\frac{\gamma_{2b}}{\gamma_{1b}} > \frac{\theta_{1a} - \theta_{1b}}{\theta_{2b} - \theta_{2a}} > \frac{\gamma_{2a}}{\gamma_{1a}}
\]

and, by assumption,

\[
\frac{\gamma_{2b}}{\gamma_{1b}} > 1 > \frac{\gamma_{2a}}{\gamma_{1a}}.
\]
will stay in the home country. Using the assumption that $\tilde{R}_a(0) = R_b$, we can rewrite this condition as

$$V_c(0, 0) = K_a(0)R_b\{1 - \frac{K_a(0)}{K_a(0)}C(0)\} < 0,$$

and using the result that $\tau = 0$, we have

$$C(0) = 1 - (g_{ba} - g_{bb})\left[\int_0^T e^{(g_{ba} - r)t} dt + \frac{e^{(g_{ba} - r)T}}{r}\right].$$

We see that $C(0)$ is positive if the advantage of learning abroad, $g_{ba} - g_{bb}$, is small or the learning period $T$ is short. Conversely, $C(0)$ is negative if $g_{ba} - g_{bb}$ and $T$ are large. If $C(0) < 0$ then $V_c(0, 0) > 0$ and everyone will emigrate and stay in the host country at least some time. However, if $C(0) > 0$ then those for whom

$$\frac{K_b(0)}{K_a(0)} > \frac{1}{C(0)} \equiv \Omega_s,$$

will stay in the home country. We can now provide the following characterization:

All those for whom

$$\frac{K_b(0)}{K_a(0)} < \frac{re^{(g_{ba} - g_{bb})T}}{R_b} \int_0^T e^{-r(t-T)} \tilde{R}_a(t) dt \equiv \Omega_{nr},$$

will emigrate and stay in the host country and those for whom

$$\Omega_s > \frac{K_b(0)}{K_a(0)} > \Omega_{nr},$$

will emigrate and return some time before $T$.\footnote{Consistency of such solution requires that}

The solution is presented in Figure 5. As seen, there is a clear pattern of the alternative migration choices. Those for whom $S_2(0)$ (which is the skill that is highly valued in country $b$) is high relatively to $S_1(0)$ (which is the skill that is highly valued in country $a$) will stay in the home country. The others will emigrate and, among them, those for whom $S_2(0)$ is high relatively to $S_1(0)$ will stay in the host country for good.

The solid boundary lines are now drawn with a slope that is less than 1, which is a necessary outcome of strong transferability that requires

$$1 > \frac{\gamma_2a}{\gamma_1a} > \frac{\theta_{1a} - \theta_{1b}}{\theta_{2b} - \theta_{2a}}.$$
Would we restrict ourselves to the one dimensional case, as in Borjas and Bratsberg (1996), this requirement would imply that all individuals who stay in the home country are more able than all immigrants which return who, in turn, are more able than all immigrants who stay abroad. This seems implausible in the case of immigration from developing countries to a developed country. In this regard, a two skill model is much more appealing, because it allows a richer set of possibilities.

5.3 Super Transferability

In this case, all immigrants stay in the host country until \( T \) and then some return, at \( T \), to the home country and others stay permanently. The life time earnings associated with the alternative plans are:

Those who go abroad and return earn

\[
W_r(T) = K_a(0) \int_0^T e^{-rt+g_{ab}t} \hat{R}_a(t) dt + e^{(g_{ba}-r)T} \frac{R_b K_b(0)}{r}. \tag{40}
\]

Those who go abroad and do not return earn

\[
W_s(T) = K_a(0) \int_0^T e^{-rt+g_{ab}t} \hat{R}_a(t) dt + K_a(0) e^{(g_{aa}-r)T} \int_T^\infty e^{-r(t-T)} \hat{R}_a(t) dt. \tag{41}
\]

Those who stay home earn

\[
W_h(T) = R_b K_b(0) \int_0^T e^{-rt+g_{bh}t} dt + e^{(g_{bh}-r)T} \frac{R_b K_b(0)}{r}. \tag{42}
\]

