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Is Brain Drain passé?
The Optimal Timing of Migration

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Abstract

This paper sheds a new perspective on models of migration by integrating in a same structure the decisions about education and work; and by incorporating return migration with 'brain waste'. Brain waste is defined as the depreciation, due to migration, in the human capital acquired in the home country.

This paper shows that brain waste, and return migration have significant effects on the optimal strategy of migration. Without these elements, brain drain is usually an optimal solution. But, when we introduce brain waste, then it is optimal to migrate as a student. Therefore, brain waste can explain why brain drain is not always optimal.

Keywords: Labor mobility; Brain drain; Brain Waste; Psychological costs; Higher education; Mismatch Costs; Return Migration; Quality of education.

JEL: F22, I23, J24.

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I. Introduction

There is a hot debate going on in the field of economic development on whether migration of individuals has positive or negative effects on the home country – the brain drain vs. brain gain debate. Those claiming that it has negative effects emphasize the loss of human capital due to the migration of the educated citizen. The ones in support of migration emphasize that finally, migration generate positive dynamic forces for development, and leads to an increase in human capital, as well as to remittances.[1]

Lately, there is also a literature emphasizing the creation of development traps due to migration, since the flow of skilled workers can be given to either a vicious, or virtuous circle.

This paper takes a different approach, and questions whether we should invest so much effort analyzing brain drain vs. brain gain, since in fact, we should focus on another question: Is it better to migrate when young, or is it better to wait until acquiring an education? If, as this paper will show, the most rational decision is to migrate before acquiring an education, then the whole question about brain drain and brain gain is passé. The research should be redirected to analyzing 'brain waste', where 'brain waste' is the depreciation in human capital due to migration.

In order to analyze the optimality of the timing of migration, I develop a model of migration, which combines the two migration decisions into a unique model – decisions about where to get an education and decision about where to work. The main reason for having a unified model is that investment in human capital cannot be disjoined from the decision about work.

In other words, in order to analyze the optimal strategy of individuals facing the possibility of migration, it is necessary to analyze the mobility of individuals encompassing decisions already at the level of education.

The model includes two new elements in the optimization: the first is 'brain waste' which is the loss of human capital acquired in the home country after migrating. Indeed, very often, human capital and education acquired in the home country cannot be completely exploited as so, and the migrant faces a high depreciation in the value of his human capital. The brain waste occurs due to the fact that knowledge acquired home is not recognized for its whole value.

Moreover, this depreciation in human capital is not exactly known at the time of migration; it is dependent on the timing of migration and to which country the migrant moves to. Indeed, we are all aware that with the same level of human capital, the success of migration is not the same at all time: there are periods in which

[1] See Docquier and Rapoport, (2008, 2012). Further references to the literature are found in Section 2 below.

migrants are well-accepted, and there are periods in which there is an anti-migrant public opinion.

In other words, while the expected level of income is known at the time of deciding whether to migrate, individuals do not know the exact realization of the depreciation that will prevail when they migrate. So, in the first stage, at the time individuals choose their strategy, income is uncertain since the brain waste is a stochastic variable.

The second element is 'return migration'. When migrants already live in the host country, they know the realization of the brain waste, and know exactly what their income is. In the case where wages offered to them are too low in the host country, they will return to their home country. In consequence, brain waste is an element affecting 'return migration'.

It is important to emphasize that 'return migration' occurs because some of the knowledge was not known ex-ante, and this level of knowledge is related to the brain waste. The individual always knows the *expected* value, but does not know ex-ante the *exact* value of the brain waste.

So, this paper takes into consideration two elements, which are linked among them due to uncertainty: 'brain waste' and 'return migration'. Indeed, a migrant facing brain waste has the choice between two possibilities. First, he can, after migrating, find out that his brain waste is not too high, and stay in the host country. Otherwise, as an alternative, if brain waste is high, he can choose to go back to his home country.

We add a third costs of migration -- psychological costs, which are different when migrating as a young or mature adult. In the empirical part of the paper, we check whether indeed, age affects psychological costs. On a sample of French migrants, we found that indeed, age significantly affects the costs. We also find that cultural distance affects the costs.

The sequential decisions of the model are presented in Chart 1. In the first step, individuals decide where to study (i.e., in country of origin or in a foreign country), and in the second step, they decide where to work. In case they have migrated for work, they also decide whether they stay in the host country or whether they return to their home country, if migration is not "successful".

