BRAIN DRAIN AND BRAIN WASTE

ARMANDO J. GARCIA PIRES[*]

Centre for Applied Research at NHH, Norwegian School of Economics, Norway

When skilled workers migrate, they face the brain waste risk, i.e., they can end up employed as unskilled. We analyze the effects of brain waste on brain drain, resulting from low international transferability of skills. We show that this type of brain waste: (1) reduces education incentives; (2) weakens the chances for a positive self-selection; and (3) decreases the possibility of a brain gain. In addition, the effectiveness of education policies that subsidize students is reduced under the presence of brain waste. Results are robust to introducing different migration costs for the skilled and the unskilled.

Keywords: Brain Drain, Brain Waste, Self-Selection, International Transferability of Human Capital
JEL classification: F22, J61

1.   INTRODUCTION

The traditional view on brain drain is that international migration leads developing countries to lose skilled workers to developed countries, due to higher wages in the latter (Bhagwati and Hamada, 1974).[1] Emigration of the skilled from poor countries to rich countries can then be detrimental to economic growth in the former through a set of negative externalities, for example, reduced productivity of those left behind, higher costs of public goods and loss of the investment made in human capital formation.

Recent contributions, however, argue that the brain drain story does not necessarily need to hold (Docquier and Rapoport, 2007). In effect, in a developing economy closed to international migration, the returns to schooling are very low and this discourages investment in education. However, if an individual is able to migrate to a high wage developed country where the returns to schooling are higher, he/she might have an extra incentive to acquire education relatively to autarchy. This new view defends that

---

[1] The term brain drain designates "the international transfer of human resources and mainly applies to the migration of relatively highly educated individuals from developing to developed countries" (Docquier and Rapoport, 2008).

migration might offset the negative brain drain effect via an increase in the number of people taking education, due to higher returns to schooling relatively to autarchy. In particular, migration can conduce to a brain gain when the increase in the number of people that acquire education due to migration prospects more than compensates for the skilled people that migrate.

According to Docquier and Rapoport (2012), the brain gain effect that can arise through migration can be strengthened or weakened with the introduction of occupational choices, network effects (Kanbur and Rapoport, 2005), fertility, education subsidies (Stark and Wang, 2002), and brain waste (Schiff, 2005). In this paper, we investigate the claim by Docquier and Rapoport (2012) on brain waste and brain drain.

Brain waste describes a situation with skill downgrading, where an individual is working in a job that requires a skill level lower than the one he/she has acquired (Reitz, 2001). In other words, brain waste arises when a skilled individual incurs in the costs of taking education but he/she does not reap the benefits of human capital acquisition, i.e.,: a skilled migrant ends up working as unskilled. With brain waste, then, skilled migrants run the risk of not accessing the rewards to human capital in the destination country. If migrants internalize this brain waste risk, the education incentives that arise with international migration can therefore be reduced, decreasing also the chances for a brain gain.

We focus on one channel of brain waste: low international transferability of skills.[2] Low international transferability of human capital occurs when skills are not easily transferable across borders. Consequently, a skilled migrant has higher chances to end up employed as unskilled (Chiswick and Miller, 2007).

An analysis of developed and developing countries' migration policies shows in fact a change of focus to the international transferability of human capital (World Bank, 2006). This interest lies in the fact that the international transferability of skills is expected to influence self-selection of migrants, once it affects the returns to migration of the skilled.[3] The main research question in the self-selection literature is if skilled individuals positively self-select into migration relatively to the unskilled (Borjas, 1987). This is an important topic, because it is believed that skilled migrants can promote positive externalities (an increase in the stock of human capital and knowledge spillovers) for the host economy and for the source economy in case they return.

In this paper, we analyze if brain waste, which results from the low international

---

[2] Illegal migration can also be a cause of brain waste (see Coniglio *et al*., 2009). However, the mechanism through which illegal migration affects brain waste is different from the one under low international transferability of skills. On this issue, see footnote 11.

[3] The theoretical literature identifies two dimensions of self-selection: selection in terms of observable skills (e.g., education, language skills and work experience) and selection in terms of unobservable skills (e.g., ability and motivation). The empirical literature, however, usually only focus in the former (Beine *et al*., 2008).

transferability of skills, affects the arguments on brain gain, and on the positive self-selection of skilled workers into migration. Our main idea is that imperfect international transferability of skills creates a brain waste risk. This is so because a skilled migrant runs the risk that his/her skills are not recognized at the destination. Therefore, when a skilled worker migrates, he/she is subject to a kind of lottery. If a skilled migrant has the skills recognized, he/she has access to the destination country's returns to skills. If a skilled migrant does not have the skills recognized, he/she has invested in education but does not receive the full returns to skills.

In order to study these issues, we compare a scenario with no brain waste to one with brain waste. We show that brain waste has the following consequences: (1) reduces education incentives; (2) weakens the chances for a positive self-selection; and (3) decreases the possibility of a brain gain. In addition, the effectiveness of education policies that aim at promoting human capital acquisition is reduced under brain waste. These results are robust to introducing different migration costs for the skilled and the unskilled.

It is important to stress that the mechanism in our paper is new, since it differs from the two central mechanisms in the brain drain literature: uncertain migration and higher returns to skill at the origin relatively to the destination. When the returns to skill are higher at the origin than at the destination, the incentives of skilled workers to take education and to migrate are reduced, promoting therefore a negative self-selection (Borjas, 1987) and a brain drain (Egger and Felbermayr, 2009). However, at the same time, skilled workers more likely return home, which can support a brain gain (Stark *et al*., 1997). In turn, when the migration decision is uncertain, if a sufficient number of emigrants that have acquired education do not migrate, for example due to not having obtained legal status at the destination, a brain gain is promoted (Docquier and Rapoport, 2007).

The results in our model, however, come through another mechanism different from the papers just mentioned. In particular, skilled migrants face an uncertainty about the returns to education at the destination that result from low international transferability of skills, i.e., the brain waste risk. This differs from Borjas (1987), Egger and Felbermayr (2009), and Stark *et al*. (1997), since the brain waste risk arises even when the returns to skill are higher at the destination than at the origin. In addition, our mechanism is also different from Docquier and Rapoport (2007), given that migrants are certain about their migration decision; they only face uncertainty about their future earnings at the destination.

The remainder of the paper is organized as follows. In the next section, we discuss the empirical evidence on brain waste and the international transferability of skills. In Section 3, we introduce the base model. In Sections 4 and 5, we present the results for the no brain waste and the brain waste scenarios, respectively. In Section 6, we analyze the implications of an education policy by the source migration country that subsidizes students. In Section 7, we then analyze the effects of different migration costs for the skilled and for the unskilled. In Section 8, we conclude with the main implications of

brain waste on brain drain.

2.   EMPIRICAL EVIDENCE

In this section, we argue that after many years of research, it is now an established fact that migrants' skills have a low level of international transferability. One of the main implication of the low international transferability of skills is brain waste.[4]

To the best of our knowledge, the first paper to present evidence on the low international transferability of skills was Chiswick (1978). Analyzing US Census data from 1970, he demonstrated that the partial effect of a year of schooling on earnings for the foreign born was 5.7 percent, whereas among the natives it was 7.2 percent. Comparable patterns (i.e., that the payoff for schooling is much lower for immigrants than for natives) have been reported for the US for later Censuses (Borjas, 1985, 1995; Chiswick, 1986; Funkhouser and Trejo, 1995; Butcher and Dinardo, 2002; and Chiswick and Miller, 2008a, 2009). In addition, Chiswick and Miller (2007) find that underutilization of skills is more common among more recent immigrants. In turn, Mane and Waldorf (2013) analyze the relation between human capital and wages in the US for migrants belonging to old migration groups, such as the Italians, and recent migrant groups, such as the Albanians. Their hypothesis is that the international transferability of skills is lower for new than for older migrant groups. Mane and Waldorf (2013) confirm this hypothesis, since Albanian emigrants earn substantially less than Italian migrants, and the human capital acquired at home by the Albanians has very low transferability to the US labor market.

Evidence on the low international transferability of skills was also found in other countries besides the US. For example, Friedberg (2000), analyzing migrants in Israel, showed the very low impact on wages of education and labor market experience acquired in the origin country, at least when compared with education and skills acquired in the host country.[5] Similarly, for Israel, but in relation only to Russian emigrants, Cohen-Goldner and Eckstein (2008) found that the imported skills had very small returns in the destination country.

For Spain, Fernández and Ortega (2008) show a very high incidence of over-education among immigrants, together with higher unemployment and a higher incidence of temporary contracts relative to natives. Long-term immigrants have lower

---

[4] Another consequence of the low international transferability of skills is an immigrant-native wage gap (for empirical evidence see Chiswick, 1980; Bleakley and Chin, 2004; Hersch, 2008; and Chiswick and Miller, 2009). This wage gap can however be independent of brain waste, i.e.,: a migrant engineer can work as an engineer in the destination country (i.e., no brain waste) but still receive less than native engineers.

[5] On the impact on labor market outcomes of working experience and education acquired in the destination country, see also Yamauchi (2004), and Ferrer and Riddell (2008).

unemployment rates, but similar incidence of temporary contracts and over-education. For Germany, Aldashev *et al*. (2012) show evidence of a large immigrant-native wage gap. This wage gap is substantially reduced when immigrants that have completed education abroad are taken out of the sample, demonstrating once again that degrees obtained abroad are much less valued than degrees obtained in the destination country. Similarly, Carneiro *et al*. (2012) find that in Portugal occupational downgrading and segregation into low wage jobs are the two main explanations for the immigrant-native wage gap in Portugal.

In turn, for Australia Chiswick and Miller (1985), using 1981 census data, show that immigrants have five per cent lower incomes than the natives and that foreign education and labor market experience have little effect on income. Chiswick and Miller (2008b) confirm these results for the 2001 census, in the sense that the low international transferability of skills has lead first time immigrants to enter into relatively low skill, low status occupations. Kostenko *et al*. (2012), in turn, present evidence that cultural and social backgrounds affect the international transferability of skills in Australia, given that non-western migrants are disproportionately present in unskilled jobs.

