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Brain Drain and Brain Return: Theory and Application to Eastern-Western Europe

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Brain Drain and Brain Return: Theory and Application to Eastern-Western Europe*

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Abstract

This paper develops a novel model of optimal education, migration and return by heterogeneous, forward-looking agents. The model is parameterized and simulated to analyze the effects of immigration policies, identifying the brain-drain, brain-gain and brain-return effects when barriers to migration are reduced. We use parameters from the literature to inform our model and simulate migration and return from middle-income to industrialized countries. In particular, we apply the model to study migration and return between Eastern and Western Europe. We find that, for plausible degrees of openness, the possibility of return migration combined with the education incentive channel turns the brain drain into a brain gain for Eastern Europe.

KEYWORDS: skilled migration, return migration, returns to education, Eastern-Western Europe

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1 Introduction

What are the consequences of increased international mobility for developing countries? Many authors (e.g., Grubel and Scott 1966, Bhagwati 1976, Bhagwati and Hamada 1974, Bhagwati and Rodriguez 1975) have emphasized the possibility of flight of the highly skilled (dubbed "brain drain") as a potential large net cost. During the last ten years, however, several theoretical models have shown the possibility of a positive effect of skilled emigration on educational incentives in the sending country, hence the presence of a brain gain together with a brain drain. More recently, empirical studies have shown that this possibility is also empirically relevant and not just a theoretical curiosum. Beine et al. (2001, 2008) use a cross-country empirical approach to test the conditions and emigration rates for which there could be a net gain to the sending country. Batista et al. (2007) and Chand and Clemens (2008) use micro-data to show the positive incentive effect of skilled emigration on education.

At the same time, analyses of international migration have recognized that return migration is a central issue with respect to the international mobility of workers. More than 30% of migrants return to their home country within two decades, and many of them go abroad as a way to enhance their skills. A typical example is the migration of college graduates in order to attend graduate programs or training programs during their early professional career. The return of these migrants is planned and motivated by the skill enhancement they receive abroad. The most influential theory of (optimal) migration and return is the one developed and tested in Borjas and Bratsberg (1986). They allow individuals of different skill levels (assumed to be given) to decide whether to migrate and whether to return and then analyze the selection of migrants and returnees as a function of their skills and of the wage dispersion in the sending and receiving country.

The most relevant models of brain gain (Stark et al., 1997, Mountford, 1997, and Beine et al., 2001), on the other hand, analyze the optimal choice of schooling with and without the migration option, and while they may include return migration (as in Stark et al., 1997) they assume that return is the unexpected consequence of a negative (individual) shock. Most of these models are primarily theoretical, and though they may derive general propositions and conditions they are not very helpful for policy simulations.

The more recent empirical analyses (summarized in Beine et al., 2008) focus on the reduced form relationship between emigration rates and the change in net human capital in the sending country. However, those models omit return migration and do not explicitly model migration policies, hence they cannot be used for analyzing the effects of changes in immigration policies or the effects of differentiated policies for temporary and permanent migrants which we will consider in this paper. The present paper is the first (to our knowledge) to combine a Borjas and Bratsberg (1986)-type of model analyzing migrant and returnee selection within a brain-gain framework where skills are not given but are acquired (via schooling), with different costs for people of different abilities. The model is the first to consider an agent making optimal decisions about education, migration and return, and is the first to analyze how these decisions vary under different degrees of tightness in the immigration policies of the receiving countries. Using the model we explain the magnitude and selection of migrants, including return flows, between developing and developed countries which are shown to depend on some key parameters and policies. Hence, in contrast to previous theoretical models, our model can be brought to the data and used to analyze and simulate the effects of immigration policies on levels of schooling and wages in the sending countries when agents optimally choose their schooling, migration and return decisions.

We use the model to explain and predict the actual migration flows of highly educated workers from low- and middle-income countries to industrialized countries. To do this, we parameterize our model with values from the literature and match some important stylized facts. First, we want to match the recent evidence that emigration rates in source countries are much larger for the highly educated than for less educated individuals. While unskilled emigration exists, Docquier and Marfouk (2006) and Grogger and Hanson (2008) clearly show that there is a much stronger tendency among the highly educated to emigrate out of source countries. Confirming this fact, Table 1[1] reports emigration rates by educational group for some representative source countries[2], calculated as the stock of people residing abroad divided by the working-age population in that group in the country of origin[3]. Note that in the year 2000 the emigration rates for the highly educated were much larger than for any

Note: emigration rates are calculated as the total number of people residing out of the country of origin relative to the working age population in the country of origin by level of education and in the aggregate. Low levels of education include people with 0 to 8 years of schooling, Intermediate levels of education include people with 9 to 12 years of schooling, and High levels of education include people with 13 years of schooling or more. "Eastern Europe" only includes the Eastern European countries admitted to the EU in 2004 and 2006. Source: Docquier and Marfouk (2006).

[2] The data are from Docquier and Marfouk (2005) who collected information from censuses of resident populations in OECD countries in the year 2000.

[3] The table distinguishes between the least educated (0 to 8 years of schooling), those with intermediate education (9 to 12 years of schooling) and the highly educated (13 years of schooling or more).

other group. For instance, for Romania, a typical Eastern European economy, and for Eastern Europe as a whole (last two rows of Table 1) the emigration rates of the highly educated were two to three times larger than the emigration rates of the less educated. In China and India the emigration rate of the highly educated was thirty to forty times larger than emigration rates among the less educated.

Table 1. Emigration by education group and country

	Emigration Rates in 2000			
	Low Education	Intermediate Education	High Education	Average
China	0.1%	0.1%	3.8%	0.2%
India	0.1%	0.4%	4.3%	0.4%
Philippines	1.4%	3.3%	13.7%	5.0%
Romania	4.6%	2.0%	11.8%	3.7%
Eastern Europe	5.0%	3.3%	14%	5.2%

Second, we want to allow for the fact that returnees are a large fraction of emigrants (usually around 30% of emigrants return within twenty years) and that they are possibly negatively selected among emigrants (i.e., returnees are the "worst" of the best)[4]. Third, we want to use the model to analyze the long-run effect of what we consider one of the most striking recent experiments in immigration law between a group of middle-income countries and a group of developed countries: the unification of Eastern and Western Europe. The process of Eastern-Western European integration produced a massive and unique relaxation of labor movement restrictions. Workers in countries such as Bulgaria, the Baltic states, Czechoslovakia, Hungary, Poland, Romania and ex-Yugoslavia went from complete isolation from Western Europe during the 1980's to free markets and some mobility in the 1990's to virtually free mobility with the accession to the European Union and the phasing-out of the transitional clauses to be completed by 2011. The model will be used to predict the long-run effects on Eastern Europe of relaxing immigration constraints. Clearly, the model can be used to analyze the effect of freer mobility on the average human capital and wages across any group of countries, as long as it is parameterized appropriately to match skill distributions, skill premia and migration costs.

[4] More details on the size, motivation and selection of returnees are discussed in Section 2 below.

There are three main, new findings in our paper, which are not only theoretical but also apply to the actual configuration of parameters represented by the Eastern-Western European case, circa 1990. First, in the presence of a premium to returnees, for which there is abundant empirical evidence, the possibility of *temporary* migration to a country with higher returns to schooling produces most of the same positive incentive effects as the possibility of *permanent* migration. The individuals who plan to migrate and return invest more in schooling and the net effect, for restrictive or mildly restrictive immigration policies in the receiving countries, is a net brain gain in the sending country. Second, in the presence of positive selection of emigrants (as is observed), the selection of returnees among emigrants depends crucially on whether the wage premium upon return increases with the education level of migrants or not. If all returnees receive the same premium for having been abroad, then returnees will be negatively selected among emigrants. In contrast, if the premium to skills upon return increases with the level of education, then only the most educated among emigrants return and this provides a further boost to the average education in the sending country. Third, even if the immigration policies of receiving countries differentiate between the highly educated and less educated immigrants, with a preference for the highly educated, as long as there is some uncertainty for both groups and the skill-bias of immigration policies is not extreme, we will still observe some return migration and brain gain under tight and moderate immigration policies.

The rest of the paper is organized as follows. Section 2 reviews the empirical literature on brain drain, brain gain and brain return; it emphasizes the novel contributions of this paper and presents the existing evidence on the size of return migration and on the wage premium upon return. Section 3 develops and solves an overlapping generations model in which workers in a poor country choose their level of education, whether or not to migrate, and whether or not to return. Section 4 uses parameters from the literature to simulate the impact of looser emigration policies on human capital and wages in the sending country. We match several general features of migration and return from developing to developed countries and apply our model to the "experiment" of reduced migration barriers between Eastern and Western Europe. We also consider the effect of different assumptions about the return premium and of more sophisticated policies in which the stringency of the policy depends on the level of education of the immigrant. Section 5 provides concluding remarks.

2 Literature Review and Evidence on Return

As stated in the introduction, this paper combines the literature on return migration, pioneered by Borjas and Bratsberg (1996), with the literature on education incentives provided by emigration (developed by Stark et al., 1997, 1998, Mountford, 1997, and Beine, Docquier and Rapoport, 2001), often known as the "Brain Drain with Brain Gain" literature. We also include the presence of agents that are heterogeneous in their abilities within a continuous range and therefore choose different levels of schooling. Whereas in some of the contributions to the "Brain Gain" literature the possibility of temporary migration is considered (as in Mountford, 1997, or Stark et al., 1997), emigrant return always arises as a consequence of shocks and not as an optimal decision. In contrast, our framework allows for an optimal decision to return and links this decision to the presence of a return premium (i.e., compensation of human capital acquired abroad) that, as we will see below, seems to be a pervasive finding in the empirical literature. Moreover, the quantitative importance of return flows documented below, along with the coincidence between the percentage of immigrants that intend to return, as documented in surveys (e.g., INSEE, 1995, found that 25% of the guest workers in France intended to go back), and the percentage that actually goes back within a couple of decades (around 30% according to OECD, 2008), suggest that migration and return may be jointly optimal decisions rather than the result of shocks: many migrants do not intend to migrate forever[5].

The debate between those who support the existence of a significant brain gain that mitigates and, for small migration levels, reverses the brain drain[6] and those who dismiss the relevance of a brain gain and emphasize the cost of brain drain[7] is not settled. A productive approach to this debate, recently followed by Beine, Docquier and Rappoport (2001, 2008), has been to use data assembled by Docquier and Marfouk (2006) to test empirically whether the education incentive effect of skilled emigration has empirical relevance. They find evidence that the effect is indeed at work, and that the combined net effect of brain drain and brain gain is positive in countries with emigration rates

[5] While certainly some migrants return because of an unexpected shock to their earnings, here we focus on the human capital motivation for migration and return. Assuming that idiosyncratic shocks are random and uncorrelated with abilities, their inclusion would not change the aggregate variables.