We first show that, under our assumption that \( g_{ba} - g_{bb} > r \), everyone will want to emigrate. This holds, because going abroad and returning always dominates staying at home. That is \( W_r(T) > W_h(T) \) because even if one earns nothing abroad, the increase in earning capacity after the completion of training abroad more than compensates for the forgone earnings at home during the training period, \( T \). Formally,

\[
W_r(T) - W_h(T) > f(T) \equiv \frac{R_b K_b(0)}{r} \int_0^T [e^{(g_{ba}-r)T} - e^{(g_{bh}-r)T} - r \int_0^T e^{-rt+g_{ab}t} dt], \tag{43}
\]

with \( f(0) = 0 \) and

\[
f'(T) = \frac{R_b K_b(0)}{r} [(g_{ba} - r) e^{(g_{ba}-r)T} - g_{bb} e^{(g_{bh}-r)T}] \tag{44}
\]

\[
> \frac{R_b K_b(0) e^{(g_{ba}-r)T}}{r} [g_{ba} - r - g_{bb}] > 0,
\]
which implies that for every $T > 0$, $f(T) > 0$ and $W_r(T) > W_b(T)$.

As it does not make sense that everyone can enter the host country, imagine that the government of the receiving country, $a$, restricts entry by requiring a minimal level of skill 1 which, by assumption, is more valuable in it. Then, those with lower endowment of skill 1 than the a minimal required value, given by $S_m^a(0)$, must stay in the home country and the rest are divided according to the shaded areas indicated in Figure 6.\textsuperscript{18} For those who are allowed in, there is a critical value such that emigrants with $\frac{K_b(0)}{K_a(0)} > \Omega_r(0)$ will choose to return to the home country at time $T$ (because for them $W_r(T) > W_s(T)$), while those for whom $\frac{K_b(0)}{K_a(0)} < \Omega_r(0)$ will stay in the host country (because for them $W_r(T) < W_s(T)$). This critical value is given by

$$\Omega_r(0) = re^{(g_a - g_b)T} \frac{R_a}{1 - R_b} + \frac{R_b - R_a}{(r + \lambda)R_b} e^{-\lambda T}.$$ \hspace{1cm} (45)

Every immigrant with a bundle of skills above the positively sloped solid line in Figure 6 will return to the home country and all others will stay in the host country.\textsuperscript{19} The boundary is drawn again with a slope less than 1, as implied by strong transferability, which also applies here.

6 **Closing the model**

We described here the immigration and remigration decisions of workers in a developing country, taking as given the rental rates of human capital in the two countries, $R_a$ and $R_b$. These two parameters respond to changes in demand and supply of labor and to the immigration policy of the receiving country. A simple way to close the model is to postulate an aggregate production function

$$Y_j = F_j(N_j, H_j),$$ \hspace{1cm} (46)

where $Y_j$ is the aggregate output of a single (composite) good in country $j$, $N_j$ is the aggregate physical (non human) capital employed in country $j$, and $H_j$ is the aggregate human capital embodied in the population of country $j$. Assuming a constant return to scale technology and free mobility of capital, the capital labor ratio (in efficiency units) in each country is uniquely determined by the maximum profit condition

$$F_j'(N_j) = \frac{N_j}{H_j} = r,$$ \hspace{1cm} (47)

where $r$ is the internationally determined return to capital. Having a fixed capital labor ratio in each country, the rental rates for human capital $R_a$ and $R_b$ are also uniquely determined. A difference between the two countries in

\textsuperscript{18}Such a restriction is analyzed by Djajic (1989) in a one skill framework.

\textsuperscript{19}The intercept is taken here to be negative, which would be the case if $\lambda$ is sufficiently small. For a large $\lambda$, the intercept can be positive.
the rental rates of human capital resulting from different technologies can be sustained if mobility of workers is restricted. If some workers move from country b to country a then, depending on the initial skills of these workers, there is a certain proportional increase in \( H_a \) and a certain proportional decrease in \( H_b \). Following the adjustments in non human capital, the aggregate output in each country, \( Y_j \), will change by the same proportions as the change in aggregate human capital.

Finally, we can translate these results into a per capita framework by rewriting the production function (46) as

\[
y_j = F^j(n_j, h_j),
\]

(48)

where \( y_j \) is per capita income in country \( j \), \( n_j \) is the per capita physical (non human) capital employed in country \( j \), and \( h_j \) is the per capita human capital embodied in the population of country \( j \).