For Canada, Baker and Benjamin (1994) find relatively negative rates of assimilation for migrants belonging to different cohorts. In turn, Reitz (2001), using 1996 census data, presents evidence of a significant underutilization of skills amongst migrants. In particular, he shows that the total annual immigrant earnings deficit was 15 billion: 2.4 billion was related to skill underutilization and 12.6 billion was related to pay inequity. This fact, that the immigrants' years of schooling and work experience accumulated before arrival is valued much less than Canadian experience of comparable natives, was confirmed for later census, such as the 2001 census (Ferrer and Riddell, 2008).

The above results have also been proved for a cross section of countries, in particular for the OECD (Heur, 2011) and for the EU (Hiris, 2004). According to Heuer (2011), compared to OECD natives, migrants from developing countries with a university degree are more often employed in occupational categories demanding less than tertiary education. In particular, 24% of all South-North migrants worked in occupations requiring tertiary education. This proportion is 4.9 percentage points lower than the share of tertiary-educated South-North migrants.

In the EU, the evidence is also supportive of brain waste because of a low international transferability of skills, mainly for migrants from Eastern Europe. Hiris (2004) finds that Eastern Europe immigrants in the EU, in spite of being comparatively more skilled than the natives, their employment is relatively less skilled. She argues that this results from the EU migration policy that restricts migration to relatively short periods of employment, and therefore encourages temporary migration. This policy has also promoted the development of a parallel labor market, which favors unskilled activities.[6]

---

[6] Similarly, after the fall of the Communist bloc, the majority of the scientific personnel arriving from

In spite of the overwhelming evidence of the low international transferability of skills, Gibson and McKenzie (2011) have recently argued that, at least in the US, brain waste does not affect the majority of skilled migrants. They defend this position because "79 percent of working migrants from developing countries with a bachelors' degree or more are working in occupations in the United States in which the majority of workers have post-secondary education, as are 90 percent of those with a master degree or more, and 96 percent of those with a Ph.D." In our opinion, this evidence does not compromise our argument on the links between brain waste and brain drain. We think so for a number of reasons, which go beyond the fact that evidence in Gibson and McKenzie (2011) is only for the US.

First, brain waste and the international transferability of skills have been the subject of policy initiatives, in both senders and receivers countries of migration. For instance, sender countries increasingly focus on the quality of their education systems, in order to make skills more transferable internationally for nationals (Lien, 2008; and Docquier and Rapoport, 2012). This has especially been the case in Latin America and Asia, where skilled emigration is substantial. In turn, receiver countries use more and more resources to evaluate the quality of foreign education systems, in order to have a more effective skills transferability policy for international immigrants. Some examples are the EU (Hiris, 2004), Australia and Canada (Reitz, 2001).

Second, the tradition in the economics literature is to think about expected (and not realized) returns from education and migration. In fact, starting with Becker (1960), economists view education as an investment decision, which is based on the expected income for different skill groups. Similarly, since Sjaastad (1962), migration has been modeled as an investment decision where an individual migrates if the expected discounted difference in the stream of expected income between the new and the old location exceeds moving costs. This discussion highlights the importance of distinguishing between the subjective (not real) probability of being employed as an unskilled at the destination as a disincentive for investment in education for potential migrants. In this respect, in what concerns migration decisions is the question of risk aversion and the differences between the subjective and objective probabilities of not finding employment in a skilled occupation very central.

In fact, the whole literature on brain drain and brain gain is developed upon the premise that migrants make their education decisions based on future earnings expectations in the destination migration market *versus* the domestic market.

Eastern Europe and the former Soviet Union were not incorporated into equivalent sectors in the EU receiving countries. For example, Hryniewicz *et al.* (1992) showed that only 22 per cent of the migrants that had migrated from their surveyed scientific institutions were still employed in science. Fassman *et al.* (1995) observed a similar pattern in Vienna's labor market amongst high skilled migrants from Poland and Hungary. Furthermore, 50 per cent of the high skilled migrants in the sample of Fassman *et al.* (1995) anticipated before arrival that they were going to suffer a skill waste.

Furthermore, the empirical evidence shows that migrants many times make their migration decisions based on unrealistic (high) expectations on future earnings in the destination country. This seems to be the case of migrants from Africa and Middle East in Europe (Coniglio *et al.*, 2009) and of migrants from South America in the US (see the discussion on the recent wave of child migration in the US, The Economist, 2014). In this paper, we extend the concepts of objective and subjective probabilities involved in migration decisions in the direction of the risk of brain waste resulting from the low international transferability of skills. In this set-up, we analyze how the brain waste risk affects the incentive to acquire education for individuals from less developed countries, who plan to migrate temporarily for work reasons to a more developed higher-wage country. We argue that for the brain waste to have an impact on education and migration choices it does not need to be very expressive in terms of the number of people affected by it. What is essential is that potential migrants expect that the brain waste risk can affect their returns from migration and education.

Third, for a developing country, human capital externalities do not come only from individuals with university education. In fact, the empirical literature on economic growth points out that in developing countries the human capital externalities can be important even for lower levels of education, such as primary school (Barro, 1997). What this tells us is that the brain waste story is not limited to higher levels of education, such as university. Accordingly, even if the brain waste risk only discourages education for lower schooling levels, migration can still have negative growth effects in the origin migration country.

The relevance of lower levels of education for source countries is recognized by a series of papers on the effects of migration on schooling choices. For instance, de Brauw and Giles (2006) show a negative relationship between migration prospects and high school enrollment in a panel of household data from China. They argue that this results from potential low returns to high school education among Chinese migrants from rural areas. The reason is that for rural migrants, legal temporary residence status might not confer the same set of benefits typically associated with permanent registration as a city resident.

In turn, Kandel and Kao (2001) find that children in Mexican households with high levels of US migration are associated with lower aspirations to attend university. They defend that Mexican migrant communities understand that "the US job market does not reward education acquired in Mexico beyond the junior or senior high school levels." Also for Mexico, Mckenzie and Rapoport (2011) find that living in a migrant household lowers the probability of completing high school by 13 percent for males. This is attributed to the fact that schooling decisions depend on the expectation of migration in the future and previous household migration experience. Given that most of Mexican migrants work in low skilled jobs, the incentives to take education are reduced.

Fourth, some groups of people are subject to higher levels of brain waste. This is especially the case for migrants from certain regions, such as Africa, Eastern Europe, and Latin America. In the case of Africa and to some extent Latin America this can be

due to the low quality of the education systems there, but such is not the case for Eastern Europe (Bratsberg and Terrell, 2002; Sweetman, 2004; Mattoo *et al.*, 2008; Docquier *et al.*, 2010; and Haley and Taengnoi, 2011).

Fifth, and because of the above, the evidence also suggests that brain waste affects the self-selection of skilled migrants. Hence, brain waste is not only a concern for individuals and source countries, but also for destination countries. For instance, Wright and Maxim (1993) point out that in Canada the self-selection of skilled workers has been affected not only by changes in the country-of-origin mix (from developed to developing countries) but also by an imperfect international transferability of skills. They say that in Canada "employers may not value education, work experience or other qualifications obtained prior to entry in Canada as highly as Canadian equivalent" (Bloom *et al.*, (1995). Similar evidence for other countries are reported in Chiswick and Miller (2007, 2008a)).

In this section, we have tried to show that brain waste and the low level of international transferability of skills have negative effects on the education incentives of potential migrants, the economic returns from migration and the positive self-selection of skilled migrants. In the following sections, we present a model that aims to capture some of the channels through which these links can emerge.

3.   THE MODEL

The model in this section is based on Docquier and Rapoport's (2007) stylized model on self-selection and brain drain. To Docquier and Rapoport (2007), we add the possibility of skilled workers to face brain waste when they migrate. As discussed in the introduction, the type of brain waste considered by us arises due to the imperfect international transferability of human capital. In particular, brain waste occurs since the migrants' skills are not fully recognized in the destination market and therefore skilled migrants end up working as unskilled.[7] The brain waste then emerges because an individual has incurred in the costs to acquire education, but he/she does not reap the benefits of it (i.e., higher wages). In this sense, a skilled migrant runs the risk of brain waste.

The world economy is made up of two countries: the origin and the destination of migration. We focus on the origin country, which is a small developing open economy, and we treat as exogenous the destination country, which is a developed economy.[8] The

---

[7] The lack of recognition of foreign credentials is unjustified when the productivity of skilled migrants is as high as the one of the natives. We suppose that the employers in the destination country have an imperfect ability to evaluate productivity and skill differences between migrants, and as a result, some skilled migrants end up working as unskilled. According to the World Bank (2006) this is very often the case.

[8] The assumption that migrants do not affect the destination country's economy is a standard assumption

results in terms of brain drain and the education incentives of migration are mostly relevant to developing countries. In turn, results relative to the self-selection of skilled migrants are also of interest to developed countries.

3.1. Production, Human Capital, and Wages

Individuals in the origin country live and work for 2 periods, $t = 1, 2$. In the first period, all individuals work as unskilled (*U*), but they can also decide to take education simultaneously in order to become skilled workers (*S*). In the second period, all individuals only work, but they can choose where to work: at the origin or at the destination. An individual that has not taken education, whether or not he/she migrates, always works as unskilled. An individual that has taken education and does not migrate always works as skilled. However, due to the brain waste risk, such is not necessarily the case if he/she migrates, i.e., a skilled migrant can end up employed as unskilled.