[6] Other recent theoretical contributions in the "brain gain" tradition are Chau and Stark (1999) and Stark and Wang (2002). Dos Santos and Postel-Vinay (2003) emphasize the beneficial effect of returnees by suggesting that they promote knowledge diffusion to the sending country.

[7] For instance, Schiff (2005).

below 20%. Our model makes parallel progress by introducing a framework in which the effect of looser migration policies on brain drain and brain gain can be studied in an overlapping generations model in which decisions regarding schooling, migration and return are made optimally. We then parameterize the model to match the initial wage distribution and migration flows in Eastern and Western Europe. Hence, complementary to the contributions of Beine et al. (2001, 2008) who approach the quantification of the brain drain and brain gain using an *estimation method,* our model approaches the quantitative aspect of the debate using a *simulation method*. This allows us to quantify the effect on human capital (and wages) of relaxing immigration restrictions in rich countries. Moreover, in contrast to the estimation approach, we are able to separate the negative contribution due to the migration of educated workers, the positive contribution due to schooling incentives, and the contribution of return migration. In fact, our model allows us to simulate a "counter-factual" scenario in which no return and no schooling incentive effects are allowed. In this way we produce quantitative simulations of the brain drain, brain gain and the brain-return effects and their dependence on the tightness of immigration laws. Since the effects obtained depend specifically on the returns to schooling, on the schooling distribution and on the return premium, and these are parameterized to match values in the literature and in the data, the empirical content of our simulation allows us to evaluate the effects of changes in immigration policies.

An important empirical magnitude that we want to match with our model is the overall size of return migration as a share of migrants. Only recently has return migration been measured accurately by combining country of origin and country of destination statistics. Section III.1 of OECD (2008) is entirely devoted to measuring return migration from OECD countries. In most cases the share of migrants who eventually return to their country of origin, after 10 to 20 years, ranges between 25 and 50%. In a previous analysis, Lalonde and Topel (1993) found that about one third of emigrants to the US between 1890 and 1957 returned home, and Dustmann and Weiss (2007) find that up to 50% of immigrants to the UK between 1992 and 2002 left the country within 10 years of their arrival. The International Migration Outlook (OECD, 2008) shows that 25 to 50% of all immigrants to a European country had re-migrated elsewhere (most likely back to their country of origin) after 5 years. These measures emphasize the magnitude of the phenomenon of return migration. In our opinion, models that consider migration as an optimal choice and return as an accidental and marginal event (as is done in most of the previous brain drain and brain gain models) miss an important aspect of international mobility. Our model explains the two-way flows as the result of optimization with migration costs.

A key parameter in determining the selection of return migrants and their level of schooling is the wage "premium" that they obtain upon return, relative to workers with similar characteristics who never migrated. We call this the "return premium". Such a premium determines the share of emigrants who return as well as their selection. In particular, if the premium is mainly a reward to the "entrepreneurial" capital developed abroad due to the connections and interactions established, we can think of it as independent of the level of education. This would be in line with several recent case studies which emphasize that returnees have been important sources of entrepreneurship (Constant and Massey, 2002, McCormick and Wahba, 2001), particularly of start-ups in high-tech sectors in countries such as India (Commander et al., 2008) and in the Hsinchu Science Park in Taipei (Luo and Wang, 2002). On the other hand, one can think of the return to entrepreneurial and other abilities upon return as being particularly high for the most highly educated. Zucker and Darby (2007) find that in the period 1981-2004 there was a strong tendency of "star scientists" in several science and technology fields in the US to return to their country of origin, at least for some period, in order to promote the start-up of high-tech firms (especially in China, Taiwan and Brazil).

Considering evidence on the wage premium to return migrants in European countries, Barrett and O'Connell (2001) find a 10-15% premium for male migrants returning to Ireland relative to similar workers who did not migrate. On the other hand, Co et al. (2000) find a 40% premium for female migrants returning to Hungary (but none for men). With respect to developing countries, Wahba (2007) identifies a 30% premium for workers returning to Egypt. Iara (2008) finds a 25-30% return premium for workers in Eastern Europe who have had experience in Western Europe, while de Coulon and Piracha (2005) and Carletto and Kilic (2009) identify a positive and significant effect on upward occupational mobility of past migration experience for Albanian returnees; the first of those studies also finds a positive return premium to self-employed returnees of around 70%. Hence, all studies find significant evidence of a return premium for at least some portion of the returnees. The evidence on the selection of return migrants and of the dependence of the return premium on migrants' schooling is more mixed. Some studies (e.g., Iara, 2008) find that the wage premium of returnees is positively associated with educational levels, while others (e.g., Barrett and O'Connell, 2001) do not find any correlation. Furthermore, some studies such as Dustmann and Weiss (2007) show that the tendency of migrants to return to their country of origin is much stronger among workers in highly skilled occupations, and Gundel and Peters (2008) use data on migrants to Germany to show a much higher return rate for the highly educated compared with the less educated. However, de Coulon and Piracha (2005) find a negative selection of returnees among emigrants. In our model, to account for both cases, we first consider a baseline scenario which produces negatively selected return migrants along with a return premium that is independent of schooling (conservative case), and we then extend the model to a case which generates positive selection with a return premium that is increasing in schooling.

3 The Model

The goal of this section is to present a model that allows us to analyze, in qualitative and quantitative terms, the effects of potential migration and return on the average human capital (and average wages) of people in the sending country, when immigration policies of the receiving countries are relaxed. While the model has a simple 2-period overlapping generations structure, it allows us to discuss the key incentives to migrate and to return in connection with human capital accumulation. The model combines a migration-and-return decision as in Borjas and Bratsberg (1986), a schooling-and-migration decision as in Stark et al. (1997) and a relation between heterogeneous costs of schooling and schooling achievements as in Stiglitz (1975). One advantage of the model is that, at the cost of specifying some functional forms, it can be analytically solved, parameterized using values from the literature, and simulated. The key insight provided by the simulations is a quantitative assessment of the impact that different degrees of openness have on brain drain, brain gain and brain return in the sending country. We describe the intuition, the basic assumptions and the main results of the model in the present section 3. We leave to the Appendix the more lengthy mathematical derivations.

3.1 Production and Wages

Consider the Home country economy (indicated with an H) as the poorer economy whose individuals may decide to emigrate. In Home there are heterogeneous workers (indexed by i) who produce one non-durable good Y according to the following aggregate production function:

$$Y = A_H L_H \overline{\chi} \tag{1}$$

where A_H indicates total factor productivity (TFP), L_H equals total employment and $\overline{\chi}$ defines the average human capital in the economy. Each individual i supplies one unit of labor and χ_i units of human capital - specific to individual i - so that the average human capital $\overline{\chi}$ is equal to $\frac{1}{L_H}\sum_1^{L_H}\chi_i$. As is customary in the "Mincerian" approach to human capital, we assume that the human capital of each individual is an exponential function of her schooling, h_i, so that $\chi_i = e^{\eta_H h_i}$ where η_H represents the returns to schooling in the home country. The production function exhibits constant returns to scale in total labor (and omits physical capital) so that it can be thought of as a long-run production function in which capital adjusts to keep the capital-output ratio constant and the productivity of a worker is determined by TFP and by her level of human capital[8]. In fact, the marginal productivity and wage in the Home country of worker i in logarithmic terms is given by:

$$\ln(w_{Hi}^1) = \ln(A_H) + \eta_H h_i \tag{2}$$

To simplify the consumption side of the model we assume that there are no financial markets so that in each period people use all their wage income to purchase good Y. Moreover, we assume that the agent's utility function is separable over time and logarithmic in each period so that expression (2) also represents the period utility from working and living at Home. We assume a production function in the Foreign country (F) similar to (1) with country-specific total factor productivity, A_F, and country-specific returns to schooling, η_F. At the same time we assume that there are costs of living abroad for a migrant (material as well as psychological) and that those costs are specific to the period of the individual's life. We express these costs in utility units and denote them by M_1 and M_2, where the subscripts refer to the period in which they are incurred. In general, we consider as relevant the case where M_1 is large enough so that not all workers from Home move to the Foreign country in the first period, and where M_2 is large enough so that not all workers from Home stay in the Foreign country in the second period[9]. We also assume $M_2 \leq M_1$, as the costs of living abroad are not likely to increase from the first to the second period following migration (adjustment to the new country, including integration and adoption of local customs, will likely make it less costly to live abroad). Notice also that as the costs are log-linear in real wages, we can think of them as also including downgrading of immigrants' skills. Thus, immigrants with a certain level of human capital may receive a proportionally lower wage than natives. The utility abroad (logarithmic wage net of costs of living abroad) for individual i when young is:

[8] Assuming full adjustment of the capital-labor ratio within one period seems appropriate since one period, here, is equal to 20-25 years (half of the working life of a person).

[9] The formal conditions under which these restrictions hold are stated in section 4.1.

$$\ln(w_{Fi}^{1}) - M_1 = \ln(A_F) + \eta_F h_i - M_1 \tag{3}$$

If the individual chooses to remain abroad in the second period, she will receive the following utility (logarithmic wage net of costs of living abroad):

$$\ln(w_{Fi}^{2}) - M_2 = \ln(A_F) + \eta_F h_i - M_2 \tag{4}$$

Since we are considering Home as the relatively poor country, we assume that $\ln(A_H) < \ln(A_F)$ so that part of the wage differential between countries is due to different productivity levels (in favor of F). Moreover, following the literature on "appropriate technological choice" and skill-biased technological progress (e.g., Acemoglu, 2002, Caselli and Coleman, 2006), we assume that the returns to schooling are higher in Foreign than in Home because a larger share of highly educated workers in that country induces the adoption of technologies that use human capital more efficiently. Hence we adopt this assumption ($\eta_H < \eta_F$), which is appropriate in the comparison between several developed and developing countries, and certainly empirically true for Eastern and Western Europe (see section 4 below), and we maintain it as a restriction for the parameters in our analysis.