The main result of this paper is that when we allow for 'return migration', brain waste, and heterogeneous psychological costs, then under plausible assumptions, it is optimal to move when young before acquiring human capital. In consequence, in countries where young individuals can travel for acquiring education, it is optimal to do so, since brain waste is null when migrating as a student.

In other words, brain drain is passé; and 'brain waste' is a main factor in setting the optimal strategy of migration.[2]

The paper is organized as follows: In the next section, we present the literature as well as empirical facts related to our model. In section III we develop the model of migration. The main proposition of our model states that the strategy of migrating after acquiring education is sub-optimal. Although, we emphasize that this result is related to assumptions about higher education. Section four presents the empirical part, and section V concludes.

II. Facts and Related Literature on the assumptions of the model

Before presenting the literature on migration and return migration, let us start with the literature on brain waste and psychological costs.

2.1. Depreciation of human capital - Brain Waste and Psychological costs

About brain waste, there is an empirical literature investigating the prominence of depreciation of human capital in various countries. For instance, Matoo et al. (2008) check the US labor market, while Lofters et al. (2014) focuses more specifically on the medical sector in Canada. Interestingly, Pires (2015) relates brain drain to brain waste.

The literature on psychological costs mainly belongs to the fields of sociology and psychology. The literature put in evidence many diverse psychological costs affecting migration. First are the "separating-family" costs. Sjaastad (1962) stressed that migrants bear costs which result from separation from family and friends including costs of loneliness and isolation. Psychological costs also include the costs of leaving one's own culture and adapting to the new one. These costs are due to the cultural differences between the sending and the receiving countries.[3]

Therefore the extent of these costs depends on the cultural differences between the origin and the destination countries. The extent of these costs are also influenced by differences in language, distance and even size of the migrant population due to network effect (see Beine et al., 2008).

Lately, culture and identity enters the realm of economics, as in the literature developed by Akerlof and Cranton (2010) which put an emphasis on "identity". This

[2] Note that return migration is due to imperfect knowledge about the loss of human capital. In this model, return migration takes place when there is ex-post a high realization of the brain waste, i.e., high level of human capital depreciation.

[3] This phenomenon of adapting to a new culture is coined as acculturation (see, Berry, 1997; Narchal, 2007). Theories of acculturation stress that the interaction between different cultures and adaptation to the majority's culture, lead to a process in which migrants are losing their own cultural identity. In extreme cases, as a result of changes in the identity of the individual, mental illness might appear (see Bhugra, 2004).

literature takes into account that one of the main element people care about is their identity, or in other word, their culture.

There are also psychological costs which are not due to acculturation or to family "loss" but to stress of adapting to a new place, and finding a job. The success of finding a job and acclimating in a new country was shown to be influenced by own fears and ex-ante beliefs. Schwarzer and Hahn (1995) show that these beliefs are evolving over time. They emphasize that moving while young to a new country decreases the subjective fears of migration, so that psychological costs are lower for young individuals. [4]

Age also influences the 'separating-family' psychological costs. Indeed, Zaiceva and Zimmermann (2008, p.8) have checked migration of workers in Europe, and have shown that married individuals with children are expected to have lower willingness to migrate because of higher psychic costs of separation from their family. Moreover, Reagan and Olsen (2000) find lower acculturation costs for those who arrived at younger ages (see also Schmidt, 1994; and Constant and Massey, 2002). In conclusion, part of the empirical literature stresses that migration costs are lower when young.

2.2. Return migration

The literature emphasizes that 'return migration', which is also coined 'out-migration' is affected by labor market characteristics. Jasso and Rosenzweig (1982) found that out-migration rates varied substantially by nationality (ranging from 20% to 50%) and concluded that both proximity to the United States and the relative attractiveness of the home country were good predictors of these rates.

Reagan and Olsen (2000), who have studied male and female out-migration, did not find any gender differentials, but they did find a lower likelihood of out-migration among those who arrived at younger ages. Duleep (1994) found that additional years of U.S. residence lowered the probability of out-migration and that these rates were highest for Western European countries, lower for Third World countries, and lowest for refugees.

Fuchs and Schundeln (2009) also analyze the elements affecting migration and return migration. They found that older individuals are more likely to return than to stay permanently, when compared with younger individuals. Dustmann who has published numerous papers on return migration, mainly focuses on the duration of migration, and relating it to after return activities (see Dustmann and Kirchkamp, 2002; Dustmann, 2003, and Dustmann and Gorlach, 2015.)