7 Brain Gain and Brain Drain

We first observe that, in the absence of externalities, individual rationality implies that the reduction in local output caused by emigration is always lower than the gain that the immigrant obtains abroad. Hence, there is always a potential gain for the developing countries if their citizens can apply their skills where they receive the highest rewards. However, in the absence of transfers, emigration can have negative effects on those who remain behind, workers as well as capital owners, through changes in factor prices or a reduced tax base and ability to finance local public goods. It was, therefore, suggested that emigrants, or the receiving developed countries, should compensate the developing countries for these losses (see Bagwhati 1976, Part I). In practice, such taxation is hard to accomplish and we shall be concerned here only with the proportional change in local per capita human capital caused by emigration and return migration, which under our assumptions is the same as the proportional change in local per capita income. We shall refer to a reduction in the per capita human capital in the home country (country \( b \)) as a brain drain and to an increase in the per capita human capital in the home country as a brain gain.

Consider the following thought experiment. Initially, there is no labor mobility between countries. Then, at a later time, costless labor migration becomes feasible. We wish to examine the implications of such a change for the developing country (country \( b \)). We have seen that, with partial transferability, emigrants from country \( b \) to country \( a \) do not return to their home country. Therefore, in this case, local aggregate output must decline. However, output per capita

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\(^{20}\)This simple analysis is completely static. Santos and Postel Vinay (2003) provide a dynamic analysis in which migration and return migration generates technological diffusion that affects the rate of growth in the receiving and sending country. Business cycle effects can also be added by letting the rental rates in the two country vary with the cycle.
in the home country may increase if the skill composition of emigrants is such that per capita endowment of human capital $h_b$ rises.\footnote{This will happen if the average skills of the stayers is higher than the population mean. Assuming that skills are distributed in the population according to a joint normal distribution, this will occur if the variance of $K_a$ (in the home country) exceeds the covariance between $K_a$ and $K_b$. However, if the inequality is reversed, emigration will reduce the average per capita endowment of human capital. See also Heckman and Honore (1990) and Borjas (1987).}

Now suppose that experience in the host country is strongly transferable. In this case, some immigrants return and some stay, but because immigrants with different initial skills return at different times it is hard to evaluate the aggregate outcome. However, with super transferability, all immigrants that return will do so at the end of the learning period, $T$. We then obtain some sharp results: For every immigrant that returns we have a brain gain if

$$\frac{R_b K_b(0)e^{(g_a-r)T}}{r} > R_b K_b(0)\left[\int_0^T e^{-rt+g_\lambda t}dt + \frac{e^{(g_a-r)T}}{r}\right].$$

(49)

We have shown above that this requirement holds under super transferability. On the other hand, there may be a per capita gain or loss from those who leave and do not return. The brain gain (loss) from any emigrant that does not return is determined by comparing his potential lifetime earnings if he would have stayed in the home country, given by

$$R_b K_b(0)\left[\int_0^T e^{-rt+g_\lambda t}dt + \frac{e^{(g_a-r)T}}{r}\right],$$

and the average lifetime earnings prior to emigration. Taking all these possibilities into account, output per capita can rise if the proportion of returning immigrants is large enough.

To the extent that the host country imposes an entry skill standard, the probabilities of exit and return must also be conditioned on having the minimal level of $S_1(0)$ required for entry. By imposing such a standard, the home country "gains" some of those who have relatively low level of skill 1 and would not have returned (because they do not have much of the local skill, 2) but it "loses" those with low level of skill 1 who would return to the home country with their augmented local skills that they would have acquired abroad. The second group may be more valuable to the home country if their weight among unaccepted immigrants is substantial. Hence, it is quite possible that by imposing a skill standard the brain drain problem faced by the home country will be aggravated. Moreover, from the point of view of the receiving country, the selection by local skill restricts entry of immigrants who would return to their home country anyway, which may not be the intended outcome of the policy.

### 8 Conclusion

We have presented a tractable model that focuses on the incentives to return immigration based on investment considerations. Under some conditions, the
model can generate a brain gain. The basic idea is that some countries are learning centers where one can learn skills more effectively, including skills that are applicable to the home country. Therefore, some individuals who go to study abroad would return to apply their acquired skills in the home country. Because immigrants also acquire skills applicable to the host country, some emigrants will prefer to stay in the host country. Generally, those who return have a relatively high endowment of the skill that is more valued in the home country and those who stay abroad have a relatively high endowment of the skill that is more valuable abroad.