In analyzing the return decision we assume that Home workers who have been abroad for one period have "enhanced" their human capital by learning new skills, abilities and techniques. If they decide to return, this increases their earnings. This extra benefit, however, would not be reaped if they stayed in Foreign where they would simply have the same wages as local workers[10]. Think, for instance, of foreign language skills, or of the knowledge of foreign laws and culture. For immigrants who stay in the host country this simply allows them to assimilate and provides no advantage vis-a-vis natives, while for those who return this provides an advantage relative to people who did not expatriate. Returnees have an advantage if they want to set up a trading company, a foreign affiliate, or interact with customers in the country of emigration. Moreover, if the country of emigration was an English-speaking country, they will have knowledge of an international language of communication and possibly knowledge of Anglo-Saxon common law, both very valuable to entrepreneurs. The assumption of a return premium is also justified by the evidence reviewed in section 2 that returnees to middle-income countries often engage in international entrepreneurial activities, act as skilled entrepreneurs

[10] We could also include some gross return to experience that accrues to the worker and increases her human capital whether or not she remains abroad. Obviously, this would not affect the comparison between wages abroad and at home in the second period and hence would not have any effect on the decision to stay or return.

and earn an additional premium on their skills.[11] A simple way to capture this "skill premium" for returnees is to write the (logarithmic) wage of a person who returns to the home country in the second period of her life after having been abroad as:

$$\ln(w^2_{FHi}) = \ln(A_H) + \eta_H h_i + \kappa \quad (5)$$

where w^2_{FH} indicates the wage in the second period of life (superscript) for individual i who has been abroad and returned home. The parameter $\kappa > 0$ is a scaling factor for human capital associated with the skills accumulated abroad. Notice that this "skill-based" motivation for return is also present in the seminal paper of Borjas and Bratsberg (1986). Essentially, the emigrant knows that a temporary stay in a developed country improves the economic options he faces back home, and when evaluating the opportunity-cost of staying in the second period, he accounts for such improved options at home. The Borjas and Bratsberg (1986) model also allows for an unexpected shock to the wage of the migrant in the receiving country, which may trigger return. We omit such a source of uncertainty which would only slightly modify our framework. Expression (5) assumes that the "return premium" is additive in logs and hence is, proportionately, independent of the level of human capital. Some empirical evidence presented in section 2 above, however, suggests that more educated workers may receive a higher proportional premium on their return. That assumption would imply the presence of a term κh_i (rather than κ) in (5). Since the implications of a return premium which increases with skill is interesting, we will explore it in the extension presented in section 4.3.1. To complete the description of the utility of individuals in all potential periods and cases, the utility of workers who stayed at home is the same in the second period as in the first period and is given by the following expression: $\ln(w^2_{Hi}) = \ln(A_H) + \eta_H h_i$.

3.2 Migration and Return

At the beginning of the first period (young) individual i chooses how much schooling to get, h_i, and simultaneously pays the cost, k_i, for this education. Immediately afterwards (still at the beginning of period 1) she also chooses whether to be considered as a candidate for migration. It is a voluntary decision whether to apply for migration or not. Once an individual has decided to be considered she faces the same probability of migrating as any other appli-

[11] The movement of universities to establish campuses abroad can also be seen as evidence of particularly high returns to foreign-style education.

cant[12]. We index the application decision with the indicator variable l_i, which takes a value of 0 if the individual does not apply for emigration and 1 if she does. Once the education and the decision to apply are resolved, the individual participates in production and earns the wage in the home country (if she did not apply to emigrate or if she applied but was not allowed to emigrate) or abroad if she was selected as a migrant. The probability of being selected as a migrant is denoted with $p \in [0, 1]$. This probability represents the tightness of immigration policies in the potential countries of destination. An increase in this probability corresponds to a loosening of immigration requirements. At the beginning of the second period people who remained at Home continue to earn wage w_{Hi} (we assume that the cost of moving in the second period is too high to make it profitable to move or that the receiving country has a policy which significantly penalizes the immigration of older workers), while emigrants living abroad can decide whether to stay in Foreign or to return. We index their decision to return with the indicator variable q_i, which takes a value of 0 if the person stays abroad and of 1 if she returns.

The only uncertainty in the model is given by the uncertain migration prospects for workers who apply. Other than that, workers know their salary at Home and in Foreign and for simplicity we assume that productivity and returns to schooling do not change (steady state assumption). While in Borjas and Bratsberg (1986) immigrants also receive a random shock to their wage abroad in the second period, so that for those hit by a negative shock returning is preferred to staying, here we do not introduce such a shock. While it may be important to explain the yearly variation of return migration, the goal of this model is to explain the long-run tendencies and effects of migration and return. Those are unlikely to be affected much by idiosyncratic or temporary shocks, hence we omit them to simplify the model. The optimal decisions of an individual can be obtained by starting with her last period and proceeding backwards. If the individual remains at Home during her first period, her utility in the second period is $\ln(w_{Hi})$ and no decision is needed; if she migrated in the first period she has to decide whether to return ($q_i = 1$) or not ($q_i = 0$), and such a choice depends on whether the utility of living abroad net of the cost, $\ln(w_{Fi}^2) - M_2$, is larger or smaller than the utility from returning $\ln(w_{FHi}^2)$. Substituting expressions (4) and (5) into the inequality one easily obtains the optimal choice q_i^* as a function of the individual's schooling:

[12] The uncertainty of migration stems from quotas, restrictions and rules imposed by the immigration policy of receiving countries. In section 4.3 below we analyze the case in which the probability of migration is not equal for all applicants but depends on their observed education or their period of stay (permanent versus temporary).

$$q^*(h_i) = \begin{cases} 1 & \text{if} \quad h_i < \frac{M_2+\kappa-(\ln(A_F)-\ln(A_H))}{\eta_F-\eta_H} \\ 0 & \text{if} \quad h_i > \frac{M_2+\kappa-(\ln(A_F)-\ln(A_H))}{\eta_F-\eta_H} \end{cases} \tag{6}$$

The larger the return premium κ and the cost of living abroad M_2, the larger is the group of returnees: only workers with high h_i would remain abroad during the second period to reap the larger education premium (due to the difference $\eta_F - \eta_H > 0$). Plugging in the optimal return decision (6) we can now solve the first period inter-temporal optimization with respect to the decision to apply for emigration or not (l_i) and for the amount of human capital to acquire. The lifetime expected utility of agent i is:

$$U(h_i, l_i, q^*(h_i)) = (1-l_i)\ln(w_H^1) + l_i[p\left(\ln(w_F^1) - M_1\right) + (1-p)\ln(w_H^1)] \tag{7}$$
$$-k_i + \frac{1}{1+\delta} l_i p[(1-q_i^*)(\ln(w_F^2) - M_2) + q_i^* \ln(w_{FH}^2)] + \frac{1}{1+\delta}(1-l_i p)\ln\left(w_H^2\right),$$

where $\frac{1}{1+\delta}$ is the inter-temporal discount factor and the variable q_i^* denotes the optimal return decision. The individual utility cost of acquiring human capital is denoted by k_i, which we assume to depend on the innate abilities of individuals, ν_i, which are distributed over an interval $[\underline{\nu}, \overline{\nu}]$. As in models of signaling[13], we assume that costs of schooling are decreasing in individual ability and increasing and convex in the amount of human capital acquired. Specifically:

$$k_i = \frac{\theta h_i^2}{\nu_i}, \tag{8}$$

where θ is an exogenous shifter of schooling costs. Since the decision to apply for emigration or not is binary, it boils down to a comparison of the following two expected utility levels:

$$\ln(w_H^1) + \frac{1}{1+\delta}\ln(w_H^2) \quad \text{vs.} \tag{9}$$
$$p(\ln(w_F^1) - M_1) + (1-p)\ln(w_H^1) +$$
$$\frac{1}{1+\delta}p[(1-q^*(h_i))(\ln(w_F^2) - M_2) + q^*(h_i)\ln(w_{FH}^2)] + \frac{1}{1+\delta}(1-p)\ln(w_H^2)$$

which imply the following optimal choice of l_i^*:

[13] See, for instance, Spence (1974) and Stiglitz (1975).

$$l_i^* = \begin{cases} 1 & \text{if} \quad h_i > \frac{M_1(1+\delta)+M_2(1-q_i^*)-\kappa q_i^* -(\ln(A_F)-\ln(A_H))(2+\delta-q_i^*)}{(\eta_F-\eta_H)(2+\delta-q_i^*)} \\ 0 & \text{if} \quad h_i < \frac{M_1(1+\delta)+M_2(1-q_i^*)-\kappa q_i^* -(\ln(A_F)-\ln(A_H))(2+\delta-q_i^*)}{(\eta_F-\eta_H)(2+\delta-q_i^*)} \end{cases} \tag{10}$$

The denominator of the right hand side expression $(\eta_F - \eta_H)(2 + \delta - q_i^*)$ is always positive. Hence, only workers with human capital above a certain threshold would apply for emigration. Notice that the probability of succeeding in the emigration process, p, does not affect the threshold level of human capital which determines the decision to apply. The reason is simple: workers with human capital above the threshold are those whose utility, net of costs, increases by migrating. Hence, they would take any probability of migrating over the certainty of staying. Those who do not apply (with human capital below the threshold) are better off not migrating.

The two functions (6) and (10) define two thresholds for the education level h. One that we call h_S defines the lowest educational level for which it is beneficial to emigrate and the other h_{MM} defines the lowest human capital level for which it is beneficial to migrate and not return in the second period. Temporary migration exists only if $h_S < h_{MM}$, in which case some workers migrate and return and others stay abroad. If $h_S > h_{MM}$, all migrants (still selected among the highly educated) are permanent (i.e., they do not return in the second period).

Putting together conditions (6) and (10) and assuming that $h_S < h_{MM}$, which is the empirically relevant case since the current model aims to explain the observed return migration, we can partition the range of schooling levels of workers into three intervals. For a level of schooling below the following threshold:

$$h_i < \frac{M_1(1+\delta) + M_2(1-q_i) - \kappa q_i - (\ln(A_F) - \ln(A_H))(2+\delta-q_i)}{(\eta_F - \eta_H)(2+\delta-q_i)} \equiv h_S \tag{11}$$

workers choose to stay at Home and not apply for emigration (hence $l_i^* = 0$, $q_i^* = 0$). For human capital levels between the values:

$$\frac{M_1(1+\delta) + M_2(1-q_i) - \kappa q_i - (\ln(A_F) - \ln(A_H))(2+\delta-q_i)}{(\eta_F - \eta_H)(2+\delta-q_i)} < h_i < \frac{M_2 + \kappa - (\ln(A_F) - \ln(A_H))}{\eta_F - \eta_H} \tag{12}$$

workers choose to apply and, conditional on emigrating, they return in the second period ($l_i^* = 1$, $q_i^* = 1$), while if they do not succeed in emigrating, they stay at Home in both periods. Finally, for values of human capital larger than the threshold h_{MM} (MM for permanent migration) defined in (13) workers choose to apply for emigration and, conditional on emigrating, they stay abroad in their second period of life ($l_i^* = 1$, $q_i^* = 0$). If they do not succeed in emigrating, they stay at Home in both periods.

$$h_i > \frac{M_2 + \kappa - (\ln(A_F) - \ln(A_H))}{\eta_F - \eta_H} \equiv h_{MM} \tag{13}$$

Notice that such a model (with the parameter restrictions imposed above) produces positive skill selection of emigrants as documented in Grogger and Hanson (2008) and Docquier and Marfouk (2006) and negative skill selection of returnees among migrants (as argued and documented in Borjas and Bratsberg, 1986)[14]. Obviously, if the education premium were smaller in the receiving country, our model would predict negative selection of migrants. However, we have imposed the restriction $\eta_F - \eta_H > 0$ as it is empirically satisfied in the case we analyze (see below) and also because it implies the observed type of migrant selection.