Theoretical models on return migration focus on various elements, but mostly on the question of self-selection, as in Mayr and Peir (2008). They develop an overlapping-generations model that allows considering the incentive effect of

[4] See Schwarzer and Hahn (1995), fig.3, p.86.

migration on schooling, as well as the choice of migrating permanently or migrating and returning. Dustmann et al., (2011) focuses on return migration in a Roy model, while Galor and Stark (1991) relates the higher investment of efforts of migrants to the probability of return migration. Another line of research focuses on the effects of return migration on the economic performances of home countries (see Docquier and Rapoport, 2012). Our model is different and focuses on the depreciation of human capital.

2.3. The literature on Migration of students and workers

The literature on migration of workers is vast. On the positive effects of migration, entitled brain gain, there are some overviews on this literature (see Docquier and Rapoport, (2008, 2012) and Gibson and McKenzie, 2011). This literature emphasizes that the possibility of migration could create some positive effects on the emigration country. This line of research has been studied by Beine et al. (2008), Gibson and McKenzie (2012), and Stark (2004). Beine et al. (2008), and Easterly and Nyarko (2009) derive the theoretical effects of migration on human capital creation, and test these effects empirically.

The debate on the brain drain vs. brain gain has stimulated the development of this field. As emphasized by Gibson and McKenzie (2011), the number of studies on this subject has increased in the last decade. Many contributions are empirical, although Docquier and Rapoport (2012) present in their survey a model permitting to discuss the conditions under which we get brain drain or brain gain.

We now focus on the literature on migration of students, which is less developed, although growing fast these last few years. Indeed, lately the literature on the mobility of students is developing and is mainly empirical. The studies in this field outline the elements affecting the costs and benefits of students' migration.[5] Heaton and Throsby (1998) focuses on the determinants of flows of students, using a cost-benefits framework that incorporates elements linked to the gravity model in international trade.

The literature has also stressed that wage level is one of the main elements affecting the decision to migrate as a student. On one hand, Mac and Moncur (2001) found that higher wages in the country of origin positively affect the rate of out-migration. It is so, because agents with higher income can bear the costs of migration more easily and have better possibilities to invest in high quality of education.

On the other hand, wage differences between the host country and the country of origin are also used to explain the patterns of migration. These studies show that flows of students are from low-wage to high-wage countries because students are motivated by the wish to exploit the opportunity to acquire employment in the country wherein they acquired their education (see Rosenzweig, 2006).

[5] See Kyung, 1996; Bessey, 2006; and Agasisti and Dal Bianco, 2007.

There is also a literature which focuses on the macro effects of migration. Papatisba (2005) argued that studying overseas enhance the social and cultural development of migrants and therefore leads to human capital gains. Moreover, she stresses that migration could be a political means to foster technological transfers and economic integration in Europe.

Some scholars emphasize also the negative effects of migration on the stock of human capital. Poutvaara (2004) argued that while migration fosters private investment in human capital, it will lead to a reduction of public investment in education, due to free riding. Following this line of reasoning, Mechtenberg and Strausz (2008) underlined the tradeoff facing government, i.e., competition versus free riding. On one hand, a central planner may decide to invest in quality of higher education in order to attract foreign students, and due to more competition, it increases the amount of investment. On the other hand, the central planner might encourage local students to obtain education overseas free of charge. This free-riding on the account of another country reduces the total amount of investment in higher education. Poot and Roskruge (2013) argue that movement of students is good for all players: the host country gets student fees, and the students themselves get higher wages.

The literature regarding mixing decisions of working and learning is still not very developed Kwok and Leland (1982), develop a multiple equilibria model of migration based on asymmetric information, wherein students prefer to remain in the country where they attended university, due to a lack of information on the "value" of their degrees. So due to signaling, good students find it more valuable to remain in the host study countries to work. In consequence, students with less "internal information", i.e., those with lower abilities, will be those who decide to return to their countries of origin. Rosenzweig, (2006) incorporates the fact that students are motivated by the wish to exploit opportunity to acquire employment in the country wherein they acquired their education. Dreher and Poutvaara (2011) empirically checks the effects of staying to work in a foreign country on the decision to migrate as a student.