Labor supply in period t in the origin country equals the amount of unskilled and skilled labor available in the economy:[9]

$$L_t = U_t + S_t. \tag{1}$$

We consider a very simple linear production function:

$$Y_t = w_t E_t, \tag{2}$$

where w_t is the wage rate and E_t is labor in efficiency units. We need to define w_t and E_t. Start with E_t:

$$E_t = U_t + h S_t, \tag{3}$$

where $h > 1$ is the skilled productivity premium, which is individual specific. Skilled

---

in the literature on brain drain. Obviously, this assumption is only innocuous if the size of the migration flows into the host economies is very low. In reality in some countries, immigration inflows are not too small relative to the local population and, as such can have an effect on the destination's country economy. For instance, Azarnert (2010a) shows that, if immigration inflows are not too small, a highly skilled immigration can be either growth enhancing or growth detriment. Immigration is growth enhancing if the positive contribution of imported brains to the host economy's human capital stock outweighs the immigration-induced adverse effect on educational incentives for natives. Immigration is growth depleting if on the contrary the latter effect dominates.

[9] Our model then only considers two factors of production: unskilled and skilled labor. Michael (2011) also introduces capital in a model of brain drain.

workers are therefore heterogeneous in productivity. The stock of human capital at time t can then be written as:

$$H_t = \frac{E_t}{L_t} = \frac{U_t + hS_t}{U_t + S_t} = 1 + P_t(h-1),$$ (4)

where P_t is the proportion of skilled workers in the origin country:

$$P_t = \frac{S_t}{U_t + S_t}.$$ (5)

In turn, the scale factor w_t, which is endogenous and time varying, measures the wage rate per efficiency unit of labor. To formalize the spillover effects associated with human capital formation, we assume following Docquier and Rapoport (2007) that w_t is an increasing function of the economy-wide average level of human capital of the workers remaining in the country, H_t:

$$w_t = w_0(H_t),$$ (6)

where $w_0 > 0$. With this formalization, we want to capture the idea of positive spillovers on human capital formation.[10]

3.2. Individual Education Choices: Autarchy

In order to illustrate the education incentives of individuals, we consider first an autarchy scenario with no migration in the second period. If in the first period an individual only works, his/her wage rate is w_1. If in the first period an individual besides working also takes education, he/she has to pay the education costs cw_1, with $0 < c < 1$. The parameter c is, then, the opportunity costs of education, which is individual specific, i.e., individuals are heterogeneous on the ability to learn.

In the second period all individuals just work. Unskilled workers earn w_2 and skilled workers hw_2. As such, the condition to acquire education in autarchy is:

---

[10] Tamura (1991) was the first to introduce the assumption of a spillover effect of human capital. Since then, this assumption has become common in the literature. See also Tamura (1996), Benabou (1996), Galor and Tsiddon (1997), Vidal (1998), Morand (1999), Viaene and Zilcha (2002a, 2002b), de la Croix and Doepke (2004), and Azarnert (2010b).

$$(1-c)w_1 + hw_2 > w_1 + w_2. \tag{7}$$

In the steady state when $w_1 = w_2 \equiv w$ this condition simplifies to:

$$c < c_{Aut} \equiv h - 1, \tag{8}$$

where the sub-script *Aut* stands for autarchy. In other words, all individuals with $c < c_{Aut}$ acquire education. It can be easily noted that in order to obtain interior solutions, we need that $h \in\ ]1, 2[$. If otherwise, all individuals would have incentives to acquire education.

3.3.   **Individual Migration Choices: Open Economy**

In an economy open to international migration, at the end of period 1 an individual can decide to migrate abroad. At the destination, the wage per-efficiency units for natives is $w^* > w$. Since we focus on the origin country, w^* is exogenous. In addition, the wage premium for skilled workers at the destination is the same as at the origin, i.e., $h = h^*$.

We consider, however, that when skilled workers migrate, they can suffer a brain waste. In our model, a skilled worker suffers brain waste if at the destination, he/she works as unskilled. In this sense, the skilled worker instead of receiving hw^*, his/her earnings are only w^*, i.e., $w^* < hw^*$ (i.e., brain waste).

In addition, migration is costly. Migration costs include not only the monetary cost to move from one country to another, but also other costs such as those related with adapting to a new culture and being away from dear ones. Accordingly, we assume that migrants (skilled and unskilled) incur in a migration costs of kw^*, with $0 < k < 1$, i.e., migration costs are measured in terms of the wage rate in the destination country. In a subsequent section, we also analyze the case where skilled and unskilled workers have different migration costs. This case is interesting because, when the skilled workers have lower migration costs than the unskilled ones, the former can more easily migrate relatively to the latter, and therefore a positive self-selection is more easily achieved. In other words, we want to check if the brain waste risk can also diminish the possibility of a positive brain gain in a scenario where skilled workers face lower restrictions to international mobility than unskilled workers.

3.4.   **No Brain Waste versus Brain Waste**

In the second stage, an individual migrates if the gains from migration are larger than the costs. Given that wages are higher at the destination, the source country can lose skilled workers to migration, i.e., brain drain. The brain drain literature, however,

presents three mechanisms that can make it possible for a developing country to achieve a brain gain: return migration (Mayr and Peri, 2008; Stark *et al.*, 1997; and Azarnert, 2012a, 2012b); remittances (Cox and Ureta, 2003); and uncertain migration decision (Beine *et al.*, 2001; and Mountford, 1997). The possibility of a brain gain is increased: if the flow of skilled workers returnees is sufficiently high (return migration); if remittances reduce liquidity constraints in the education of the younger (remittances); or if many individuals that have invested in human capital do not migrate because, for example, they do not get a legal visa (uncertain migration).

As usual in the brain drain literature, we consider only one channel for brain gain. We choose temporary migration, because, according to the empirical evidence, this is the more relevant channel for a positive brain drain (see, Dustmann and Weis, 2007; Mayr and Peri, 2008). In fact, Mayr and Peri (2008) show that one fourth of all migrants return to the origin country. In the case of the highly educated, an even greater proportion of migrants return to their respective home countries. We then assume that migrants spend a share $0 < \gamma < 1$ of their second period working life in the destination country and $1 - \gamma$ as returnees. One way to justify this assumption is to think, like in Docquier and Rapoport (2007), that candidate migrants are only allowed by the host country authorities to spend a fraction γ of their working life in the destination. In fact, as defended by Docquier and Rapoport (2007) many immigration programs targeting the educated and the skilled are designed for temporary immigrants.

In Docquier and Rapoport (2007) migrants would benefit from a longer duration of their migration experience, if they were allowed to do so; hence, the (fixed) length of the migration episode is actually constrained by immigration policies adopted at destination. Letting *d* represent the duration of the migration experience, the assumption in Docquier and Rapoport (2007) can actually be interpreted as $d \leq \gamma$, with utility-maximizing migrants choosing the constrained optimum $d = \gamma$.

Additionally, we compare two scenarios in the destination country: (1) no brain waste; and (2) brain waste. We model the brain waste case as a probability p_s of a skilled worker to work as skilled. In this way, a higher p_s stands for a higher international transferability of skills.[11]

In the no brain waste scenario, therefore, a skilled worker always works as skilled at the destination. This is the case usually considered in the brain drain literature (Docquier and Rapoport, 2007). Then, for skilled workers, under perfect international transferability of skills (i.e., work as skilled), $p_s = 1$. In turn, in the brain waste scenario,

---

[11] In footnote 2, we have argued that brain waste can also be caused by illegal migration, but that the mechanism is a different one from the imperfect international transferability of skills. If brain waste occurs because of illegal status, migration should be portrayed as a sequential, two-step, decision: a skilled worker first decides whether to apply for a legal permit; if he/she is denied such a permit, then he/she has to choose whether to migrate illegally and suffer from a brain waste, i.e., work as an unskilled at destination.

skilled workers have a probability $p_s \in (0,1)$ of working as skilled in the destination country (and $1 - p_s \in (0,1)$ of working as unskilled). As can be seen from Figure 1, skilled workers choose between a safe option of not migrating with earnings hw, and a gamble/lottery of migrating with: (i) a probability p_s to end up working as skilled with wage hw^*; (ii) and a probability $1 - p_s$ to end up working as unskilled with wage $w^* > w$. In this sense, we talk about a brain waste risk.
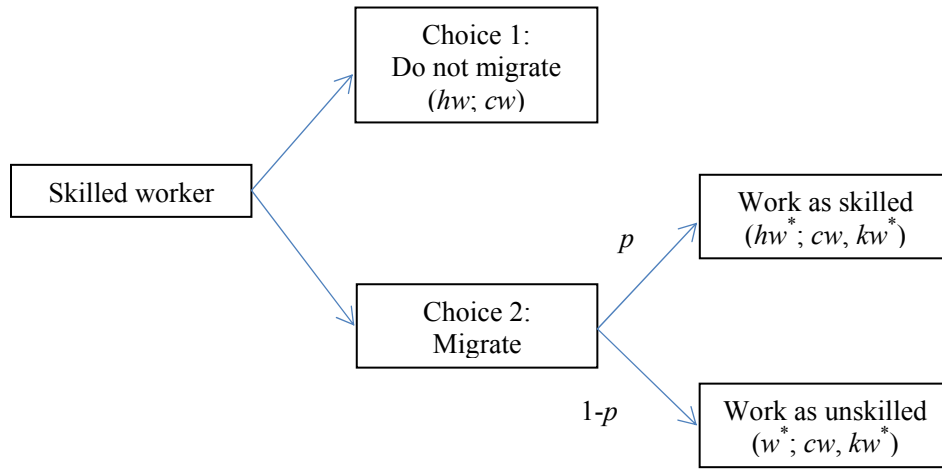

Figure 1.   Migration Decision of Skilled Workers

For a given individual, the lifetime income alternatives, under both the no brain waste and the brain waste scenarios, are then:

$$
\begin{aligned}
I(S,NM) &= (1-c)w_1 + hw_2, \\
I(S,MI) &= (1-c)w_1 + w^*(\gamma(1 + p_s(h-1)) - k) + (1-\gamma)hw_2, \\
I(U,NM) &= w_1 + w_2, \\
I(U,MI) &= w_1 + w^*(\gamma - k) + (1-\gamma)w_2,
\end{aligned}
\tag{9}
$$

where *NM* stands for non-migration and *MI* for migration. Assuming a uniform distribution of abilities, the proportion of educated workers at the origin at a given point in time is then:

$$
P_{p_s} = \frac{(1-\gamma)cp_s}{1 - \gamma cp_s},
\tag{10}
$$

where cp_s is the opportunity costs of education for a given level of p_s (the

probability of an individual to work as skilled in the destination country).