3.3 The Schooling Decision

Differentiating (7) with respect to human capital h_i, and keeping in mind that q_i^* and l_i^* are equal to either 0 or 1 so that we only need to keep track of the thresholds h_S and h_{MM}, optimal schooling is given by the following linear function of the individual's ability ν_i:

$$h_i^* = \frac{\frac{2+\delta}{1+\delta}(\eta_H + l_i^* p(\eta_F - \eta_H)) - \frac{1}{1+\delta} l_i p q_i^* (\eta_F - \eta_H)}{2\theta} \nu_i \tag{14}$$

The relationship between ability and optimal schooling depends on the subsequent optimal choice of whether to apply for emigration and whether to return. Those choices, in turn, depend on the values of h_i relative to the thresholds. The easiest way to analyze the optimal choice of schooling and migration as a function of individual ability, ν_i, is to consider the three different migration choices (no migration, migration and return, and permanent migration) and plot, for each one of them, the optimal schooling choice as a

[14] Notice that a return premium that is positively related to schooling would generate a positive selection of returnees among emigrants, as we describe in section 4.3.1.

function of ν_i. This gives the following three functions:

$$
\begin{aligned}
h_i^{S*} &= \frac{1}{2\theta}\frac{2+\delta}{1+\delta}\eta_H\nu_i \quad \text{for} \quad l_i^* = 0 \\
h_i^{MR*} &= \frac{1}{2\theta}\left[\frac{2+\delta}{1+\delta}\eta_H + p(\eta_F - \eta_H)\right]\nu_i \qquad \text{for} \quad l_i^* = 1, q_i^* = 1 \\
h_i^{MM*} &= \frac{1}{2\theta}\left[\frac{2+\delta}{1+\delta}\eta_H + \frac{2+\delta}{1+\delta}p(\eta_F - \eta_H)\right]\nu_i \quad \text{for} \quad l_i^* = 1, q_i^* = 0
\end{aligned}
\tag{15}
$$

where the notations h_i^{S*} , h_i^{MR*}, h_i^{MM*} indicate, respectively, the optimal amount of schooling for people who do not migrate (S), for people who migrate and return (MR) and for people who migrate permanently (MM). It is clear from inspection of the coefficients of the linear relationships in (15) that they go from smallest (S) to largest (MM). The optimal functions in (15) together with the threshold values (11) and (13) determine the correspondence between individual ability, ν_i, and the schooling and migration decisions. Figure 1 illustrates the relationship between ν_i and h_i^* and reports the threshold values (11) and (13) determining migration behavior. The figure shows that workers of ability lower than ν_S, formally given by expression (16) below, choose to acquire relatively little education and not apply for emigration ($l_i^* = 0$, $q_i^* = 0$):

$$
\nu_S \equiv \frac{2\theta}{\frac{2+\delta}{1+\delta}\eta_H + p(\eta_F - \eta_H)}\frac{M_1(1+\delta) + M_2 - (\ln(A_F) - \ln(A_H))(2+\delta)}{(\eta_F - \eta_H)(2+\delta)} \tag{16}
$$

For ability levels between ν_S and ν_{MM} (defined in equation (17) below), workers choose to acquire an intermediate level of education, apply for emigration and, conditionally on migrating, return in the second period ($l_i^* = 1$, $q_i^* = 1$) :

$$
\nu_{MM} \equiv \frac{2\theta}{\frac{2+\delta}{1+\delta}\eta_H + \frac{2+\delta}{1+\delta}p(\eta_F - \eta_H)}\frac{M_2 + \kappa - (\ln(A_F) - \ln(A_H))}{\eta_F - \eta_H} \tag{17}
$$

Finally, for ability levels greater than ν_{MM}, workers apply to emigrate and, if successful, they stay abroad in the second period. The three bold segments in Figure 1 represent the schooling levels of the three groups of workers: those who stay, returning migrants and permanent migrants. Those with low ability (below ν_S) get little education and do not even attempt to migrate. Those with intermediate ability (between ν_S and ν_{MM}) attempt to migrate and, if they succeed (with probability p), they return in the second period. Those with high ability (above ν_{MM}) attempt to migrate and, if succesful, they stay abroad in

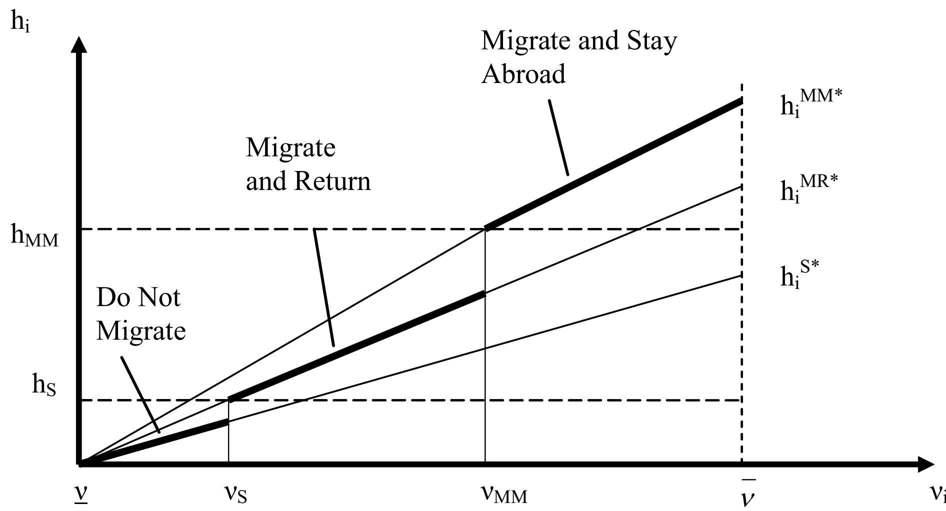

Figure 1: Optimal schooling and migration decisions as a function of personal abilities

the second period. These features are consequences of the key assumption that $\eta_F > \eta_H$. While within the range of parameters taken from the literature and explored in section 4, the ability threshold for migrating, ν_S, is always below the ability threshold, ν_{MM}, although it is in principle possible that $\nu_{MM} \leq \nu_S$. In this case, there would be no return migration. This is illustrated in Figure 2: workers with ability below $\nu_S = \nu_{MM}$ stay at home, while those with ability higher than ν_{MM} migrate in the first period and stay abroad in the second period. As discussed in section 2, all empirical studies suggest that return migration is sizeable and significant, and so we focus on the relevant case in which there are returnees as well as permanent migrants.

Before proceeding further we want to emphasize the role of p, the probability of migrating, in affecting the level of schooling of each group. An increase in p in our model has two effects. First, it increases the slope of h_i^{MR*} and therefore decreases the value of the threshold ν_S, and second it increases the slope of h_i^{MM*} and hence decreases the threshold ν_{MM}. This implies that a larger range of workers (those with abilities between ν_S and $\overline{\nu}$) will get more schooling than before – this is the incentive effect already pointed out in the literature by Mountford (1997), Stark, Helmenstein and Prskawetz (1997, 1998) and Beine, Docquier and Rapoport (2001). However, people in this group will also have a higher probability of leaving – this is the classic brain drain effect.

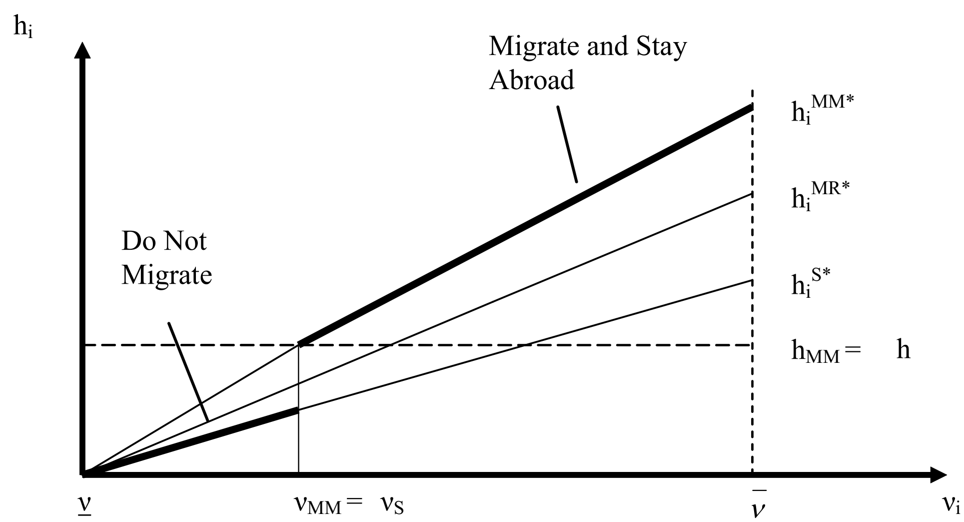

Figure 2: Optimal schooling and migration decisions in the case with no return migration.

Since the group of returnees lies between the ability levels ν_S and ν_{MM} and both thresholds shift to the left, their share in the total does not change much, but the education acquired for each level of ν increases. Hence, in a model in which there are prospects of migration, be they temporary (with return) or permanent, a higher probability of success in migrating increases the incentives to acquire education for both types, and hence the "brain gain" mechanism extends to both types of migrants.