Lately, quality of education has been introduced as an element that influences decisions about migration. Haupt et al., (2013) analyze the brain drain vs. brain gain in a framework in which quality of higher education is endogenous. Van Bouwel (2009), and Thiessen and Ederveen (2006) also focus on quality of education, and take as proxy of quality the number of national universities among the top 200 in international rankings.

There are also studies on the effects of migration on the social environment as more migration will lead to a reduction in cultural differences over time (see Poutvaara, 2004 and Mechtenberg and Strausz, 2008). We now turn to present a model which does not draw a dichotomy between decisions on education and those on employment. Instead, it will combine these two into one model.

III. The Model

The model we present permits to analyze the optimality of the brain drain strategy. In order to do so, we introduce the elements of 'return migration' and 'brain waste' into a framework combining the decisions related to migration of students and workers. The model we develop is the following: In the first step, individuals decide where to study, and in the second step, they decide where to work. In the case where they have chosen to work abroad, they then also decide whether or not to return to their home country, if the migration is not successful. The main assumption of the model is imperfect information on the level of brain waste.

The model focuses on the returns as well as on the costs of migration. Starting with returns, there are two main elements which affect the returns: wages and quality of higher education. Wages affects net income in a direct way, while the quality of education affects it through the level of human capital. This paper focuses on the quality of higher education as a main element driving migration: students know that their human capital is a function of the quality of the education they have received.[6]

Let us now describe the various stages of decisions, displayed in Chart 1. In the first period, individuals invest in acquiring human capital, H, and decide whether to study overseas in country F, or in his home country, in country S. Their decision is a function of the costs and returns from acquiring human capital.[7]

In the second period, they decide where to work: either overseas, or in their home country. In case, they migrate to work, they will have to decide in a next stage whether to stay or to return to their home country, i.e., 'return migration', if migration is not successful. We could denote this model as a two^{+}steps model.

The main idea of this model is that the decision to work is not independent of the decision the individual took previously in the first period. Moreover, the individual takes into consideration the expected costs of brain waste. As we present in the next section, the individual has imperfect information on the size of the depreciation of his human capital. If depreciation will be high, so that migration is not successful, he can return to his home country at a cost.

We first present the various costs affecting the decision of migrating; we then turn to analyze the returns.

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[6] See Aghion et al. (2009) and Brezis (2012), which discuss the notion of quality of higher education. On the relation of quality of secondary education and human capital, see Card and Krueger (1992) and Hanushek and Woessman (2007).

[7] This paper does not tackle the question about multi-migration or successive countries of migration.

3.1. Costs of Migration

In this paper, there are three different costs related to migration: (i) tuition fees, (ii) depreciation in human capital, and (iii) psychological costs. The first costs are related to the tuition fees, T, which are different between home and host countries; and we define the costs as the difference between tuition fees abroad, and tuition fees in the home country: $T_F - T_S$. This gap in tuition fees is an element which affects the decision about whether to migrate before acquiring an education or after.

The second costs are due to a depreciation of human capital. We show now that depending on the relative size of 'return migration' and 'brain waste', the individual will either choose return migration, or stay and 'pay the price' of the depreciation of his human capital.

3.1.1 Brain waste

The exact realization of the costs related to depreciation of human capital, C which are subtracted from the returns, are unknown to the individual at the time of the decision before deciding where to study. The individual can only calculate the *expected value* of the costs, E(C). In order to do so, we have to analyze the costs in the various cases he is facing.

There are in fact two possibilities: (a) He can either succeed in finding an adequate job in the country he moves to. (b) As an alternative, he can choose to go back and work in his home country.

a. Brain waste when staying in the host country

In the case where the individual has migrated after acquiring education, and he stays in the host country, there is a depreciation, Z to the human capital he has accumulated in the home country. This is the *brain waste*. The loss of human capital is a stochastic variable, and the individual does not know upfront if and how much will be his loss of human capital.

The depreciation in human capital is function of two main variables. The first one, 'distance', x, represents the dissimilarity between countries, since the depreciation is a function of how dissimilar the host country is from his own country. It is not a question of physical distance properly, but rather of differences in the labor market between these two countries. It is also a function of differences of culture as stressed in section II above. The dissimilarity element, x, is known and affects the size of the brain waste.

The second element affecting brain waste is the depreciation costs per unit of distance, b. The depreciation costs per unit of distance, b is a stochastic variable, since there are years when the costs are higher, and years when lower.