3.5.   Discussion of the Model

In this sub-section, we argue that the brain waste risk in this paper differs from other mechanisms in the migration literature. In particular: high returns to skill at the origin relatively to the destination (Borjas, 1987; Egger and Felbermayr, 2009; and Stark *et al*., 1997) and uncertain migration (Docquier and Rapoport, 2007). We discuss first the former and then the latter.

In our model, the return to skill is hw at the origin and $p_s hw^* + (1 - p_s)w^*$ at the destination (see Figure 1). The destination return to skill is as such equal to hw^* for p_s skilled migrants that do not suffer brain waste and w^* for $(1 - p_s)$ skilled migrants that suffer brain waste. For the latter, two scenarios are possible: (1) $w^* > hw$; or (2) $w^* < hw$. If $w^* < hw$, (the case considered in Borjas, 1987; Egger and Felbermayr, 2009; and Stark *et al*., 1997) a skilled migrant that suffers brain waste loses with migration. If this were the case, a utility-maximizing migrant would decide to return home, i.e., $d = 0$. If we want to keep the assumption that $d = \gamma$, then we need to rule out the case that $w^* < hw$. This is not a drawback of our model, on the contrary, because it clearly shows that what drives the results in our model is different from other models in the literature, Borjas (1987), Egger and Felbermayr (2009), and Stark *et al*. (1997). In other words, contrary to these papers, the main mechanism in our model, the brain waste risk, is independent of having a high return to skill at the origin than at the destination.[12]

In turn, if $w^* > hw$, a skilled migrant that suffers brain waste can still gain by migrating, if the wage returns at the destination pays for the migration and the education costs. However, he/she would be potentially better off without taking education, i.e., without paying the costs of education *cw*. As we have seen above, this is the brain waste risk: the incentives for an individual to take education can be reduced if at the destination an unskilled worker can do as well as him/her, without the need to incur in the additional costs of education.[13] The choice to migrate, then, depends on the relation between the return to skill at the origin (which is certain) and the expected return to skill at the destination (which is uncertain).

---

[12] A higher return to skills at the origin than at the destination can conduce to: (i) a negative self-selection, once it reduces the incentives of skilled workers to migrate relatively to the unskilled (Borjas, 1987); (ii) a brain drain, since it lowers the education incentives (Egger and Felbermayr, 2009); (iii) a brain gain, because it encourages skilled migrants to return to the origin.

[13] Mountford (1997) observes that such an incentive can exist via the differential probability of illegal migration across various levels of education.

The migration decision in our paper has also a different type of uncertainty from the one in Docquier and Rapoport (2007). In Docquier and Rapoport (2007), a potential migrant does not know if after taking education he/she will get a legal visa in the destination country. When the legal status is not granted, a skilled individual abstains from migrating, therefore contributing to a brain gain. In our paper, instead, the uncertainty arises due to the possibility of brain waste. In other words, an individual is uncertain about his/her earnings in the destination country, but not about his/her migration decision. However, this uncertainty introduces a brain waste risk for skilled workers, which is not present in Docquier and Rapoport (2007).

It is then important to highlight that our results go through even if we impose that the return to skills are always higher at the destination (see above), or if we introduce uncertain migration. This proves our claim that the central mechanism in this paper, the brain waste risk, differs from those based on high returns to skill at the origin relatively to the destination and on uncertain migration.

4.   NO BRAIN WASTE SCENARIO

In this section, we analyze the no brain waste scenario, i.e., $p_s = 1$.

4.1.   Self-Selection

Skilled and unskilled workers' incentives to migrate are given by $S_{p_s=1} = I(S,MI) - I(S,NM)$ and $U_{p_s=1} = I(U,MI) - I(U,NM)$, respectively. The subscript $p_s = 1$ indicates no brain waste scenario. At the steady state (i.e., $w_1 = w_2 \equiv w$), the relation between skilled and unskilled workers' incentives to migrate equals:

$$S_{p_s=1} - U_{p_s=1} = \gamma(\omega - 1)(h - 1) > 0 , \tag{11}$$

where $\omega = w^*/w$ is the relative wage destination-origin. Under the no brain waste scenario, therefore, a skilled worker has always more incentives to migrate than an unskilled worker. However, a positive self-selection of skilled workers is promoted if and only if $S_{p_s=1} = I(S,MI) - I(S,NM) > 0$ and $U_{p_s=1} = I(U,MI) - I(U,NM) < 0$, (i.e., skilled workers migrate and unskilled workers do not migrate):

$$\begin{aligned} S_{p_s=1} &: \gamma h(\omega - 1) > k\omega, \\ U_{p_s=1} &: \gamma(\omega - 1) < k\omega. \end{aligned} \tag{12}$$

A positive self-selection of skilled workers is then encouraged when the returns to skills (h) are high.[14] In order to follow the brain drain literature, in the rest of this section, we assume that Equation 12 is always satisfied. This is necessary for two reasons. First, we eliminate corner solutions where all individuals migrate. Second, and as we are going to prove below, migration increases the incentives of individuals to acquire education. This is needed in order for a brain gain to arise.

4.2.   Education Incentives and Migration

Under the no brain waste scenario, only the following individuals will acquire education (evaluate $I(S, MI)$ with $I(U, NM)$):

$$c < c_{p_s=1} \equiv \omega(\gamma h - k) + (1 - \gamma)h - 1 . \tag{13}$$

To check if migration increases the education incentives of natives relatively to autarchy, we compare Equations 13 and 8:

$$c_{p_s=1} - c_{Aut} = \gamma h(\omega - 1) - k\omega > 0 . \tag{14}$$

As long as the positive self-selection condition holds (Equation 12), the incentives to acquire education under the no brain waste scenario are higher than under autarchy.

4.3.   Brain Drain or Brain Gain?

In the no brain waste scenario, a brain gain emerges if the derivative of P with respect to γ (Equation 10) is positive at the skilled workers' threshold level of migration, Equation 12:

$$\left[\frac{dP_{p_s=1}}{d\gamma} \right]_{\gamma h(\omega-1)=k\omega} = \frac{(h-1)(h-2) + h(\omega-1)k\omega}{(1 - \gamma(h-1))^2} . \tag{15}$$

It is straightforward to note the following. First, the sign of Equation 15 depends only on the numerator since the denominator is always positive. Second, the sign of the numerator in Equation 15 is determined by the parameters ω, k and h. In particular, defining the numerator in Equation 15 as $\Delta_{p_s=1}$, we can show that:

---

[14] Self-selection is just determined by h, since h is the only parameter that affects skilled and unskilled workers' migration decisions asymmetrically; all the other parameters (ω, γ, and k) work symmetrically for the two groups.

$$\frac{d(\Delta_{p_s=1})}{d\omega} = h - k > 0,$$

$$\frac{d(\Delta_{p_s=1})}{dk} = -\omega < 0, \tag{16}$$

$$\frac{d(\Delta_{p_s=1})}{dh} = \omega - 2(2-h) > 0 \; or \; \frac{d(\Delta_{p_s=1})}{dh} = \omega - 2(2-h) < 0.$$

The skill premium (h) has an ambiguous effect on brain drain: h only contributes for a brain gain for high relative wage destination-origin (ω).[15] In turn, high relative wage destination-origin (ω) and low migration costs (k) promote a brain gain.

5. BRAIN WASTE SCENARIO

In this section, we analyze the brain waste scenario, i.e., $p_s \in (0,1)$.

5.1. Self-Selection

As for the no brain waste case, skilled and unskilled workers' incentives to migrate is given by $S_{p_s \in (0,1)} = I(S,MI) - I(S,NM)$ and $U_{p_s \in (0,1)} = I(U,MI) - I(U,NM)$, respectively. The subscript $p_s \in (0,1)$ indicates brain waste scenario. At the steady state (i.e., $w_1 = w_2 \equiv w$) the relation between skilled and unskilled workers' incentives to migrate is:

$$S_{p_s \in (0,1)} - U_{p_s \in (0,1)} = \gamma p_s (\omega - 1)(h - 1) > 0. \tag{17}$$

Skilled workers then do not necessarily have more incentives to migrate than the unskilled, since $S_{p_s \in (0,1)} > U_{p_s \in (0,1)}$ or $S_{p_s \in (0,1)} < U_{p_s \in (0,1)}$. This contrasts with the no brain waste scenario where skilled workers always have higher incentives to migrate than the unskilled (Equation 11). In particular, under the brain waste scenario, skilled workers have lower incentives to migrate than the unskilled if the probability of working as skilled is low (low p_s) and the relative wage destination-origin is low (low ω).

The result in Equation 17 therefore should affect self-selection. To investigate this, we need to define when a positive self-selection of skilled workers arises in the brain

---

[15] The ambiguity arises in part from the fact that when $h = h^*$, the comparative static exercises on h refer to simultaneous changes on h and h^*. This should be kept in mind for the comparative static exercises on h below.

waste scenario, i.e.,: when $S_{p_s \in (0,1)} = I(S, MI) - I(S, NM) > 0$ and $U_{p_s \in (0,1)} = I(U, MI)$ $-I(U, NM) < 0$:

$$
\begin{aligned}
&S_{p_s \in (0,1)} : \gamma h(\omega(p_s(h-1)+1) - h) > k\omega, \\
&U_{p_s \in (0,1)} : \gamma(\omega - 1) < k\omega.
\end{aligned}
\tag{18}
$$

Under the brain waste scenario, skilled workers might not have more incentives to migrate than the unskilled (Equation 17), also the possibility of a positive self-selection is reduced relatively to the no brain waste case. This is particularly so when the probability of skilled workers to suffer brain waste is high (low p_s). Furthermore, relatively to the no brain waste case, the skill premium (h) has an ambiguous effect on self-selection. The reason for this is that under the brain waste scenario, a skilled worker has no guarantee that he/she will reap the benefits of h in the destination country, i.e., the brain waste risk.[16]

For the same reasons as for the no brain waste scenario, in the rest of this section we assume that Equation 18 is always satisfied. We want to study education incentives and brain drain when the brain waste scenario supports a positive self-selection, since the opposite case is not interesting, i.e., with a negative self-selection of skilled migrants, migration cannot increase education incentives and promote a brain gain.