The model presented above allows us to solve explicitly for the average level of human capital of workers in the Home country. Given the simple (logarithmic) wage equations in (2)-(5), once we know the human capital level for an individual we can easily compute their logarithmic wage. To make the model operational and to derive expressions for average schooling and wages, we assume that the distribution of abilities $\nu \in [0, \overline{\nu}]$ is uniform with density $1/\overline{\nu}$. Moreover, the Home country population consists of two generations: the young (denoted with the subscript 1) and the old (denoted with the subscript 2). The pre-migration size of each generation at time t is denoted by ϕ_{1t} and ϕ_{2t} (for the young and the old, respectively) and the post-migration size, which is relevant in order to compute average human capital (and average wages), is given by $\phi_{1t}(1-m_{1t})$ and $\phi_{2t}(1-m_{2t})$, respectively, where m_{1t} and m_{2t} are the shares of young and old living abroad. Therefore, the average human capital in the Home country in period t, $\overline{h}_t$, is given by the following expression:

$$\overline{h}_t = \frac{\phi_{1t}(1-m_{1t})\overline{h}_{1t} + \phi_{2t}(1-m_{2t})\overline{h}_{2t}}{\phi_{1t}(1-m_{1t}) + \phi_{2t}(1-m_{2t})} \tag{18}$$

where $\overline{h}_{1t}$ and $\overline{h}_{2t}$ are the average levels of schooling of young and old people living at Home. The young are those who did not emigrate (either by choice or because they did not succeed in the application process), while the old are a mixture of those who remained and those who returned. In the next section we express the dependence of $\overline{h}_{1t}$ and $\overline{h}_{2t}$ on the parameters of the model and, in particular, on the probability of migrating.

3.4 Average Human Capital and Wages

If there is no possibility of emigration ($p = 0$) because the home country does not allow it (as was the case in Eastern Europe before 1990) or because the foreign country does not let any immigrants in, returns to education are equal to η_H and everybody in the source country chooses the level of education identified by $h_i^{S*}(\nu_i)$ in (15). The average human capital in autarky would then be the same in the Home country for young and old individuals and would equal:

$$\overline{h}^A = \frac{1}{2}h_i^{S*}(\overline{\nu}) = \frac{\eta_H}{4\theta}\frac{2+\delta}{1+\delta}\bar{\nu} \tag{19}$$

Now consider the case with positive probability of migration, $0 < p < 1$. Some workers, depending on their ability, have an incentive to invest more in schooling and take a chance at emigrating (possibly with return). The average human capital of young individuals who remain in the Home country depends on the average human capital of three groups, represented by the three thick solid segments in Figure 1. Considering the relevant case, $\nu_S < \nu_{MM}$[15], there will be a group of least educated who do not apply for emigration and pursue the lowest possible level of education for their ability. A second group gets an intermediate level of education and applies for emigration (with the prospect of migrating and returning) but is not selected to migrate, and a third group gets the highest education (with the prospect of migrating and staying abroad) but is not selected either. Expression (20) below shows the average human capital of the young generation, $\overline{h}_1$, as a weighted average of mean human capital in each of these three groups. The weights are the share of each group in the total

[15] Appendix A shows the value of average human capital when $\nu_S > \nu_{MM}$.

young population (after migration) and the averages, because of the uniform distribution assumption, are the mid-points between the lowest and highest schooling level in the group:

$$\begin{aligned}\overline{h}_1 &= \frac{\frac{1}{2}h^{S*}(\nu_S)\nu_S}{\nu_S+(1-p)(\overline{\nu}-\nu_S)} + \frac{\frac{1}{2}\left[h^{MR*}(\nu_{MM})+h^{MR*}(\nu_S)\right](1-p)(\nu_{MM}-\nu_S)}{\nu_S+(1-p)(\overline{\nu}-\nu_S)} \\ &\quad + \frac{\frac{1}{2}\left[h^{MM*}(\bar{\nu})+h^{MM*}(\nu_{MM})\right](1-p)(\bar{\nu}-\nu_{MM})}{\nu_S+(1-p)(\overline{\nu}-\nu_S)} \qquad (20)\end{aligned}$$

The first term on the right-hand-side of (20) is the product of the average human capital of individuals who prefer to stay at Home, given by $\frac{1}{2}h^{S*}(\nu_S)$, and their share in the total non-migrating young population, given by $\frac{\nu_S}{\nu_S+(1-p)(\overline{\nu}-\nu_S)}$ [16]. The second term contains the average human capital of workers who get a higher education, are planning to migrate and return, but are not selected, $\frac{1}{2}\left(h^{MR*}(\nu_{MM})+h^{MR*}(\nu_S)\right)$, times their share in the non-migrating, young population $\frac{(1-p)(\nu_{MM}-\nu_S)}{\nu_S+(1-p)(\overline{\nu}-\nu_S)}$. The third term equals the product of average human capital for individuals who plan to migrate and remain abroad but end up not migrating, $\frac{1}{2}\left(h^{MM*}(\bar{\nu})+h^{MM*}(\nu_{MM})\right)$, times their share in the non-migrating population $\frac{(1-p)(\bar{\nu}-\nu_{MM})}{\nu_S+(1-p)(\overline{\nu}-\nu_S)}$.

The average human capital of the old generation in the Home country can be calculated in a similar way. The only difference is that all the individuals who migrated and whose ability was between ν_S and ν_{MM}, are now back in the Home country. Hence, the expression of average human capital for the old generation is given by:

$$\begin{aligned}\overline{h}_2 &= \frac{\frac{1}{2}h^{S*}(\nu_S)\nu_S}{\nu_{MM}+(1-p)(\bar{\nu}-\nu_{MM})} + \frac{\frac{1}{2}\left[h^{MR*}(\nu_{MM})+h^{MR*}(\nu_S)\right](\nu_{MM}-\nu_S)}{\nu_{MM}+(1-p)(\bar{\nu}-\nu_{MM})} \\ &\quad + \frac{\frac{1}{2}\left[h^{MM*}(\bar{\nu})+h^{MM*}(\nu_{MM})\right](1-p)(\bar{\nu}-\nu_{MM})}{\nu_{MM}+(1-p)(\bar{\nu}-\nu_{MM})} \qquad (21)\end{aligned}$$

The interpretation of the three terms on the right hand side of (21) is the same as in (20). In fact, the only difference in the calculation of the shares is that in the old generation all workers in the $[\nu_S, \nu_{MM}]$ interval are at Home (since those who migrated have returned) and the total size of the old population at home is equal to $\frac{\nu_{MM}+(1-p)(\bar{\nu}-\nu_{MM})}{\bar{\nu}}$.

If we substitute the expressions for h^{S*}, h^{MR*} and h^{MM*} from (15) into (20)

[16] Because of the uniform distribution of abilities, the share can be expressed as the simple ratio of the support of ν for the group and the total support, accounting for the fact that in the interval $[\nu_s, \bar{\nu}]$ only a fraction $(1-p)$ ends up staying.

and (21), we obtain the expressions (32) and (33) reported in the Appendix B that link the average human capital of the young and of the old to the parameters and to the threshold values ν_S and ν_{MM}. In steady state, when parameter values and immigration policies are stable, one can calculate the average human capital for the whole population by combining in expression (18) the average human capital of young and old from (32) and (33), accounting for the fact that the share of individuals who are in the Home country from the first generation, $(1-m_1)$, is equal to $\frac{\nu_S+(1-p)(\bar{\nu}-\nu_s)}{\bar{\nu}}$ and the share of individuals at Home from the second generation, $(1-m_2)$, is $\frac{\nu_S+(\nu_{MM}-\nu_S)+(1-p)(\bar{\nu}-\nu_{MM})}{\bar{\nu}}$.

Finally, to evaluate average wages (equal to income per capita) in the Home economy, we can easily combine the average wage of workers in each of the three groups (between 0 and ν_S , between ν_S and ν_{MM} and between ν_{MM} and $\bar{\nu}$) weighted by the share of that group among young or old workers (if we are calculating the average wage for a cohort) or in the total population (if we are calculating the average wage overall). Let us define $\overline{w}_{L1}$, $\overline{w}_{M1}$ and $\overline{w}_{H1}$ as the average wage of workers with, respectively, low abilities (below ν_S), medium abilities (between ν_S and ν_{MM}) and high abilities (above ν_{MM}) when they are young and $\overline{w}_{L2}$, $\overline{w}_{M2}$ and $\overline{w}_{H2}$ as their average wage when they are old. While the average wage and the size of the first and third groups are the same when young or old, the average wage and the size of the second group (migrants who return) is different, and we have to keep track of the fact that only a fraction $(1-p)$ is in the Home country when young, whereas the entire group is in the country when old. To avoid redundant notation we let $\overline{w}_{L1} = \overline{w}_{L2} = \overline{w}_L$ and $\overline{w}_{H1} = \overline{w}_{H2} = \overline{w}_H$ such that the average wage for the young generation $\overline{w}_1$, the average wage for the old generation $\overline{w}_2$, and the average wage overall, $\overline{w}$, are given by the following expressions:

$$\begin{aligned} \overline{w}_1 \;=\; & \overline{w}_L \left(\frac{\nu_S}{\nu_S+(1-p)(\overline{\nu}-\nu_S)}\right) + \overline{w}_{M1}\left(\frac{(1-p)(\nu_{MM}-\nu_S)}{\nu_S+(1-p)(\overline{\nu}-\nu_S)}\right) \qquad (22) \\ & +\overline{w}_H \left(\frac{(1-p)(\bar{\nu}-\nu_{MM})}{\nu_S+(1-p)(\overline{\nu}-\nu_S)}\right) \end{aligned}$$

$$\overline{w}_2 = \overline{w}_L \left(\frac{\nu_S}{\nu_S + (\nu_{MM} - \nu_S) + (1-p)(\bar{\nu} - \nu_{MM})} \right) + \tag{23}$$

$$\overline{w}_{M2} \left(\frac{(\nu_{MM} - \nu_S)}{\nu_S + (\nu_{MM} - \nu_S) + (1-p)(\bar{\nu} - \nu_{MM})} \right) + \tag{24}$$

$$\overline{w}_H \left(\frac{(1-p)(\bar{\nu} - \nu_{MM})}{\nu_S + (\nu_{MM} - \nu_S) + (1-p)(\bar{\nu} - \nu_{MM})} \right)$$

$$\overline{w} = \frac{\phi_1(1-m_1)\overline{w}_1 + \phi_2(1-m_2)\overline{w}_2}{\phi_1(1-m_1) + \phi_2(1-m_2)} \tag{25}$$

where ϕ_1 and ϕ_2 are the pre-migration populations of the currently young and old cohorts and $(1-m_1)$ and $(1-m_2)$ are the shares of those cohorts in the Home country, which differ by the fraction of workers who return. Using the production function and expressions (2) and (5) to calculate individual wages (for those who stay and for the returnees), the average wage for each of the three groups is given by the following expressions:

$$\overline{w}_L = \frac{1}{\nu_S} \int_0^{\nu_S} A_H e^{\eta_H \frac{\eta_H}{2\theta} \frac{2+\delta}{1+\delta} \nu} d\nu \tag{26}$$

$$\overline{w}_{M1} = \frac{1}{(\nu_{MM} - \nu_S)} \int_{\nu_S}^{\nu_{MM}} A_H e^{\eta_H \frac{1}{2\theta} \left(\frac{2+\delta}{1+\delta} \eta_H + p(\eta_F - \eta_H) \right) \nu} d\nu \tag{27}$$

$$\begin{aligned} \overline{w}_{M2} = & \frac{(1-p)}{(\nu_{MM} - \nu_S)} \int_{\nu_S}^{\nu_{MM}} A_H e^{\eta_H \frac{1}{2\theta} \left(\frac{2+\delta}{1+\delta} \eta_H + p(\eta_F - \eta_H) \right) \nu} d\nu + \\ & \frac{p}{(\nu_{MM} - \nu_S)} \int_{\nu_S}^{\nu_{MM}} A_H e^{\eta_H \frac{1}{2\theta} \left(\frac{2+\delta}{1+\delta} \eta_H + p(\eta_F - \eta_H) \right) \nu + \kappa} d\nu \end{aligned} \tag{28}$$

$$\overline{w}_H = \frac{1}{(\bar{\nu} - \nu_{MM})} \int_{\nu_{MM}}^{\bar{\nu}} A_H e^{\eta_H \frac{1}{2\theta} \left(\frac{2+\delta}{1+\delta} \eta_H + \frac{2+\delta}{1+\delta} p(\eta_F - \eta_H) \right) \nu} d\nu \tag{29}$$