Emphasizing only one consideration for moving, planned acquisition of human capital, and assuming no costs or legal obstacles for immigration, we get some sharp results. In particular, to generate brain gain from return migration, it is necessary that the increase in the local earnings of a returning immigrant exceeds the whole cost of forgone earnings at home, while staying abroad. But in this case, the private incentives to emigrate are so large that everyone would emigrate if possible. In practice, this is not possible, of course, because of restrictions of entry into the host country. However, the model can still have some interesting implications concerning the form that entry restrictions take. Many countries restrict entry to "qualified workers" that are in short supply in the receiving country. Because such standards are based on skills relevant to the host country, it is possible that a substantial number of immigrants who would have returned to the home country with augmented local skills are also excluded, implying a potentially larger brain drain for the home country (see Djajic, 1989).

Our model can also address wage differentials between natives and immigrants in the receiving country. Suppose that immigrants who wish to enter the receiving country and are allowed to do so have, on the average, a higher endowment than natives of the more highly valued skill 1. Then, initially, these immigrants will receive lower wages than natives because the rental rate of human capital that they receive is lower than that of natives, \( R_b < R_a \). However, as the rental rate that immigrants receive in the receiving country rises and approaches \( R_a \), those immigrants who stay in the host country will eventually overtake the natives in terms of average wages.

We discussed here only learning by doing on the job. However, the basic ideas also apply to learning in school. A policy issue that applies to both cases is how to allocate the gains from immigration among individuals and in between countries. Tuition policies in the context of student migration are discussed in Rosenzweig (2006) and Kennan (2009). This problem is somewhat more complicated in the case of learning on the job, where the opportunity costs are not directly observable. Further issues arise if one can move to a learning center in order to acquire skills that are applicable in a third country rather than the home country, resulting in chain migration.\(^2\) In this case, the natural solution

\(^{2}\) To some extent, Israel was such a stepping stone for Russian immigrants who learned English and modern technology in Israel and then moved on to the US or Canada. Of those immigrants who arrived in 1990-1991 and stayed until 1995 about 5% have left until 2004. Remigration was higher among the highly educated and among those who arrived to Israel at
would be to require a payment from the immigrant for the "general" human capital that she acquired. Finally, an important issue that we did not discuss are the potential externalities if the skills of different workers in a given economy are complements. Hence, brain drain or gain can have magnified consequences through the impacts of emigration (immigration) on the workers who stay in the home country and also further consequences for the workers in the receiving country.

References


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a young age, where 11.4% have left by 2004. These figures were provided to us by Eric Gould. See Gould and Moav (2008) for a description of the data.


9 Appendix

This appendix shows that early exit is always optimal. We conduct the analysis separately for the three types of transferability.

9.1 Partial Transferability

We have shown in the text that, in this case, an immigrant who leaves the home country will never return. Therefore, the present value of lifetime earnings (evaluated at time $T$) of a migrant who moves from the home country to the receiving country at time $\tau$ is

$$W(\tau) = R_b K_b(0) \int_0^\tau e^{(g_{bb} - r)t} dt + K_a(0) \int_0^{T-\tau} e^{(g_{aa} - r)t} \tilde{R}_a(t) dt$$

$$+ K_a(0) e^{g_{ab} \tau + g_{aa}(T-\tau) - r\tau} \int_{T-\tau}^\infty e^{-rt} \tilde{R}_a(t) dt.$$  (A1)

and

$$W'(\tau) = e^{(g_{ab} - r)\tau} \{ R_b K_b(0) e^{(g_{bb} - g_{ab})\tau} + (g_{ab} - r) K_a(0) \int_0^{T-\tau} e^{(g_{aa} - r)t} \tilde{R}_a(t) dt$$

$$(g_{ab} - g_{aa} - r) K_a(0) e^{g_{aa}(T-\tau)} \int_{T-\tau}^\infty e^{-rt} \tilde{R}_a(t) dt \}.$$  (A2)

$$W''(\tau) = (g_{ab} - r) W'(\tau) + e^{(g_{ab} - r)\tau} \{ (g_{bb} - g_{ab}) R_b K_b(0) e^{(g_{bb} - g_{ab})\tau}$$

$$- g_{aa}(g_{ab} - g_{aa} - r) K_a(0) e^{g_{aa}(T-\tau)} \int_{T-\tau}^\infty e^{-rt} \tilde{R}_a(t) dt$$

$$- g_{aa} e^{-r(T-\tau)} \tilde{R}_a(T - \tau) K_a(0) e^{g_{aa}(T-\tau)} \}.$$  (A3)