5.2. Education Incentives and Migration

With brain waste, only the following individuals acquire education:

$$
c < c_{p_s \in (0,1)} \equiv \omega(\gamma(p_s(h-1)+1) - k) + (1-\gamma)h - 1.
\tag{19}
$$

The first question we must ask is if migration increases education incentives relatively to autarchy. To do this, we compare Equation 19 with Equation 8:

$$
c_{p_s \in (0,1)} - c_{Aut} = \gamma(\omega(p_s(h-1)+1) - h) - k\omega.
\tag{20}
$$

As for the no brain waste scenario, then, as long as the positive self-selection condition holds (Equation 18), the incentives to acquire education under the brain waste scenario are higher than under autarchy.

More interesting, however, is to evaluate the education incentives under the no brain waste and the brain waste scenarios. To check this we compare Equation 13 with

---

[16] From Equation 18, we can also see that the remaining parameters (k, ω, and γ) cannot affect self-selection, since they promote migration symmetrically for unskilled and skilled workers.

Equation 19:

$$c_{p_s=1} - c_{p_s \in (0,1)} = (1 - p_s)\gamma\omega(h-1) > 0 \ . \tag{21}$$

Relatively to the no brain waste scenario, the brain waste scenario reduces the incentives of individuals to acquire education.[17] This is so, because brain waste diminishes the expected returns to education.

The disincentive to acquire education, which arises under the risk of brain waste (resulting from imperfect international transferability of skills), is central in this paper for two reasons. First, the brain waste risk is the main force operating in our model. Second, the brain waste risk is what makes our results robust to different assumptions (see Section 7).

5.3. Brain Drain or Brain Gain?

In the brain waste scenario, a brain gain emerges if the derivative of P in relation to γ (Equation 10) is positive at the skilled workers' threshold level of migration, Equation 18:

$$\left[\frac{dP_{p_s \in (0,1)}}{d\gamma}\right]_{\gamma(\omega(p_s h + (1-p_s))-h)=k\omega} = \frac{(h-1)(h-2) - h + \omega(p_s(h-1)+1) - k\omega}{(1-\gamma(h-1))^2} \ . \tag{22}$$

To analyze the effects of the different parameters on brain drain under the brain waste scenario, note first that the sign of Equation 22 depends only in the numerator since the denominator is always positive. By computing the derivative of the numerator of Equation 22, we obtain the following relations (for the sake of notation, we represent the numerator of Equation 22 as $\Delta_{p_s \in (0,1)}$):

$$\frac{d(\Delta_{p_s \in (0,1)})}{dp_s} = \omega(h-1) > 0,$$

$$\frac{d(\Delta_{p_s \in (0,1)})}{d\omega} = 1 + p_s(h-1) - k > 0, \tag{23}$$

$$\frac{d(\Delta_{p_s \in (0,1)})}{dk} = -\omega < 0,$$

---

[17] Note that this depends only on brain waste, since temporary migration does not play a role, i.e., even for $\gamma = 1$ (permanent migration) the above conclusion holds.

$$\frac{d(\Delta_{p_s \in (0,1)})}{dh} = \omega p_s - 2(2-h) > 0 \quad \text{or} \quad \frac{d(\Delta_{p_s \in (0,1)})}{dh} = \omega p_s - 2(2-h) < 0 .$$

Note first that relatively to the no brain waste scenario (Equation 16), under the brain waste scenario, the skill premium (h) continues to have an ambiguous influence on brain drain: h only contributes for a brain gain for high ω and high p_s. In turn, high probability of not suffering brain waste (high p_s), high relative wage destination-origin (ω) and low migration costs (low k) promote a brain gain. The reverse happens for low p_s, low ω and high k, i.e., when brain waste becomes more relevant, a brain drain might arise.

In this way, this result may help to explain the empirical evidence on brain drain by Beine *et al*. (2008). In particular, Beine *et al*. (2008) show that the countries with a brain drain are mostly located in Africa and Latin America. In addition, available empirical evidence also indicates that these two regions suffer more from low international transferability of skills (Schoeni, 1997; and Mattoo *et al*., 2010). Then, if the brain waste mechanism presented in this paper is at work in Africa and Latin America, low international transferability of skills might be partially responsible for the brain drain observed in these regions.

Another central issue is to evaluate brain drain outcomes under the no brain waste scenario and under the brain waste scenario. To check this, we compare Equation 15 with Equation 22:

$$\left[\frac{dP_{p_s=1}}{d\gamma}\right]_{h\gamma(\omega-1)=k\omega} - \left[\frac{dP_{p_s \in (0,1)}}{d\gamma}\right]_{\gamma(\omega(p_s h+(1-p_s))-h)=k\omega} = \frac{\omega(1-p_s)(h-1)}{(1-\gamma(h-1))^2} . \tag{24}$$

We can then see that, relatively to the no brain waste scenario, brain waste reduces the chances of a brain gain. This is so, since under the brain waste scenario, education incentives triggered by migration are weakened relatively to the no brain waste scenario.

6.   EDUCATION POLICY

In this section, we analyze if an education policy that subsidizes students can increase the chances of a brain gain relatively to a scenario with no education policy.[18] For simplicity, as in Docquier and Rapoport (2007), we now make migration costs equal

---

[18] Similar to Docquier and Rapoport (2007), we assume that the government budget is balanced and that there is no need for fiscal adjustments due to migration. Introducing these issues would not qualitatively change the results.

to zero. The consequence of having $k = 0$ is that, independently of having or not having an education policy, migration will always promote a brain gain relatively to a non-migration scenario. However, the important point for education policies is not mainly if they can promote a brain gain (since, as we have seen in the previous sections, a brain gain depends crucially on migration costs), but if education policies can promote more brain gain than without education policies. Since results for this last issue are not affected by migration costs, we exclude them.

In the education policy scenario, following Docquier and Rapoport (2007), the government in the origin migration country collects an income tax on the educated and the uneducated adults that remain in the country.[19] The tax can be applied to give a direct subsidy to each young that takes education. The objective of this policy is to increase enrolment rates in schools and therefore to increase the human capital stock in the country.

As in Docquier and Rapoport (2007), we express the tax in terms of skilled workers' wages, Thw, where $0 < T < 1$ is the tax rate. The part of the tax directed to subsidies to students is denoted in relation to the local wage, Zw, where $0 < Z < 1$ stands for the subsidy rate. We use the upper-scripts T and $T = 0$ to refer to the "education policy" and the "no education policy" cases, respectively.

With the education policy above, the life income for alternative migration choices is:

$$I(S, NM)^T = (1 - c + Z)w_1 + hw_2(1 - T),$$
$$I(S, MI)^T = (1 - c + Z)w_1 + \gamma w^*(hp_s^T + (1 - p_s^T)) + (1 - \gamma)hw_2(1 - T),$$
$$I(U, NM)^T = w_1 + w_2(1 - Th),$$
$$I(U, MI)^T = w_1 + \gamma w^* + (1 - \gamma)w_2(1 - hT).$$

$$(25)$$

Note that we distinguish the brain waste risk without an education policy, $p_s^{T=0}$, and with an education policy, p_s^T. The idea is that the brain waste risk can be different in these two scenarios. Several empirical papers have in fact documented the low quality of education systems in various developing countries (see, Bratsberg and Terrell, 2002; Docquier *et al*., 2010; Haley and Taengnoi, 2011; Mattoo *et al*., 2008; Sweetman, 2004; Li and Sweetman, 2014; and Kaarsen, 2014). In this sense, an education policy could be used to send a signal to receiving migration countries that the education system in the sending country of migration is of high quality, and as result to increase the international transferability of skills of migrants from the sending country.[20]

---

[19] We do not consider the political economy of migration and taxation (see, Epstein *et al*., 1999).

[20] Other way through which the governments of sending migration countries can promote the international transferability of skills is via bilateral agreements with host countries of migration. With these agreements, the origin migration country would guarantee the quality of the professionals. In turn, the

Under the education policy case, the closed economy critical level of education becomes:

$$c < c_{Aut} \equiv h - 1 + z .$$ (26)

In order to obtain interior solutions for the education policy case, we need to assume that $(h + Z) \in \left]1,2\right[$. Otherwise, all individuals would have incentives to acquire education. For the no policy scenario, in turn, the lifetime income for alternative migration choices is as in Equation 9 with $k = 0$ and the closed economy critical level of education is as in Equation 8.

Next, we compare the education policy and the no education policy cases. This exercise is done for both the no brain waste and the brain waste scenarios.