Notice that the difference between $\overline{w}_{M1}$ and $\overline{w}_{M2}$ is the return of the share p of workers who were abroad and who are now endowed with the extra productivity term κ in their human capital. Due to the exponential dependence of wages on schooling and, in turn, abilities, it is easy to solve the integrals above. Expressions (34)-(37) in Appendix B provide the analytical solutions to (26)-(29). In the next section we discuss and simulate in detail the response of human capital and wages to different migration policies.

4 Simulation of Migration Policies

The model presented above is clearly stylized. The advantage, however, is that most of its variables have a measurable empirical counterpart. We can thus impose some structure on its predictions by parameterizing it with the use of existing estimates and the matching of some essential features of the data. We can then simulate the model to provide insight into the effects of migration policies on human capital and wages in the sending country. Our parameter choices are reflective of Eastern and Western Europe as Home and Foreign countries, respectively. As we argued above, this is a unique and interesting case, and the features of selection and return migration are quite representative of what takes place between middle income and rich countries. Immigration policy changes can be captured by a shift of p from 0 (a value appropriate for the late eighties when the Iron Curtain was preventing most movement between East and West) to the policies allowing emigration rates of 10-15% of the population (as measured by Docquier and Marfouk, 2006). Moreover, envisioning the full admission of Eastern Europe into the EU we can analyze the impact of even freer mobility of labor. Our model allows us to identify the effects of such policy changes on schooling and wages in Eastern Europe in the long-run. Even more importantly, and novel to this model, the adopted framework allows us to decompose the total effect on average human capital into the "pure drain from migration", the "incentive effect from migration" and the effect stemming from "incentives from migration and return". The genuine insight of the model is that for plausible parameter values, the incentive and the return channels produce important differences in human capital and wages, relative to what is predicted by the pure human capital "drain" effect of migration. Schooling incentives and temporary migration are crucial issues when evaluating the effect of international migration on human capital and wages in the sending country. We will also discuss the importance of the "return premium" in determining the size and the selectivity of return migrants and we will discuss the possibility of using it as a migration policy instrument, as countries may, for example, institute tax-exemption policies that favor the highly-skilled returnees and encourage their return. Let us first describe the parameter choice for the base case and for plausible variations and then, in turn, we will discuss the effects of increased international migration and the role of return migration in determining the average human capital in the sending country.

4.1 Choice of Parameters

Table 2 shows the choice of parameters that we use in our baseline simulation. They are in part obtained from the literature and in part chosen to match observed migration and return flows between Eastern and Western Europe. The ratio of labor productivity abroad and at home, A_F/A_H, is set equal to 2. This reflects the relative labor productivity between the average Eastern European country and the average Western European country (Germany or the UK) measured in the late eighties and reported in Hall and Jones (1999)[17]. This assumption implies that the difference in logarithmic productivity $\ln(A_F)$ - $\ln(A_H)$, which is the term entering all the relevant expressions in section 3, is equal to ln(2). We further take as returns to one year of schooling the values $\eta_H = 0.04$ and $\eta_F = 0.08$ for the Home and the Foreign country, respectively. These values are based on average returns to schooling in Poland and East Germany (for the East) and in Western Germany and the UK (for the West), both taken around the late eighties when the Iron Curtain collapsed and available in Hendricks (2004). As the difference in returns to schooling between East and West is an important determinant of the selection of migrants, we check our model using estimates of η_H equal to 0.06 (which are close to the estimated returns in Hungary as of 1995) and we also analyze the case in which returns to schooling increase from 0.04 to 0.06, which was the trend in Hungary and Poland between 1985 and 1995, as noted in Hendricks (2004). The parameter κ is chosen so that a plausible share of workers would return. As we documented in section 2 above, return rates of 20-30% for migrants from Eastern Europe to Western Europe seem quite plausible. Hence κ is chosen so as to deliver return migration rates between 0.2 and 0.3 at current migration rates; this turns out to be around 0.5.

Table 2: Baseline Choice of Parameters

Parameter	A_F	A_H	φ	η_F	η_H	κ	Φ_1
Value	2 φ	φ	1	0.08	0.04	0.5	0.5
Parameter	Φ_2	θ	δ	$\underline{\nu}$	$\overline{\nu}$	M_1	M_2
Value	0.5	1	0.5	0	480	1.5 ln(2)	0.67 ln(2)

The pre-migration sizes of the cohorts of young and old workers (ϕ_1 and ϕ_2) are both set equal to 0.5 (so that total population is standardized to 1). This

[17] Iranzo and Peri (2009) also use this value in their simulations of the impact of bilateral trade and migration on the productivity of Eastern and Western Europe after 1989.

captures the essential stagnation of the population of Eastern Europe for the last two decades (with possibly a slight decline). We experiment with a range of utility costs of residing abroad in the first and second period of life, M_1 and M_2. They are, however, always chosen so as to match the following two restrictions. First, $M_1 + \frac{M_2}{1+\delta} > [\ln(A_F) - \ln(A_H)]\frac{2+\delta}{1+\delta}$ so that the present discounted utility cost for the least skilled worker is higher than the present discounted benefit from migrating. This implies that for the least skilled worker it is too costly to migrate, and therefore not everybody would migrate even in the absence of legal restrictions to migration. Second, $M_2 + \kappa > \ln(A_F) - \ln(A_H)$ such that some emigrants will always return in the second period. As stated above, the percentage of migrants who return within ten years is always non-negligible in the data, and this is a feature that we would like our model to match. While there are reasons to believe that migration costs may be smaller for the highly educated, we assume that they are independent of the level of education. Grogger and Hanson (2008) show, and our model confirms, that one can explain differential migration rates across education groups simply as a consequence of differential returns. The chosen values and restrictions above imply that in all the considered cases the threshold h_S is strictly larger than 0 and the threshold h_{MM} is strictly larger than h_S. Hence, in all cases we have some temporary and some permanent migrants. The variable h is literally interpreted as years of schooling, while individual ability ν (which clearly does not have a natural scale) is standardized to vary between a lower bound $\underline{\nu}$=0 and an upper bound $\bar{\nu}$ such that the highest human capital attained in autarky, $h_i^{S*}(\overline{\nu}) = \frac{\eta_H}{2\theta}\frac{2+\delta}{1+\delta}\overline{\nu}$, is equal to college education (16 years). Moreover, this standardization, combined with the uniform distribution assumption, implies that the average years of schooling in autarky is equal to 8. This is a very good approximation for the Eastern European economies around the 1985-1990 period. The Barro and Lee (2000) dataset, in fact, puts the average schooling in transitional economies in Eastern Europe at 8.5, with Poland at the low end of the spectrum with an average of 6.8 in 1990 and East Germany, Hungary and Czechoslovakia at the high end with average schooling between 8.7 and 10.1 years. Moreover, a uniform distribution assumes that there are individuals with very low schooling levels, and specifically that some have educational levels below the threshold h_S. This is also true for most Eastern European countries. As of 1990, the percentage of population 25 years or older with no schooling at all was 4.7% in Bulgaria, 5.4% in Romania and 12.4% in Yugoslavia. Hence, even when the threshold h_S is low (as in the baseline scenario in which it is 2.88 years) there are always individuals with lower levels of education who do gain from emigrating. The parameter δ is chosen to be equal to 0.5, which implies a yearly discount rate of 2% and a length of one period (half a working life in the model) of 20 years.

4.2 Baseline Case

Table 3 shows the effect on average schooling and wages of progressively looser migration policies, from left to right. The parameter p, which captures the probability of migrating (conditional on applying for migration), ranges from 0 to 0.3. This produces migration rates between 0 and 25%, which covers the range of migration rates calculated by Docquier and Marfouk (2006); for most countries, except for some very small Caribbean islands and a few African countries, no economy has emigration rates larger than 25%. The simulations reported in Table 3 represent our baseline case. In these simulations we use a utility cost of living abroad equal to 1.5 times the productivity differential $(1.5 * \ln(2))$ between the rich and poor country and a cost of remaining abroad in the second period equal to 0.67 (two thirds) of the logarithmic wage differential. While it is hard to pinpoint the empirical value of migration costs (we show results for different values in Tables A1 and A2), migration costs should represent substantial costs, especially for less educated workers, and should be substantially smaller in the second period when migrants have adjusted to the new country.

Again, recall that these costs include material costs, loss of skills due to downgrading and psychological costs. We choose the parameter κ to be 0.5 in order to produce plausible return migration rates of 20-30%. This also implies a return premium for the highly educated of around 40% (0.5/1.21) of their wage, in line with the estimates of Co et al. (2000) for female returnees. Under zero probability of successful application ($p = 0$), the young generation (first row), the old generation (second row) and the overall population (third row) have 8 years of average schooling (primary completed). Each of the first three rows reports the level of $\overline{h}_1$ (average schooling of young), $\overline{h}_2$ (average schooling of old) and $\overline{h}$ as the probability of migration p increases. Recall that eight years of schooling corresponds to the average schooling for Eastern Europe in the nineties. In the following three rows we report the average wages for the young cohort ($\overline{w}_1$), the old cohort ($\overline{w}_2$) and the population overall ($\overline{w}$). In order to identify the winners and losers from freer migration policies we also report, in the following three rows, the average wage of each of the four relevant skill groups characterized by different education levels and migration behavior.