Using integration by parts of $\int_{T-\tau}^\infty -re^{-rt} \tilde{R}_a(t) dt$, the second term in the
curled brackets in (A3) can be rewritten as

\[-g_{aa}(g_{ab} - g_{aa} - r)K_a(0)e^{g_{aa}(T-\tau)} \int_{T-\tau}^{\infty} e^{-rt} \tilde{R}_a(t)dt - g_{aa}e^{-r(T-\tau)} \tilde{R}_a(T - \tau)K_a(0)e^{g_{aa}(T-\tau)} \]

\[= -g_{aa}K_a(0)e^{g_{aa}(T-\tau)}[(g_{ab} - g_{aa}) \int_{T-\tau}^{\infty} e^{-rt} \tilde{R}_a(t)dt - r \int_{T-\tau}^{\infty} e^{-rt} \tilde{R}_a(t)dt + e^{-r(T-\tau)} \tilde{R}_a(T - \tau)] \]

\[= -g_{aa}K_a(0)e^{g_{aa}(T-\tau)}[(g_{ab} - g_{aa}) \int_{T-\tau}^{\infty} e^{-rt} \tilde{R}_a(t)dt - \int_{T-\tau}^{\infty} e^{-rt} \frac{d\tilde{R}_a(t)}{dt}dt].\]

Having assumed that \(g_{ab} < g_{ab} < g_{aa}\) and \(\frac{d\tilde{R}_a(t)}{dt} > 0\), we see that \(W'(\tau) \leq 0 \implies W''(\tau) > 0\). Hence, there is no interior solution for \(\tau\) in the interval \((0, T)\). Given our result that \(W'(T) < 0\), it must then be the case that \(W'(\tau) < 0\) for all \(\tau\) such that \(0 < \tau < T\), implying \(\tau = 0\).

### 9.2 Strong Transferability

We have shown in the text that, in this case, an immigrant may return to the home country at some time \(\varepsilon\) such that \(\tau < \varepsilon < T\). Therefore, the present value of life time earnings (evaluated at time 0) of a migrant who moves from the home country to the receiving country at time \(\tau\) and returns at \(\varepsilon\) is

\[W(\tau) = R_bK_b(0) \int_0^\tau e^{(g_{ab} - r)t} dt + \max_{\varepsilon} \{K_a(0)e^{(g_{ab} - r)(\varepsilon - \tau)} \int_\tau^\varepsilon e^{(g_{aa} - r)(t-\tau)} \tilde{R}_a(t)dt\}

+ R_bK_b(0)e^{g_{aa}(\varepsilon - \tau) + g_{ab}\tau} \int_\varepsilon^T e^{g_{ab}(t-\varepsilon - r)t} dt

+ R_bK_b(0)e^{g_{aa}(\tau - \varepsilon) + g_{ab}\tau + g_{ab}(T-\varepsilon - r)T} \}

(A4)

Changing variables, we can rewrite

\[W(\tau) = R_bK_b(0) \int_0^\tau e^{(g_{ab} - r)t} dt + e^{(g_{ab} - r)\tau} \max_{\varepsilon} \{K_a(0)e^{(g_{ab} - g_{ab})\tau} \int_0^{(g_{ab} - r)\tau} e^{(g_{aa} - r)t} \tilde{R}_a(t)dt\}

+ R_bK_b(0)e^{(g_{ab} - g_{ab})(\varepsilon - \tau)} \int_\varepsilon^{(g_{ab} - r)\tau} e^{(g_{ab} - r)t} dt

+ R_bK_b(0)e^{(g_{ab} - g_{ab})(\tau - \varepsilon)} \frac{e^{(g_{ab} - r)(T-\tau)}}{r} \}