6.1. Education Policy: No Brain Waste Scenario

We start by defining the migration conditions for skilled and unskilled workers. In the education policy and the no education policy cases, we have, respectively:

$$
\begin{aligned}
S_{p_s=1}^{T} &: \omega > 1 - T, \\
U_{p_s=1}^{T} &: \omega > 1 - hT, \\
S_{p_s=1}^{T=0} &: \omega > 1, \\
S_{p_s=1}^{T=0} &: \omega > 1.
\end{aligned}
$$ (27)

As a result, only the following individuals will acquire skills in the education policy and the no education policy cases:

$$
\begin{aligned}
c < c_{p_s=1}^{T} &\equiv \omega \gamma h + (1 - \gamma)h(1 - T) + Z + hT - 1, \\
c < c_{p_s=1}^{T=0} &\equiv h(\omega \gamma + (1 - \gamma)) - 1.
\end{aligned}
$$ (28)

From here it is straightforward to find $P_{p_s=1}^{T}$ and $P_{p_s=1}^{T=0}$. To study brain drain, we compute the derivatives of $P_{p_s=1}^{T}$ and $P_{p_s=1}^{T=0}$ with respect to ω. In both cases, the derivatives are evaluated at the skilled workers' migration threshold level (Equation 27):

---

destination migration country would assure the recognition of the education credentials. A well-known example of this case is Philippines (Docquier and Rapoport, 2012).

$$\left[\frac{dP_{p_s=1}^T}{d\omega}\right]_{\omega=1-T} = \frac{(1-\gamma)\gamma h}{(1-\gamma(h+Z-1))^2} > 0,$$

$$\left[\frac{dP_{p_s=1}^{T=0}}{d\omega}\right]_{\omega=1} = \frac{(1-\gamma)\gamma h}{(1-\gamma(h-1))^2} > 0. \tag{29}$$

Given that these two derivatives are positive, a brain gain arises irrespective of the origin country subsidizing or not subsidizing education. As discussed above, the reason for this result is that migration costs are zero. As such, the only interesting thing to analyze when $k=0$ is if the education policy case promotes a higher level of brain gain than under the no education policy case. Comparing the brain drain conditions under the education policy and the no education policy cases, we obtain:

$$\left[\frac{dP_{p_s=1}^T}{d\omega}\right]_{\omega=1-T} - \left[\frac{dP_{p_s=1}^{T=0}}{d\omega}\right]_{\omega=1} = \frac{\gamma^2 hZ(1-\gamma)(1-\gamma(h+Z-1)+(1-\gamma(h-1)))}{(1-\gamma(h+Z-1))^2(1-\gamma(h-1))^2}. \tag{30}$$

In the no brain waste scenario, a subsidy to students reinforces the possibility of a brain gain relatively to the no education policy case.

6.2. Education Policy: Brain Waste Scenario

We begin again by deriving the migration conditions for skilled and unskilled workers. For the education policy and the no education policy cases these conditions are, respectively:

$$S_{p_s\in(0,1)}^T : \omega(p_s^T(h-1)+1) > h(1-T),$$

$$U_{p_s\in(0,1)}^T : \omega > 1-hT,$$

$$S_{p_s\in(0,1)}^{T=0} : \omega(p_s^{T=0}(h-1)+1) > h,$$

$$S_{p_s\in(0,1)}^{T=0} : \omega > 1. \tag{31}$$

In the education policy and the no education policy cases, only the following individuals become skilled:

$$c < c_{p_s\in(0,1)}^T \equiv \omega(p_s^T\gamma h + (1-p_s^T)) + (1-\gamma)h(1-T) + Z + hT - 1,$$

$$c < c_{p_s\in(0,1)}^{T=0} \equiv \gamma\omega(p_s^{T=0}h + (1-p_s^{T=0})) + (1-\gamma)h - 1. \tag{32}$$

From these two equations, we can derive $P_{p_s \in (0,1)}^{T}$ and $P_{p_s \in (0,1)}^{T=0}$ to study brain drain. As above, we compute the derivatives of $P_{p_s \in (0,1)}^{T}$ and $P_{p_s \in (0,1)}^{T=0}$ with respect to ω and we evaluate them at the skilled workers' migration threshold level (Equation 31):

$$\left[\frac{dP_{p_s \in (0,1)}^{T}}{d\omega}\right]_{\omega = \frac{h(1-T)}{p_s^T(h-1)+1}} = (1-\gamma)\gamma \frac{p_s^T(h-1)+1}{(1-\gamma(h+Z-1))^2} > 0,$$

$$\left[\frac{dP_{p_s=1}^{T=0}}{d\omega}\right]_{\omega = \frac{h}{p_s^{T=0}(h-1)+1}} = (1-\gamma)\frac{p_s^{T=0}(h-1)+1}{(1-\gamma(h-1))^2} > 0. \tag{33}$$

Under the brain waste scenario, and again due to the absence of migration costs ($k=0$), a brain gain is promoted independently of a country having or not having an education policy. What is important to analyze is if the education policy increases the brain gain relatively to the no education policy case. To study this, we compare the brain drain conditions under the education policy and the no education policy cases:

$$\left[\frac{dP_{p_s \in (0,1)}^{T}}{d\omega}\right]_{\omega = \frac{h(1-T)}{p_s^T(h-1)+1}} - \left[\frac{dP_{p_s \in (0,1)}^{T=0}}{d\omega}\right]_{\omega = \frac{h}{p_s^{T=0}(h-1)+1}} \tag{34}$$

$$= \frac{(1-\gamma)p_s^T(h-1)+1)(\gamma(1-\gamma(h-1))^2 - (1-\gamma(h+Z-1))^2)}{(1-\gamma(h+Z-1))^2(1-\gamma(h-1))^2}.$$

First notice that if the education policy does not affect the level of international transferability of skills, i.e., $p_s^T = p_s^{T=0} = p_s$, Equation 34 simplifies to:

$$\left[\frac{dP_{p_s \in (0,1)}^{T}}{d\omega}\right]_{\omega = \frac{h(1-T)}{p_s(h-1)+1}} - \left[\frac{dP_{p_s \in (0,1)}^{T=0}}{d\omega}\right]_{\omega = \frac{h}{p_s(h-1)+1}} \tag{35}$$

$$= \frac{(1-\gamma)p_s(h-1)+1)(\gamma(1-\gamma(h-1))^2 - (1-\gamma(h+Z-1))^2)}{(1-\gamma(h+Z-1))^2(1-\gamma(h-1))^2}.$$

We can show that Equation 35 is negative when $\gamma(1-\gamma(h-1))^2 < (1-\gamma(h+Z-1))^2$. It can be easily seen that this is more likely when Z is sufficiently high.[21] This

---

[21] To see this note that the sign of Equation 35 depends only on the term in the numerator inside the large

demonstrates that in the presence of the brain waste risk, when the opportunity costs of subsidization are high (high *Z*), an education policy that subsidizes students can be ineffective in promoting the local level of human capital.

If, in turn, the education policy increases the international transferability of skills, i.e., $p_s^T > p_s^{T=0}$, then, there are higher chances that the education policy promotes the local level of human capital relatively to the no education policy case. In fact, when $p_s^T > p_s^{T=0}$, Equation 34 is positive if $\gamma(p_s^T(h-1)+1)(1-\gamma(h-1))^2 > (p_s^{T=0}(h-1)+1)$ $(1-\gamma(h+Z-1))^2$. Again, this is more likely to happen when *Z* is sufficiently small. However, the same occurs the higher p_s^T is relatively to $p_s^{T=0}$, i.e., the difference between the level of international transferability of skills under the education case and the no education policy case.[22] The reason for this is that the education policy *per se* does not necessarily increase the international transferability of skills, i.e., do not affect p_s^T. And, as we have seen in the rest of this paper, the brain waste risk (p_s), is an important component concerning education decisions of individuals.

So far, we do not know how the brain waste scenario does relatively to the no brain waste scenario. Comparing the effectiveness of the education policy under the no brain waste and the brain waste scenarios, we obtain:

$$\left[\frac{dP_{p_s \in (0,1)}^T}{d\omega}\right]_{\omega=\frac{h(1-T)}{p_s(h-1)+1}} - \left[\frac{dP_{p_s=1}^T}{d\omega}\right]_{\omega=1-T} = \frac{(1-\gamma)\gamma(1-p_s^T)(h-1)}{(1-\gamma(h+Z-1))^2}. \tag{36}$$

The role of the education policy is therefore unambiguously weakened under the brain waste scenario relatively to the no brain waste case. Again, the rationale for this result is that brain waste reduces the returns to education, i.e., since brain waste reduces the incentives of individuals to acquire education, it also renders the education policy less efficient. However, as $p_s^T \to 1$, the no education policy case and the no education police case approach. This shows that, in our set-up, education policies without being

parenthesis (all other terms are positive). The derivative of the numerator in relation to *Z* equals $-2\gamma(\gamma(Z+h-1)-1)$, which is negative for $Z > ((1-\gamma(h-1))/\gamma)$.

[22] To see this note that the sign of Equation 34 depends only on the term in the numerator inside the large parenthesis (all other terms are positive). The derivative of the numerator in relation to *Z* equals $-2\gamma(p_s^{T=0}(h-1)+1)(\gamma(Z+h-1)-1)$, which is negative for $Z > ((1-\gamma(h-1))/\gamma)$. However, the derivative of the numerator in relation to p_s equals $\gamma(h-1)(\gamma(h-1)-1)^2 > 0$, which is always positive, and the derivative of the numerator in relation to $p_s^{T=0}$ equals $-(h-1)(\gamma(Z+h-1)-1)^2 < 0$, which is always negative.

complemented with policies that target the international transferability of skills run the risk of not fulfilling the objective of increasing the local level of human capital stock.[23]

7.   EFFECTS OF DIFFERENT MIGRATION COSTS FOR SKILLED AND UNSKILLED

In this section, we analyze the case where the migration costs are different for the migrants that end up working as skilled (k_s) and as unskilled (k_U), i.e., $k_s \neq k_U$. The most interesting scenario is when $k_s < k_U$, because if this occurs the returns to skill resulting from migration increase (and there are higher chances of a positive self-selection and brain gain).[24] This robustness check is relevant, since when migration costs are different for skilled and unskilled, the relationship between the (net) skill premium at home and abroad is affected. In fact, if the foreign net skill premium is higher than the one prevailing at origin, we might expect that the odds for a positive self-selection and a brain gain increase, since skilled agents enjoy a higher return to skill at destination. In other words, we want to analyze that even in a set-up that promote a positive self-selection and a brain gain, our results in the central case still emerge.