Table 3: Migration probability and source-country variables
Baseline scenario

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$\overline{h}_1$, young	8	8.30	8.60	8.89	9.17	9.45	9.70
$\overline{h}_2$, old	8	8.26	8.51	8.75	8.97	9.18	9.37
$\overline{h}$, overall	8	8.28	8.55	8.82	9.07	9.31	9.53
Wages							
By Generation Group							
$\overline{w}_1$, young	1	1.01	1.02	1.04	1.05	1.07	1.08
$\overline{w}_2$, old	1	1.01	1.03	1.05	1.07	1.09	1.10
$\overline{w}$, overall	1	1.01	1.03	1.04	1.06	1.08	1.09
By Skill Group							
$\overline{w}_L$, less educated	0.75	0.75	0.75	0.75	0.75	0.75	0.75
$\overline{w}_{M1}$, medium educated, young	0.86	0.86	0.86	0.85	0.85	0.85	0.85
$\overline{w}_{M2}$, medium educated, old	0.86	0.89	0.91	0.94	0.96	0.99	1.02
$\overline{w}_H$, highly educated	1.13	1.15	1.17	1.19	1.21	1.23	1.25
Emigration Rates and Return Migration Rates							
Share of emigrants	0	0.041	0.082	0.125	0.167	0.210	0.254
Share of returnees among emigrants		0.272	0.255	0.239	0.225	0.212	0.201

Workers with ability below ν_S (low) who do not pursue migration earn wage $\overline{w}_L$ as defined in equation (26). Those with ability between ν_S and ν_{MM} (medium) earn wage $\overline{w}_{M1}$, defined by equation (27) when young (if they stay at home), while they earn an average of $\overline{w}_{M2}$ as defined by expression (28) when old (including the premium for the returnees). Finally, those with ability above ν_{MM} (high) who pursue permanent migration earn an average wage equal to $\overline{w}_H$ (given by expression (29)) both while young and old (if they end up not migrating). Since we report wages relative to the average wage for $p = 0$ (which is standardized to one), it is easy to calculate the percentage variation in wages as the probability of migration changes, as well as the relative wages across groups. Finally, the last two rows report the percentage of the total population living abroad, namely the "emigration rate" under a definition comparable to that of Docquier and Marfouk (2006). These rows also report the return rate – i.e., the percentage of total migrants who return.

The baseline case implies that workers with less than 2.88 years of schooling ($h_s = 2.88$) will not pursue migration, those with schooling between 2.88 years and 6.72 years will pursue migration and return, while those with more than 6.72 years will pursue permanent migration (these values are reported in the footnote to Table 3). The overall long-run effect of a higher migration

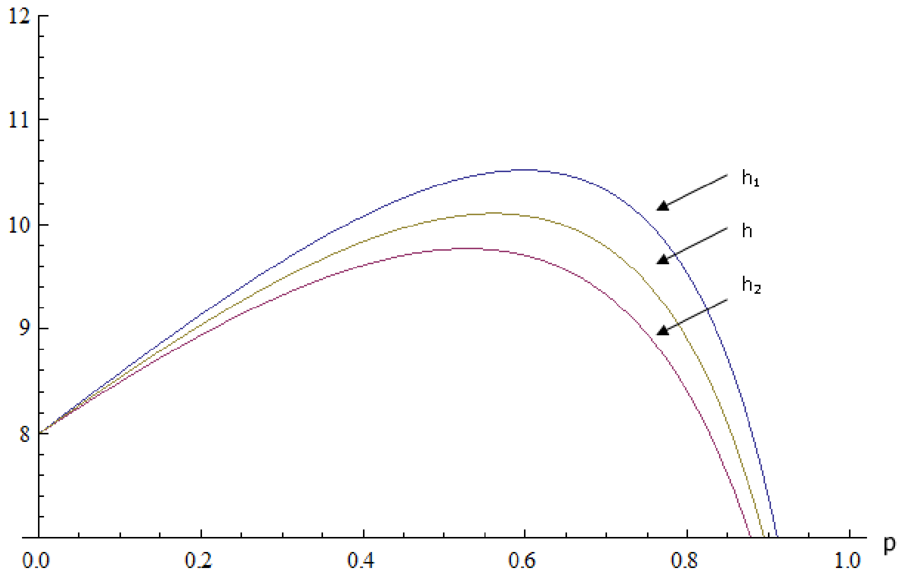

Figure 3: Average schooling of the young, old and overall as a function of emigration probability: baseline case.

probability on average education is strictly positive in the chosen range. Average education increases by 1.5 years going from no international mobility to significant mobility, $p = 0.3$. This increase is an average of the increase of 1.7 years of schooling for the young generation, due to the *incentive effect* generated by the possibility of migration, and the increase of 1.4 years for the old generation, since the average schooling of a returnee is slightly below the average schooling of the remaining workers. Even at $p = 0.15$, which produces a moderate 12.5% emigration rate, the average education gain relative to autarky is equal to 0.8 years. Such improvements in average schooling produce an increase in the average wage (income per worker) of 4% relative to autarky in the case where $p = 0.15$, and of 9% in the case where $p = 0.30$. At a probability of migrating equal to 0.15 the young generation has an average wage that is larger by 4% relative to autarky simply due to the incentives to acquire higher education. The older generation, which includes the returnees who have slightly lower average schooling than natives who remained at home, but earn a "return premium" (κ), receives an average wage 5% higher than in autarky. Obviously these gains do not include the wage gains of permanent migrants (that are earned abroad). The important result emerging from Table 3 is that the combination of incentives and return migration, for plausible values of returns to schooling and return rates, produces sizeable positive effects on average home-country education (and wages) in steady state. In the considered range of migration probability (0 to 0.3) the incentive-plus-return effect more than offsets the drain from selective migration. Figure 3 shows the behavior of average human capital for the young generation, the old generation and their aggregate as p varies between 0 and 1. We see that the effect of p on the human capital of the first generation is hump shaped, becoming negative for values of p higher than 0.9 (because higher levels of schooling are coupled with emigration of some of the most highly educated). The net human capital (average schooling) of the second generation is always smaller than that of the first generation. This is because returnees, negatively selected among migrants, are less skilled on average than the population that stays at home. In the plausible range, however, for a value of p between 0 and 0.3, both generations, young and old, experience increasing levels of average schooling as p increases (as shown in Table 3).

Rows seven to ten of Table 3 report the wages of different groups of workers with low, intermediate and high education under different migration regimes. The intermediate group is split between young individuals, inclusive only of those who did not migrate, and old individuals, inclusive of stayers plus the returnees. Recall that the returnees have the extra wage premium due to their experience abroad, hence they earn more than those with intermediate education who did not migrate. Looking at each group we see that the average wage (and schooling) of the group with lowest ability does not change much as p increases– in fact it declines a bit. Migration incentives do not generate any change in education per unit of ability for this group and selection produces lower average schooling (because the threshold ν_S decreases as p rises). The average wage of the intermediate group when young also does not change much with p. This, however, is the result of two opposing effects. Higher p increases the schooling of each ability type, but it also produces a selection of individuals with progressively lower abilities in the range of potential migrants (ν_S and ν_{MM} decrease). The average wage of the intermediate group when old is larger and increases with p because of the return premium κ. Finally, the group with highest education experiences the largest increase in wages (and schooling) as p increases because workers choose more schooling per unit of ability. Both the increase in average schooling (and wages) of the group with ability above ν_{MM} and the increase in the size of this group relative to the others produce the positive effect on average schooling and wages as p increases.

4.2.1 The Role of Incentives and Return Migration

The positive effect of an increasing migration probability on average human capital and wages illustrated in Table 3 (and Figure 3) results from the fact that the education incentives plus the wage premium for returnees *reverse* the loss of human capital due to skilled migration. Here we are interested in understanding: i) how large the decrease in average human capital would be if the two positive channels were not operating, and ii) what the effect would be if no return migration was allowed.

Table 4: Scenario with no return migration.

Panel A: Schooling and Wages

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$\bar{h}_1 = \bar{h}_2 = \bar{h}$	8	8.32	8.63	8.93	9.22	9.49	9.75
Wages							
$\bar{w}_1 = \bar{w}_2 = \bar{w}$	1	1.01	1.03	1.04	1.05	1.07	1.08
w_L	0.75	0.75	0.75	0.75	0.75	0.75	0.75
$w_{M1} = w_{M2} = w_H$	1.05	1.07	1.09	1.11	1.13	1.15	1.18
Share of emigrants	0	0.041	0.082	0.124	0.166	0.208	0.251
Share of returnees among emigrants	0	0	0	0	0	0	0

Panel B: Differences with the Baseline Case

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Differences in Years of Schooling							
$\bar{h}_1$, young	0	0.02	0.03	0.04	0.05	0.04	0.05
$\bar{h}_2$, old	0	0.06	0.12	0.18	0.25	0.31	0.38
$\bar{h}$, overall	0	0.04	0.08	0.11	0.15	0.18	0.22
Differences in Wages							
$\bar{w}_1$, young	0	0	0.01	0	0	0	0
$\bar{w}_2$, old	0	0	0	-0.01	-0.02	-0.02	-0.02
$\bar{w}$, overall	0	0	0	0	0	-0.01	-0.01
$\bar{w}_L$, less educated	0	0	0	0	0	0	0
$\bar{w}_{M1}$, medium educated. young	0.19	0.21	0.23	0.26	0.28	0.30	0.33
$\bar{w}_{M2}$, medium educated. old	0.19	0.18	0.18	0.17	0.17	0.16	0.16
$\bar{w}_H$, highly educated	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.07
Share of emigrants	0	0	0	0	0	0	0
Share of returnees among emigrants	0	-0.272	-0.255	-0.239	-0.225	-0.212	-0.201

To answer these questions we examine two alternative scenarios. Table 4 and Figure 4 show the simulated values of schooling and wages as the probability of migrating increases when we eliminate the return channel (by setting $\kappa = 0$ so that there is no return premium and therefore no return). Since we only allow for permanent migration the education incentive effect is stronger. However, this is also a less plausible scenario as statistics show that between 20 and 30% of emigrants return. Next, Table 5 and Figure 5 show the schooling and wage levels in the case of no incentive effects of permanent or temporary migration (as we impose a fixed correspondence between ability and the schooling level, which is unaffected by the probability of migration) and no return migration. Panels B of Tables 4 and 5 report the difference of each variable from the baseline case with migration and return.