(A5)

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Using the envelope theorem,

\[ W'(\tau) = R_b K_b(0)e^{(g_{ab}-r)\tau} + e^{(g_{ab}-r)\tau} \{(g_{ab} - g_{bb})K_a(0)e^{(g_{ab}-g_{bb})\tau} \int_0^{\tau-r} e^{(g_{aa}-r)t} \tilde{R}_a(t)dt \]

\[ \quad - R_b K_b(0)e^{(g_{aa}-g_{bb})(\varepsilon-\tau)}e^{(g_{ab}-r)(\tau-r)} \]

\[ \quad - (g_{bb} - r)R_b K_b(0)e^{(g_{aa}-g_{bb})(\varepsilon-\tau)}e^{(g_{ab}-r)(\tau-r)} \frac{\partial}{\partial \tau} e^{(\varepsilon-\tau)} \]

\[ \quad + (g_{bb} - r)e^{(g_{ab}-r)\varepsilon} \{ \tau \} \],

which, evaluated at the optimum of \( \varepsilon - \tau \), yields

\[ W'(\tau) = e^{(g_{ab}-r)\tau} \{ R_b K_b(0) + (g_{ab} - r)K_a(0)e^{(g_{ab}-g_{bb})\tau} \int_0^{\tau-r} e^{(g_{aa}-r)t} \tilde{R}_a(t)dt \]

\[ \quad - R_b K_b(0)e^{(g_{aa}-g_{bb})(\varepsilon-\tau)} \}

\[ W''(\tau) = (g_{ab} - r)W'(\tau) \]

\[ \quad + e^{(g_{ab}-r)\tau} \{(g_{ab} - g_{bb})(g_{ab} - r)K_a(0)e^{(g_{ab}-g_{bb})\tau} \int_0^{\tau-r} e^{(g_{aa}-r)t} \tilde{R}_a(t)dt \]

\[ \quad + (g_{ab} - r)K_a(0)e^{(g_{ab}-g_{bb})\tau}e^{(g_{ab}-r)(\varepsilon-\tau)} \tilde{R}_a(\varepsilon-\tau) \frac{d(\varepsilon-\tau)}{d\tau} \]

\[ \quad - (g_{ba} - r)R_b K_b(0)e^{(g_{ab}-r)(\varepsilon-\tau)} \frac{d(\varepsilon-\tau)}{d\tau} \]

From Figure 2, we see that \( \varepsilon \) declines in \( \frac{K_a(t)}{K_a(0)} = \frac{K_a(0)}{K_a(t)}e^{(g_{ab}-g_{aa})\tau} \). Having assumed that \( g_{bb} > g_{ab} \) it follows that \( \varepsilon \) declines in \( \tau \) and, therefore, \( \varepsilon - \tau \) declines in \( \tau \). We conclude that for \( g_{ab} < r < g_{ba} \), \( W'(\tau) = 0 \implies W''(\tau) > 0 \). This also holds if the immigrant’s optimal choice is to return at \( T \) in which case \( \frac{d(\varepsilon-\tau)}{d\tau} = -1 \). Hence, there is no interior solution for \( \tau \) in the region \((0, T)\).

Having shown that \( W'(T) < 0 \), the only possible corner is at \( \tau = 0 \). That is, a worker in country \( b \) who plans to emigrate and return at some \( \varepsilon \) prior to or at \( T \) will emigrate immediately. For those who plan to stay in the host country, the results in the previous subsection continue to hold and they too will emigrate immediately.

### 9.3 Super Transferability

We have shown in the text that, in this case, all immigrants will return at \( T \). In this case, the present value of life time earnings (evaluated at time 0) of a
We now need to consider two branches; the conditioned on country and the second one, denoted by $W_2$, represents the case in which conditioned on $W_1$, the immigrant stays in the host country. For the second branch, we have

$$W_2 = R_b K_b(0) \int_0^\infty e^{(g_{ab} - r)t} dt + K_a(0) \int_0^T e^{-rt + g_{aa}(t - \tau)} \tilde{R}_a(t - \tau) dt$$

$$+ e^{-T \max \left\{ R_b K_b(T), K_a(T) \int_0^T e^{-r(t - T)} \tilde{R}_a(t - \tau) dt \right\}}$$