We can think of two elements related to timing which affect the size of the depreciation costs, b. The first is the business cycle. If migrants arrive at a period of boom, they start working in the host country with higher wages and a lower

depreciation of their human capital. A second effect related to timing is the 'anti-migration public opinion', which is not known in advance. Indeed, there are times when migrants are less welcome, and other time when they are more welcome. This all affects the size of the depreciation.

For simplicity, we assume that b is distributed uniformly on [0, b_h] with b_h being the maximum discount factor, which may be affected by exogenous factors, as social norms. We denote the average discount as $\bar{b}$, which is equal to:

$$\bar{b} = b_h / 2 \tag{1}$$

We assume that at the time of making their decision about where to study, individuals do not know the exact realization of b that will prevail when they migrate. Therefore ex-ante when deciding whether to study in their own country or to learn overseas, they only know the expected discount factors. Moreover, we add a constant, $\lambda > 0$ influenced by policy which represents policy factors affecting the brain waste.

Therefore taking all these elements into consideration, the total depreciation in human capital takes the form:

$$Z(t) = b.x + \lambda \tag{2}$$

b. Returning to the home country

The migrant can also decide to return home (see Chart 1). However, when the migrant goes back home, there is a cost of travelling back: We define it as A, and it encompasses all costs of returning home.

c. Expected value of costs related to depreciation in human capital

The decision to be taken by an individual, when being already in the host country, is choosing between staying there or returning home. Thus, it is given by the comparison between *Z*, the brain waste, and *A*, the cost of return migration (see chart 1). This link between 'brain waste' and 'return migration' is what this paper emphasizes.

Hence, when the realization of the depreciation rate b is low enough, then individuals stay in the host country, while when it is high enough, they decide to move back to their country of origin.

Analyzing the two possible strategies, we get that the costs of moving takes the form:

$$\begin{aligned} &if \quad b \le (A-\lambda)/x \quad then\, C = Z \\ &if \quad b \ge (A-\lambda)/x \quad then\, C = A \end{aligned} \tag{3}$$

Hence ex-ante, when A is not too big such that $[b_h x + \lambda] > A$, the expected mismatch costs, C will be given by:

$$E(C) = \int_0^{(A-\lambda)/x} \frac{Z(t)}{b_h} db + \int_{(A-\lambda)/x}^{d_h} \frac{A}{b_h} db \quad (4)$$

So that:

$$E(C) = A - \frac{(A-\lambda)^2}{4\bar{b}x} \quad (5)$$

Equation (5) represents the expected value of the costs related to the brain waste, encompassing together depreciation in human capital, Z, as well as return migration costs, A.

This is the main equation of this model, since it sheds a new perspective on the modelization of migration, and brain waste. It is quite intuitive that the expected value of the costs, E(*C*) are a positive function of three elements: the dissimilarity between countries, x; the average depreciation costs, $\bar{b}$; and the return costs, A. When these elements are substantial, it will affect the optimality of the decisions on when to migrate - after education or before.

We now turn to the last cost related to migration: psychological costs.

3.1.2 Psychological costs

The literature presented in the second section emphasizes that psychological costs affect decisions about migration. Moreover, the psychological costs are higher for mature adults than young ones. Therefore in this paper, we assume that there are two different psychological costs, one borne by adults migrating, P_o (o for old), and one by the students, which are smaller and coined, P_y.[8] In summary, the three costs included in this paper are: differences in tuition fees, brain waste costs and psychological costs. We now turn to discuss the returns.

3.2. Returns from migration

One main element which affects the future income of students is the accumulated human capital. This accumulated human capital is a function of the quality of higher education they have acquired, as stressed by the literature above. Indeed, students are aware that quality of higher education is heterogeneous and varies across countries; the higher the quality, the higher the human capital they are acquiring.[9]

[8] We check this assumption in the empirical section.

[9] The assumption is that the choice of the country is based on its best universities, and that students are aware of the *aura* of the country. Of course, there is heterogeneity in the quality of universities in a given

The second element which influences the future income of students is the wages paid for a given amount of human capital.

So, individual's earning is a function of two factors: (i) The wage per unit of human capital, w_i where *i* is the index of the country in which the individual decides to work (country S or country F). (ii) the quality of higher education, Q_j which affects the accumulated human capital (where *j* is the index of the country in which he gets an education).