The alternative lifetime income paths for a skilled individual when $k_s \neq k_U$ are (for the unskilled these are the same as in Equation 9):

$$
\begin{aligned}
I(S,MI) &= (1-c)w_1 + w^* (p_s (\gamma(h-1) - k_s + k_U) + \gamma - k_U) + (1-\gamma)hw_2, \\
I(U,MI)^T &= w_1 + w^* + (\gamma - k_U) + (1-\gamma)w_2.
\end{aligned}
\tag{37}
$$

The difference between the migration incentives for skilled and unskilled workers is then:

$$
S_{p_s \in (0,1)} - U_{p_s \in (0,1)} = \gamma(h-1)(p_s \omega - 1) + p_s \omega(k_U - k_s) > 0.
\tag{38}
$$

Skilled workers have more incentives to migrate than the unskilled for larger k_U and lower k_s. Also higher ω, and higher p_s only contribute positively for higher

---

[23] If individuals were credit constrained, direct subsidies to students would potentially become more central (Phan, 2012). In any case, the only way to reduce brain waste would continue to be via an increase in the international transferability of skills.

[24] We then assume that a skilled worker that suffers brain waste (i.e., that works as unskilled) has the same migration costs as an unskilled worker. However, results are very similar if the migration costs are based on the skill level, and not in employment, i.e., if all skilled workers have migration costs k_s.

migration incentives for the skilled, if $k_s < k_U$.

A positive self-selection of skilled workers arise if $S_{p_s \in (0,1)} > 0$ and $U_{p_s \in (0,1)} > 0$, this is so for:

$$S_{p_s \in (0,1)} : \gamma h(\omega(p_s(h-1)+1)-h) > \omega(p_s k_s + (1-p_s)k_U),$$
$$U_{p_s \in (0,1)} : \gamma(\omega-1) < k_U \omega. \tag{39}$$

Equation 39 shows that a positive self-selection of skilled workers is encouraged for low k_s. In turn, low k_U promotes both skilled and unskilled workers migration, and as a result, the effects on self-selection are neutralized. Furthermore, higher p_s only contributes for a positive self-selection if $k_s < k_U$. These results are independent of brain waste, since they also arise with $p_s = 1$. The only difference when $p_s = 1$ is that k_U stops to affect skilled workers, and therefore low k_U, by supporting more unskilled migration, can undermine a positive self-selection.

In terms of education incentives, we obtain that only the following individuals acquire education:

$$c < c_{p_s \in (0,1)} \equiv \omega(\gamma(p_s(h-1)+1) - k_U(1-p_s) - k_s p_s) + h(1-\gamma) - 1. \tag{40}$$

The education incentives, then, decrease with both k_U and k_s. Comparing this threshold level with the one under autarchy (Equation 8), we arrive at:

$$c_{p_s \in (0,1)} - c_{Aut} = \gamma(\omega(p_s(h-1)+1) - h) - \omega(p_s k_s + (1-p_s)k_U). \tag{41}$$

If the condition for self-selection holds (Equation 40), then as in the central case, education increase with migration. Note, however, that k_U and k_s depress the higher incentives to education that arise under the migration scenario relatively to autarchy.

Furthermore, evaluating the case with no brain waste ($p_s = 1$) against the one with brain waste ($p_s \in (0,1)$), we have:

$$c_{p_s=1} - c_{p_s \in (0,1)} = (1-p_s)\omega(\gamma(h-1) - (k_s - k_U)) > 0. \tag{42}$$

When $k_s < k_U$, and, as in the central case, more individuals take education under the no brain waste scenario than under the brain waste one. Interesting, though, while

higher k_s reduces the advantage of the no brain waste case relatively to the brain waste one, the opposite occurs with k_U. This is so because under the no brain waste case, skilled individuals always incur in migration costs k_s. However, under the brain waste case, skilled workers can either pay k_U or k_s depending on whether they suffer brain waste or not, respectively.

In turn, the possibility of a brain gain is the following:

$$
\left[\frac{dP_{p_s \in (0,1)}}{d\gamma} \right]_{\gamma(\omega(p_s h + (1-p_s))) - h = \omega(p_s k_s + (1-p_s)k_U)}
$$

$$
= \frac{(h-1)(h-2) - h + \omega(p_s(h-1)+1) - \omega(p_s k_s + (1-p_s)k_U)}{(1-\gamma(h-1))^2}. \tag{43}
$$

It can be shown that brain gain is encouraged for low k_s and low k_U. Relatively to the central case, brain gain continues to increase with ω, and h has an ambiguous effect. In addition, as long as $k_s < k_U$, higher p_s also promotes a brain gain.

Furthermore, the relation between brain drain under the brain waste and the no brain waste case is:

$$
\left[\frac{dP_{p_s = 1}}{d\gamma} \right]_{h\gamma(\omega-1) = k_s \omega} - \left[\frac{dP_{p_s \in (0,1)}}{d\gamma} \right]_{\gamma(\omega(p_s h + (1-p_s)) - h) = \omega(p_s k_s + (1-p_s)k_U)}
$$

$$
= \frac{(1-p_s)((h-1) - k_s - k_U))\omega}{(1-\gamma(h-1))^2}. \tag{44}
$$

Again, brain gain is more likely under the no brain waste scenario than under the brain waste one. This result illustrates that even when migration costs promote a positive self-selection of skilled workers (i.e., for $k_s < k_U$), brain waste can reduce education incentives and the chances of a brain gain.

8. DISCUSSION

In this paper, we have argued that since the brain waste risk reduces the returns to education, it also influences education incentives, brain drain, and self-selection. In this sense, we have compared a scenario with no brain waste to a scenario with brain waste. We have focused on the case where the brain waste arises due to a low international transferability of skills.

We have showed that, relatively to the no brain waste scenario, the brain waste scenario has several negative effects. For the origin country of migration, it reduces the incentives of individuals to acquire education and it weakens the possibility of brain gain to arise. For the destination country of migration, it undermines the chances of a positive self-selection of skilled migrants.

In addition, an education policy that subsidizes students has less chances of increasing the human capital stock in the origin migration country under the brain waste scenario than under the no brain waste scenario. However, if an education policy also increases the international transferability of skills, the efficiency of the education policy increases.

We have also analyzed if our results are robust to assuming different migration costs for the skilled and the unskilled workers. This case is relevant, since when the skilled migrants face higher migration costs than the unskilled migrants, a positive self-selection of skilled workers, and a brain gain are promoted. We find that even when this is the case, the results from the central case in the paper still hold. This shows that the central mechanism in our model, the brain waste risk, is what drives our results.

Our paper opens some roads for future work. First, the paper could be extended to a general equilibrium framework that endogenizes the destination country. Second, other sources of low international transferability of human capital could be explored, such as illegal migration. Third, the results in this paper should be tested with data on international migration flows and human capital levels of sending countries.

REFERENCES

Aldashev, A., J. Gernandt, and S. Thomsen (2012), "The Immigrant-Native Wage Gap in Germany," *Journal of Economics and Statistics*, 232, 490-517.

Azarnert, L. (2010a), "Is Skilled Immigration Always Good for Growth in the Receiving Economy?" *Economics Letters*, 108, 116-118.

_____ (2010b), "Free Education, Fertility and Human Capital Accumulation," *Journal of Population Economics*, 23, 449-468.

_____ (2012a), "Guest-worker Migration, Human Capital and Fertility," *Review of Development Economics*, 16, 318-330.

_____ (2012b), "Male versus Female Guest-Worker Migration: Does it Matter for Fertility in the Source Country?" *Research in Economics*, 66, 1-6.

Baker, B., and D. Benjamin (1994), "The Performance of Immigrants in the Canadian Labour Market," *Journal of Labor Economics*, 12, 369-405.

Barro, R. (1997), *Determinants of Economic Growth*, Cambridge, MA: MIT Press.

Becker, G. (1960), "Underinvestment in College Education?" *American Economic Review: Papers and Proceedings*, 50, 346-354.

Beine, M., F. Docquier, and H. Rapoport (2001), "Brain Drain and Economic Growth: Theory and Evidence," *Journal of Development Economics*, 64, 275-289.

_____ (2008), "Brain Drain and LDC's Growth: Winners and Losers?" *Economic Journal*, 118, 631-652.

Benabou, R. (1996), "Equity and Efficiency in Human Capital Investments: The Local Connection," *Review of Economic Studies*, 63, 237-264.

Bhagwati, J., and K. Hamada (1974), "The Brain Drain, International Integration of Markets for Professionals and Unemployment," *Journal of Development Economics*, 1, 19-43.

Bleakley, H., and A. Chin (2004), "Language Skills and Earnings: Evidence from Childhood Immigrants," *Review of Economics and Statistics*, 86, 481-496.

Bloom, D., G. Grenier, and M. Gunderson (1995), "The Changing Labour Market Position of Canadian Immigrants," *Canadian Journal of Economics*, 28, 987-1005.

Borjas, G. (1985), "Assimilation, Changes in Cohort Quality, and the Earnings of Immigrants," *Journal of Labor Economics*, 3, 463-489.

_____ (1987), "Self-Selection and the Earnings of Immigrants," *American Economic Review*, 77, 531-544.

_____ (1995), "Assimilation and Changes in Cohort Quality Revisited: What Happened to Immigrant Earnings in the 1980s?" *Journal of Labor Economics*, 13, 201-245.

Bratsberg, B., and D. Terrell (2002), "School Quality and Returns to Education of U.S. Immigrants," *Economic Inquiry*, 40, 177-198.

Butcher, K., and J. Dinardo (2002), "The Immigrant and Native-Born Wage Distributions: Evidence from United States Censuses," *Industrial and Labor Relations Review*, 56, 97-121.

Carneiro, A., N. Fortuna, and J. Varejão (2012), "Immigrants at New Destinations: How They Fare and Why," *Journal of Population Economics*, 25, 1165-1185.

Chiswick, B. (1978), "The Effect of Americanization on the Earnings of Foreign Born Men," *Journal of Political Economy*, 86, 897-921.