We now need to consider two branches; the first one, denoted by $W_1$, represents the case in which conditioned on $\tau$, the immigrant returns to the home country and the second one, denoted by $W_2$, represents the case in which conditioned on $\tau$, the immigrant stays in the host country. For the first case,

$$W_1(\tau) = R_b K_b(0) \int_0^\tau e^{(g_{ab} - r)t} dt + K_a(0) \int_0^T e^{(g_{ab} - r)t} \tilde{R}_a(t) dt$$

$$+ e^{-T \max \left\{ R_b K_b(T), K_a(T) \int_0^T e^{(g_{ab} - g_{ba})(\tau + g_{ba}T) - \lambda(\tau)} \right\}}$$

and for $g_{ab} < r$ and $g_{ba} - g_{bb} > r$, we have that

$$W_1'(\tau) = R_b K_b(0) e^{(g_{ab} - r)\tau} + (g_{ab} - r) e^{(g_{ab} - r)\tau} K_a(0) \int_0^{(g_{ab} - r)\tau} e^{(g_{aa} - r)x} \tilde{R}_a(x) dx$$

$$+ e^{-T \max \left\{ R_b K_b(T), K_a(T) \int_0^T e^{(g_{ab} - r)(T - \tau) + (g_{ab} - r)\tau} \tilde{R}_a(T - \tau) + e^{-rT R_b K_b(0) e^{g_{bb} + g_{ba}(T - \tau)} (g_{bb} - g_{ba})} \right\}} < 0.$$
and

\[
W_2'(\tau) = R_b K_b(0) e^{(g_{ab}-r)\tau} + (g_{ab} - r) K_a(0) e^{(g_{ab}-r)\tau} \int_0^{T-\tau} e^{-rt+g_{aa}t} \tilde{R}_a(t) dt \\
+ e^{-r\tau} K_a(0) e^{g_{ab}\tau + g_{aa}(T-\tau)} (g_{ab} - g_{aa} - r) \int_{T-\tau}^{\infty} e^{-rt} \tilde{R}_a(t) dt. \quad (A13)
\]

Imposing the constraint that for this case

\[
\frac{R_b K_b(T)}{r} < K_a(T) \int_T^{\infty} e^{-r(t-T)} \tilde{R}_a(t - \tau) dt, \quad (A14)
\]

we get

\[
W_2'(\tau) < e^{(g_{ab}-r)\tau} K_a(0) \{ r e^{(g_{aa}-g_{ba})(T-\tau)} e^{r(T-\tau)} \int_{T-\tau}^{\infty} e^{-rt} \tilde{R}_a(t) dt \\
+ (g_{ab} - r) \int_0^{T-\tau} e^{-rt+g_{aa}t} \tilde{R}_a(t) dt \\
+ e^{g_{aa}(T-\tau)} (g_{ab} - g_{aa} - r) \int_{T-\tau}^{\infty} e^{-rt} \tilde{R}_a(t) dt \}. \quad (A15)
\]

Thus, assuming that \( g_{ab} < r \), a sufficient condition for \( W_2'(\tau) \) to be negative is

\[
re^{(g_{aa}-g_{ba})(T-\tau)} e^{r(T-\tau)} + e^{g_{aa}(T-\tau)} (g_{ab} - g_{aa} - r) < 0 \quad (A16)
\]

\[
g_{aa} - g_{ab} > r \quad e^{(r-g_{ba})(T-\tau)},
\]

which always holds given our assumptions that \( g_{ab} < g_{bb} < g_{aa} \) and \( g_{ba} - g_{bb} > r \). Hence, in this case too, any person that emigrates does so at time 0. However, the motives for this behavior are different in the two cases. Those who return wish to increase their local capital and if \( g_{aa} > g_{bb} \) the gain is maximized by going abroad as early as possible. In contrast, those who do not return wish to increase their capital abroad and if \( g_{aa} > g_{ab} \) this is maximized by going abroad as soon as possible.
Figure 1: Determination of time in the host country, partial transferability
Figure 2: Determination of time in the host country, strong transferability
Figure 3: Determination of time in the host country, super transferability
Figure 4: Determination of who emigrates, partial transferability
Figure 5: Emigration and return migration, strong transferability
Figure 6: Emigration and return migration, super transferability