For sake of simplicity, we assume that the income takes the following form:[10]

$$W_{ij} = \psi(w_i, Q_j,) = w_i Q_j^{\alpha} \qquad \alpha < 1 \tag{6}$$

We can now present the net returns for each of the strategy (see Chart 1).

3.3. Net returns

We start by presenting the strategy at the right hand side of Chart 1: A_F .

(i) Moving as student and staying to work – strategy A_F .

Agents migrate, in the first stage, to country F in order to obtain education and remain there after graduation. The income in this specific strategy is a function of Q_F and w_F .[11] The costs incurred when choosing this strategy are the psychological costs P_y, and the tuition fees overseas, T_F and the net income in strategy A_F is:

$$NV_{AF} = w_F Q_F^{\alpha} - (T_F + P_Y) \tag{7}$$

The second possible strategy is temporary migration:

(ii) Temporary migration – strategy A_S .

Individuals migrate as student but later on return to their home country after graduation. The earnings under this strategy is a function of quality of education overseas, Q_F and wages at home, w_S . The costs incurred when choosing this strategy are the psychological costs P_y, the tuition fees overseas, T_F , and some small costs of returning home: ε .[12] The net income is:

$$NV_{AS} = w_S Q_F^{\alpha} - (T_F + P_Y + \varepsilon) \tag{8}$$

(iii) *Permanent migration after acquiring education in home country – strategy,* B_F

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country. But for a student with a given ability, which can enter a specific level of universities, the aura of a country with many top universities affects the quality of the human capital he acquires.

[10] We ignore the whole present value of income, and focus on the earning of a specific year, since discount factor will affect all incomes in a similar way.

[11] This model focuses on migration between home and foreign countries, and it does not analyze moving from one foreign country to another.

[12] We assume that some small psychological costs also occur when he returns home, but smaller than A.

The third possible strategy is that an individual will obtain education in his home country and migrate in order to work, following graduation. This is the usual "brain drain" strategy. The value of earnings under this strategy is a function of quality of education at home, Q_S and wages overseas, w_F. The costs incurred when choosing this strategy are the psychological costs P_o, the tuition fees in the home country, T_S, and the expected mismatch costs due to brain waste, E(C). Net income is:

$$NV_{BF} = w_F Q_S^{\alpha} - [T_S + A - \frac{(A-\lambda)^2}{4\bar{b}x} + P_o] \quad (9)$$

And the last strategy:

(iv) *No migration – strategy,* B_S.

An individual obtains education in his home country and remains to work there following graduation. In this case, there are no costs except the tuition fees at home, T_S. The net income under this strategy is:

$$NV_{BS} = w_S Q_S^{\alpha} - T_S \quad (10)$$

We can now analyze the equilibrium.

3.4. Optimization

An individual decides whether to migrate for education purpose or later on as skilled worker, according to the net returns under each of these four strategies (equations 7-10). In the next proposition we analyze whether individuals should move before or after acquiring education, i.e., the 'brain drain' strategy. Under which condition is this strategy optimal?

Let us define:

Condition I: $$A - \frac{(A-\lambda)^2}{4\bar{b}x} + P_o > Q_S^{\alpha}(w_F - w_S).$$

Condition II: $$(P_o - P_Y) + w_F(Q_F^{\alpha} - Q_S^{\alpha}) > (T_F - T_S)$$

Proposition:

(i) Under either Condition I or Condition II, Brain Drain (strategy B_F*) is suboptimal and individual will prefer either to leave their country already as a student, or to stay in their home country.*

(ii) Higher costs of 'return migration' or higher depreciation of human capital lead to higher probability that Brain Drain is suboptimal.

Proof:

The second part of the proposition is based on Condition I. It is easy to see that when A or bx increase, then the probability that Condition I holds increase.

In other words, higher costs of returns, A or higher brain waste due to either higher dissimilarity, x or depreciation rate of human capital, b, leads to the fact that individuals will then prefer to migrate as a student.

The proof of the first part of the proposition is presented in the Appendix. This proposition states that either under Condition I or II, there is always a strategy which will be better that B_F, the usual brain drain. In other words, when we allow for migration of students, and brain waste is non negligible, it is optimal either to migrate as a student or to stay home. Moreover, whenever the quality of higher education is higher overseas, then migrating as a student, A_F is the optimal choice.