_____ (1980), "The Earnings of White and Coloured Male Immigrants in Britain," *Economica*, 47, 81-87.

_____ (1986), "Is the New Immigration Less Skilled Than the Old?" *Journal of Labor Economics*, 4, 168-192.

Chiswick, B.R., and P.W. Miller (1985), "Immigrant Generation and Income in Australia," *Economic Record*, 61, 540-553.

_____ (2007), "The International Transferability of Immigrants' Human Capital Skills," IZA Discussion Paper, 2670.

_____ (2008a), "Why is the Payoff to Schooling Smaller for Immigrants?" *Labour Economics*, 15, 1317-1340.

_____ (2008b), "Occupational Attainment and Immigrant Economic Progress in Australia," *Economic Record*, 84, 45-56.

_____ (2009), "Earnings and Occupational Attainment among Immigrants," *Industrial Relations*, 48, 454-465.

Cohen-Goldner, S., and Z. Eckstein (2008), "Labor Mobility of Immigrants: Training, Experience, Language, And Opportunities," *International Economic Review*, 49, 837-872.

Coniglio, N., G. de Arcangelis, and L. Serlenga (2009), "Intentions to Return of Clandestine Migrants: The Perverse Effect of Illegality on Skills," *Review of Development Economics*, 13, 641-657.

Cox Edwards, A., and M. Ureta (2003), "International Migration, Remittances and Schooling: Evidence from El Salvador," *Journal of Development Economics*, 72, 429-461.

De Brauw, A., and J. Giles (2006), "Migrant Opportunity and the Educational Attainment of Youth in Rural China," IZA Discussion Paper, 2326.

De la Croix, D., and M. Doepke (2004), "Public versus Private Education When Differential Fertility Matters," *Journal of Development Economics*, 73, 607-629.

Docquier, F., and H. Rapoport (2007), "Skilled Migration: The Perspective of Developing Countries," in J. Baghwati, and G. Hanson, eds., *Skilled Migration: Prospects, Problems and Policies*, New York: Russell Sage Foundation.

_____ (2008), "Brain Drain," in S. Durlauf, and L. Blume, eds., *The New Palgrave Dictionary of Economics*, Second Edition, Palgrave Macmillan.

_____ (2012), "Globalization, Brain Drain and Development," *Journal of Economic Perspectives*, 50, 681-730.

Docquier, F., Ç. Özden, and G. Peri (2010), "The Wage Effects of Immigration and Emigration," NBER Working Paper, 16646.

Dustmann, C., and Y. Weiss (2007), "Return Migration: Theory and Evidence from the UK," *British Journal of Industrial Relations*, 45, 236-256.

Egger, H., and G. Felbermayr (2009), "Endogenous Skill Formation and the Source Country Effects of Skilled Labor Emigration from Developing Countries," *Journal of Economics and Statistics*, 229, 706-729.

Epstein, G., A. Hillman, and H. Ursprung (1999), "The King Never Emigrates," *Review of Development Economics*, 3, 107-121.

Fassman, H., J. Kohlbacher, and U. Reeger (1995), "Forgetting Skills at Borderline: Foreign Job-Seekers on the Viennese Labour Market," *Studi Emigrazione*, 117, 78-89.

Fernández, C., and C. Ortega (2008), "Labor Market Assimilation of Immigrants in Spain: Employment at the Expense of Bad Job-Matches?" *Spanish Economic Review*, 10, 83-107.

Ferrer, A., and W.C. Riddell (2008), "Education, Credentials and Immigrant Earnings," *Canadian Journal of Economics*, 41, 186-216.

Friedberg, R. (2000), "You Can't Take it With You? Immigrant Assimilation and the Portability of Human Capital," *Journal of Labor Economics*, 18, 221-251.

Funkhouser, E., and S. Trejo (1995), "The Labor Market Skills of Recent Male Immigrants: Evidence from the Current Population Survey," *Industrial and Labor Relations Review*, 48, 792-811.

Galor, O., and D. Tsiddon (1997), "The Distribution of Human Capital and Economic Growth," *Journal of Economic Growth*, 2, 93-124.

Gibson, J., and D. McKenzie(2011), "Eight Questions about Brain Drain," *Journal of Economic Perspectives*, 25, 107-128.

Haley, M., and S. Taengnoi (2011), "The Skill Transferability of High-Skilled US Immigrants," *Applied Economics Letters*, 18, 633-636.

Hersch, J. (2008), "Profiling the New Immigrant Worker: The Effects of Skin Color and Height," *Journal of Labor Economics*, 26, 345-386.

Heuer, N. (2011), "Occupation-Specific South-North Migration," *Tübinger Diskussionsbeitrag*, 328.

Hiris, L. (2004), "The Determinants of East-West Labour Migration in the Context of EU Enlargement," PhD Thesis, University of the West of England, Bristol.

Hryniewicz, J., B. Jalowiecki, and A. Mync (1992), "The Brain Drain in Poland, Université de Varsovie, Institut Européen de Développement Régional et Local," *Etudes Régionales et Locales*, 9.

Kaarsen, N. (2014), "Cross-Country Differences in the Quality of Schooling," *Journal of Development Economics*, 107, 215-224.

Kanbur, R., and H. Rapoport (2005), "Migration Selectivity and the Evolution of Spatial Inequality," *Journal of Economic Geography*, 5, 43-57.

Kandel, W., and G. Kao (2001), "The Impact of Temporary Labor Migration on Mexican Children's Educational Aspirations and Performance," *International Migration Review*, 35, 1205-1231.

Kostenko, W., M. Harris, and X. Zhao (2012), "Occupational Transition and Country-of-Origin Effects in the Early Stage Occupational Assimilation of Immigrants: Some Evidence from Australia," *Applied Economics*, 44, 4019-4035.

Li, Q., and A. Sweetman (2014), "The Quality of Immigrant Source Country Educational Outcomes: Do they Matter in the Receiving Country?" *Labour Economics*, 26, 81-93.

Lien, D. (2008), "Quality-Assurance Programs and the Brain Drain," *Education Economics*, 1, 59-73.

Mane, K., and B. Waldorf (2013), "Human Capital and Wages: A Comparison of Albanian and Italian Immigrants," *The Annals of Regional Science*, 51, 53-72.

Mattoo, A., I. Neagu, and Ç. Özden (2008), "Brain Waste? Educated Immigrants in the US Labor Market," *Journal of Development Economics*, 87, 255-269.

Mayr, K., and G. Peri (2008), "Return Migration as Channel of Brain Gain," CReAM Discussion Paper, 04/08.

Mckenzie, D., and H. Rapoport (2011), "Can Migration Reduce Educational Attainments? Evidence from Mexico," *Journal of Population Economics*, 24, 1331-1358.

Michael, M. (2011), "Welfare Effects of Immigration Policies in the Presence of Skilled, Unskilled Labor and Capital Mobility," *Review of Development Economics*, 15, 651-663.

Morand, O. (1999), "Endogenous Fertility, Income Distribution, and Growth," *Journal of Economic Growth*, 4, 331-349.

Mountford, A. (1997), "Can a Brain Drain be Good for Growth in the Source Economy?" *Journal of Development Economics*, 53, 287-314.

Phan, D. (2012), "Migration and Credit Constraints: Theory and Evidence from Vietnam," *Review of Development Economics*, 16, 31-44.

Reitz, J. (2001), "Immigrant Skill Utilization in the Canadian Labour Market: Implications of Human Capital Research," *Journal of International Migration and Integration*, 2, 347-378.

Schiff, M. (2005), "Brain Gain: Claims about Its Size and Impact on Welfare and Growth Are Greatly Exaggerated," IZA Discussion Paper, 1599.

Schoeni, R. (1997), "New Evidence on the Economic Progress of Foreign-Born Men in the 1970s and 1980s," *The Journal of Human Resources*, 32, 683-740.

Sjaastad, L. (1962), "The Costs and Returns of Human Migration," *Journal of Political Economy*, 70, 80-93.

Stark, O., C. Helmenstein, and A. Prskawetz (1997), "A Brain Gain with Brain Drain," *Economics Letters*, 55, 227-234.

Stark, O., and Y. Wang (2002), "Inducing Human Capital Formation: Migration as a Substitute for Subsidies," *Journal Public Economics*, 86, 29-46.

Sweetman, A. (2004), "Immigrant Source Country Educational Quality and Canadian Labour Market Outcomes," Statistics Canada Working Paper, 234.

Tamura, R. (1991), "Income Convergence in an Endogenous Growth Model," *Journal of Political Economy*, 99, 522-540.

_____ (1996), "From Decay to Growth: A Demographic Transition to Economic Growth," *Journal of Economic Dynamics and Control*, 20, 1237-1261.

The Economist (2014), "Migration to the United States: Under-age and on the Move," Jun 28th 2014 (Available at http://www.economist.com/news/briefing/21605886-wave-unaccompanied-children-swamps-debate-over-immigration-under-age-and-move?fsrc=tumb/chart).

Viaene, J., and I. Zilcha (2002a), "Capital Market Integration, Growth and Income Distribution," *European Economic Review*, 46, 301-327.

_____ (2002b), "Public Education under Capital Mobility," *Journal of Economic Dynamics & Control*, 26, 2005-2036.

Vidal, J.-P. (1998), "The Effect of Emigration on Human Capital Formation," *Journal of Population Economics*, 11, 589-600.

World Bank (2006), *Global Economic Prospects: Economic Implications of Remittances and Migration*, Washington: World Bank.

Wright, R., and P. Maxim (1993), "Immigration Policy and Immigrant Quality: Empirical Evidence from Canada," *Journal of Population Economics*, 6, 337-352.

Yamauchi, F. (2004), "Are Experience and Schooling Complementary? Evidence from Migrants' Assimilation in the Bangkok Labor Market," *Journal of Development Economics*, 74, 489-513.

Mailing Address: Armando J. Garcia Pires, Centre for Applied Research at NHH (SNF), Norwegian School of Economics (NHH), Helleveien 30, 5045 Bergen, Norwey. Tel : 47 5595 9622. E-mail: armando.pires@snf.no..