Obviously, there are times where it is still optimal to migrate as an adult. Indeed, the brain drain strategy, B_F is commonly used for individuals from poor countries who cannot afford learning abroad, and for whom tuition fees abroad are too high. They move when they have saved enough to travel to the developed world.

This model is especially meaningful for countries in the border of the developed world, from which students can easily travel to learn. This model shows that they will either stay in their countries, or move when they are still young. For them, the strategy of migrating as adult is suboptimal.

In other words, for the strategy 'brain drain' to be optimal it is necessary that both conditions I *and* II will not hold. These conditions mean that migrating as student is not optimal, either due to big differences between tuition fees, to a small brain waste or small psychological costs when adult.

To conclude, this model shows that brain drain and the migration of educated individuals are sub-optimal, although under specific conditions. Since over time, these conditions will become more frequent, the optimal strategy of individuals will be to migrate before acquiring an education.

In the next section, we check empirically one of the elements we have introduced in this paper: the migration costs. We check whether they are indeed lower when one migrates young.

IV. Empirical Results

Since one of the assumptions of the model is that costs of migration especially psychological costs are different when young or mature adult, in the following part, we check whether these costs are a function of age.

We estimate the following equation:[13]

$$P = a_0 + a_1 age + a_2 NbChild + a_3 Identity + a_4\, family + a_5 Frenchspouse + a_6 language + a_7 time + a_8 Frenchfriends + a_9\, \mathrm{Re}ligious + a_{10} gender + u$$

We investigate this equation based on a questionnaire for a sample of 300 migrants from France to Israel in June 2016. The fact that all migrants come from the same country – France, reduces some of the idiosyncrasies, and we focus on specific variables which affect psychological costs. The costs of migration were defined as the difficulty with migration and the regret about having come to Israel.

4.1. The variables of the model

The descriptive statistics of the variables are presented in Table 1.

"Regrets" is the variable which stands for the psychological costs of migration. We have asked the question whether migration is difficult and whether he/she is satisfied from his decision of migration on a scale from 1 to 5.

'age' is the age of the individual.

'Gender' is a dummy variable which is 1 if male, and 0 otherwise.

'Nb-child' is the number of children the individual currently has.

'Identity" is a dummy variable which is 1 when the individual describes himself as having roots in Israel, and 0 otherwise.

'family' is a dummy variable which is 1 if most of his family is in Israel, and 0 otherwise.

'French-spouse' is a dummy variable which is 1 if his wife/her spouse is French, and 0 otherwise.

'language': on a scale from 1 to 10, individuals assert their knowledge of Hebrew.

'time' measure the numbers of years in Israel.

'Frenchfriends' is a dummy variable which is 1 if most of his/her friends are French, and 0 otherwise.

'Religious': on a scale from 1 to 6, individuals rate how religious they are from atheist to orthodox.

4.2. Empirical results

Table 2 presents the results when the dependent variable is psychological costs of migration.

(i) Age and time

We find that age has significant positive effects on costs in most regressions presented.

[13] I thank Leah Azoulay and Rudy Arrouasse for their excellent research assistance on this part.

However, we also find that time affects 'regrets' positively and significantly: the more time the individual is in Israel, the higher are his migration costs. This seems somehow counter-intuitive. It makes the effect of age even more interesting.

(ii) Sociological Factors

First, we find that the number of children negatively affects regret. In other words, families with children have lower costs of migration.

We find that knowing the language, or having roots is reducing migration costs. We also find that religiosity negatively affects regret. Usually orthodox families meet at the synagogue and probably have better social networks and are better integrated with Israelis.

What is interesting is that social network of French friends does not help (probably they complain together while meeting at the coffee shops, which leads to an increase in the level of regret!). The effect is positive but insignificant; French spouse negatively affects costs but not always significant, and family is not significant.

In conclusion, migration costs are a function of age as we have assumed in our model.

V. Conclusion

This paper has shown that brain waste, and return migration have significant effects on the optimal strategy of migration. Without these elements, brain drain is usually an optimal solution. But, when we introduce brain waste due to depreciation in the human capital acquired at home, then it is optimal to migrate as a student. Therefore, brain waste can explain why brain drain is not always optimal.

Our model sheds a new perspective on the modelization of migration, and brain waste, denoted by the expected value of the costs, E(*C),* which as we have shown, are a positive function of three elements: the dissimilarity between countries, x; the average depreciation costs, $\bar{b}$; and the return costs, A. When these elements are substantial, it will affect the optimality of the decisions on when to migrate - after education or before.

This model encompasses the idea that in the past, when learning overseas was not as easy as today, brain drain was more frequent. In the future, we might face a structure in which young people, with secondary education will leave the country to learn overseas, and will not come back, unless return migration seems for them a better choice.

In this paper, we develop a model of migration that merges the decision to move as a student with the decision to migrate as a worker, and which introduces in the model, the possibility of 'return migration' as well as the depreciation in human capital, coined as 'brain waste'.

Another element included in this paper are the psychological costs. We assume that psychological costs increase with age, and the empirical part of the paper corroborates this assumption.

In conclusion, in the past, mobility of students was not feasible, and students were mostly learning in their own country. Globalization today permits this kind of migration at least for students from OECD countries, and in the future, probably from the whole world. Therefore it is important to notice that brain drain which was the optimal solution for individuals of countries without the possibility of higher education abroad, will give place to the strategy we stress in our model: The strategy of migrating as students.

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Appendix– proof of the proposition

I.

Under which condition do we get that $B_S \succ B_F$?

1. If $w_S > w_F$

Then this is obvious.

2. If $w_F > w_S$.

Then, under Condition I, we get that $B_S \succ B_F$.

II.

Under which condition do we get that $A_F \succ B_F$?

If: $(P_o - P_Y) + w_F (Q_F^{\alpha} - Q_S^{\alpha}) > (T_F - T_S)$ **Condition II**

Then, we get that $A_F \succ B_F$.

So either due to condition I, or to condition II, B_F is not optimal.

TABLE 1

DESCRIPTIVE STATISTICS

	Overall panel			
Variable	Mean	Std. Dev.	Min	Max
Migration costs	0.1371	0.0755	1	5
Age	4.7223	1.5401	1	7
Nb-child	2.3280	1.8331	0	8
Identity	0.9367	0.2438	0	1
Family	0.3564	0.4797	0	1
French spouse	1.0232	0.2484	0	2
language	2.2765	1.2963	0	5
Time	1.1146	1.2838	0	6
Friends	1.3121	0.6768	1	3
Religious	4.6593	0.6778	1	6
Gender	0.3598	0.4807	0	1

TABLE 2: REGRESSION RESULTS: DETERMINANTS OF MIGRATION COSTS

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.3930** (0.0593)	0.2802** (0.0371)	0.2773** (0.0365)	0.3722** (0.0578)	0.2477** (0.0350)	0.2567** (0.0356)
age	0.0044 (0.0038)	0.0069* (0.0039)	0.0067* (0.0038)	0.0057 (0.0039)	0.0074** (0.0037)	0.0078** (0.0038)
Nb-child	-0.0069** (0.0032)	-0.0101** (0.0031)	-0.1002** (0.0031)	-0.0060* (0.0032)	-0.0084** (0.0030)	-0.0088** (0.0031)
Identity	-0.0980** (0.0212)	-0.1091** (0.0212)	-0.1086** (0.0210)	-0.1163** (0.0211)	-0.0901** (0.0213)	-0.1098** (0.0212)
family	-0.0086 (0.0094)	-0.0119 (0.0096)	-0.0119 (0.0095)	-0.0073 (0.0095)	-0.0090 (0.0094)	-0.0098 (0.0095)
French-spouse	-0.0508** (0.0199)	-0.0239 (0.0198)	-0.0232 (0.0196)	-0.0314 (0.0197)	-0.0466** (0.0200)	-0.0250 (0.0198)
language	-0.0128** (4.34)	-0.0112** (0.0043)	-0.0112** (0.0042)	----------	----------	----------
time	0.0073 (0.0046)	0.0094** (0.0044)	0.0093** (0.0044)	----------	----------	----------
French-friends	0.0104 (0.0081)	----------	----------	----------	0.0090 (0.0070)	----------
Religious	-0.0217** (0.0084)	----------	----------	-0.0212** (0.0084)	----------	----------
Gender	-0.0032 (0.0093)	-0.0050 (0.0096)	----------	----------	----------	----------
R^2	0.1648	0.1599	0.1594	0.1559	0.1157	0.1344
Obs	249	251	254	256	254	256

p < 10% * p < 5% **

Chart 1: Individual's decision