Table 5: Scenario with no return migration and no incentive effects

Panel A: Schooling and Wages

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$h_1 = h_2 = h$	8	7.93	7.87	7.79	7.71	7.62	7.52
Wages							
$w_1 = w_2 = w$	1	0.99	0.99	0.99	0.98	0.98	0.98
w_L	0.75	0.75	0.75	0.75	0.75	0.75	0.75
$w_{M1} = w_{M2} = w_H$	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Share of emigrants	0	0.037	0.076	0.115	0.156	0.197	0.239
Share of returnees among emigrants		0	0	0	0	0	0

Panel B: Differences with the Baseline

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$\overline{h}_1$, young	0	-0.36	-0.71	-1.07	-1.42	-1.78	-2.12
$\overline{h}_2$, old	0	-0.32	-0.62	-0.93	-1.23	-1.52	-1.8
$\overline{h}$, overall	0	-0.34	-0.66	-1	-1.32	-1.64	-1.96
Wages							
$\overline{w}_1$, young	0	-0.02	-0.03	-0.05	-0.07	-0.09	-0.1
$\overline{w}_2$, old	0	-0.02	-0.03	-0.05	-0.07	-0.08	-0.09
$\overline{w}$, overall	0	-0.02	-0.03	-0.05	-0.07	-0.08	-0.1
$\overline{w}_L$, less educated	0	0	0	0	0	0	0
$\overline{w}_{M1}$, medium educated. young	0.19	0.19	0.2	0.2	0.2	0.2	0.21
$\overline{w}_{M2}$, medium educated. old	0.19	0.18	0.18	0.17	0.17	0.16	0.16
$\overline{w}_H$, highly educated	-0.08	-0.1	-0.12	-0.14	-0.16	-0.18	-0.2
Share of emigrants	0	0	0	0	0	0	0
Share of returnees among emigrants	0	-0.271	-0.252	-0.235	-0.219	-0.205	-0.193

From the comparison of these two cases with the baseline, two facts become apparent. First, the presence of temporary migration modifies only slightly

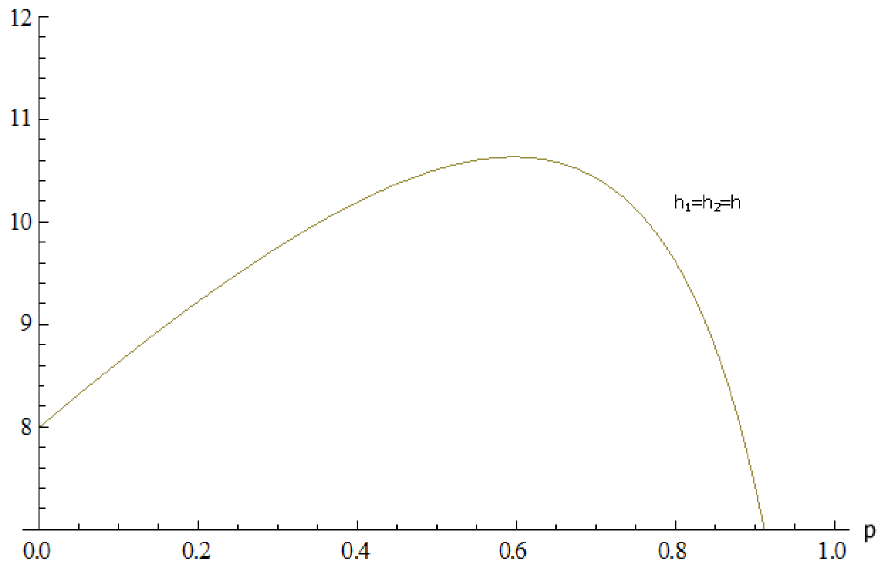

Figure 4: Average schooling of the young, old and overall as a function of emigration probability: the case of no return migration.

the effects of permanent migration. In particular, since return migration is especially beneficial at intermediate ability levels and induces workers to pursue more schooling than stayers but less than permanent migrants, the possibility of returning attenuates slightly the positive incentive effects of migration. However, the case with return migration looks quite similar to the case with only permanent migration (Table 4 and Figure 4): for plausible values of p (around 0.2) the possibility of return reduces the positive effect on human capital by only about a fifth of one year of schooling, and wages are even closer to the baseline (1% difference). This is because the premium to skills accumulated abroad partly makes up for lower schooling. In contrast, the case with no incentives and only permanent migration (Table 5 and Figure 5) looks very different. In that case, selective migration (as returns to schooling are still higher abroad) only produces a drain of highly educated individuals, and for plausible values of migration probability ($p = 0.2$) the pure brain drain effect reduces average schooling by 1.3 years and average wages by 7% relative to no migration. The percentage of emigrants under each scenario is the same. What changes significantly is the education of those who do not migrate (incentive effect) and the percentage of those returning (return is ruled out both in Table 4 and 5).

The interesting quantitative insight of the exercise is that the incentive

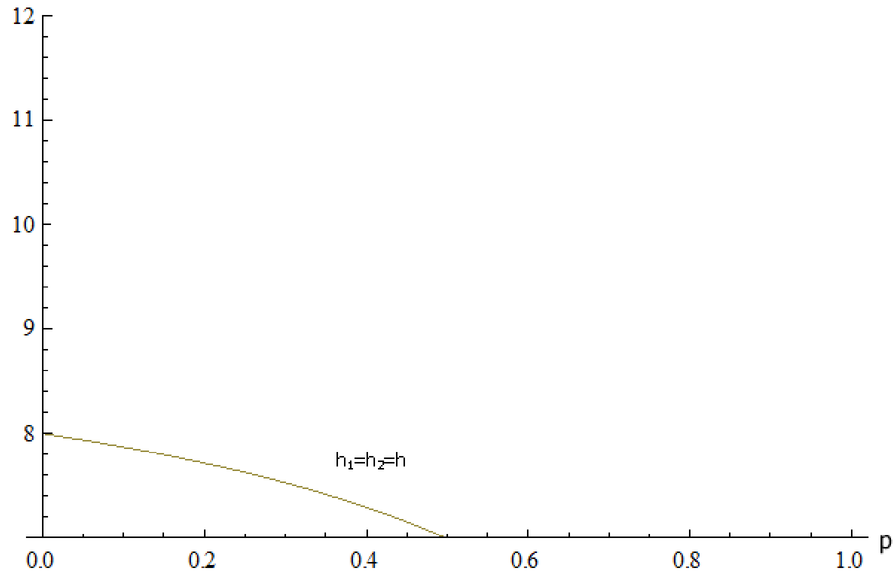

Figure 5: Average schooling of the young, old and overall as a function of emigration probability: the case of no return migration and no incentive effects.

effects of both temporary and permanent migration are strong enough to produce positive human capital and wage effects in the Home country for the parameter combination used in the baseline case and for reasonable values of p. This is a further quantitative confirmation that the return and incentive effects are relevant. Inspection of Figures 3 and 4 also reveals that there is a level of p above which the "brain drain" effect becomes stronger than the incentive plus return effect such that the average schooling and average wage of the remaining workers decreases with p. For our chosen parameter configuration, however, this happens at very high levels of p (above 0.6), which would imply migration rates above 50%, far higher than those that currently exist. This finding confirms the qualitative relation between mobility and human capital gains in the long run, as estimated by Beine et al. (2008). Their estimates, however, imply net gains only up to emigration rates of 20-25%. Our model delivers a stronger brain gain effect than what they estimate because our model, parameterized for Eastern Europe, delivers a stronger response of education to immigration incentives than what Beine et al. (2008) find in their cross-country analysis. As long as this exercise is illustrative of the potential effects of relaxing immigration policies in Western Europe, we can say that Eastern Europe would even benefit, in net terms, from a *doubling* of the flow of migrants to the West (even if those who migrate are among the best educated and even if migrants move only temporarily).

4.2.2 Sensitivity to Migration Costs

The costs of living abroad in the first and second period of life are parameters that are hard to pin down. Hence Table A1 in the Appendix presents simulations where, compared to the baseline, the migration costs in the first period (M_1) are reduced by 20% and Table A2 in the Appendix shows the effect of increasing the costs of staying abroad in the second period (M_2) by around 20%. The impacts are relatively small and their direction is as expected. In Table A1, lower costs of working abroad in the first period of life (i.e., lower geographic moving costs, or reduced loss of skills when migrating) induce more people to emigrate, reduce the schooling threshold for migration, and create stronger incentives to get educated. The average effect, relative to the baseline case, is to increase schooling and wages for each generation (again the extra incentive effect is larger than the extra drain effect). In Table A2, the higher cost of staying abroad in the second period induces higher return rates and smaller emigration rates (relative to the baseline). The resulting increase in temporary migrants, whose average schooling is lower than that of potential permanent migrants, produces a smaller positive schooling effect (relative to the baseline case) and a smaller positive wage effect for both young and old.

4.2.3 Sensitivity to Returns to Schooling

The values of $\eta_H = 0.04$ and $\eta_F = 0.08$ were chosen from estimates reported in Hendricks (2004) and reflect Eastern and Western European countries around 1985. That same database has some estimates available (for Hungary, Poland, Slovenia and most Western European countries) for the years around 1995. While the returns to schooling in Western Europe did not change much from 1980 to 1995 for Eastern Europe, possibly because of the transition to a market economy, the return to schooling rose to around 0.06 in the mid-nineties. Hence in Table A3 we simulate the long-run effects assuming returns to schooling in Eastern Europe equal to 0.06, and in Table A4 we simulate the effects on schooling, wages and return migration under the assumption that the return to schooling increased from 0.04 to 0.06 (and the agents knew this). Hence, the generation that was young in the early nineties may have migrated from Eastern Europe when $\eta_H = 0.04$ but considered whether to return in the 2000's when $\eta_H = 0.06$. This introduces a further incentive to return. There are three differences between Table A3 and the baseline scenario. First, as returns to schooling are higher than in the baseline case, Eastern Europe has a higher level of education even with no mobility (the average schooling is 12 years). Second, loosening immigration policies has a much smaller effect on human capital formation, and now for $p > 0.25$ the drain effect prevails on the gain and there is a decrease in average schooling. Finally, under this parameter configuration there is less emigration and more return. Still, even in this case, mobility plus return is beneficial to average schooling in Eastern Europe for low values of p. The case in which there is an increasing return to education, reported in Table A4, on the other hand, shows a different pattern. Emigration plus return is still beneficial, and now for the whole range of p between 0 and 0.3 average schooling and wages are increasing in p. While the emigration rates are very close to the baseline scenario, in this case there is larger return migration. Now between 50 and 60% of emigrants return in order to take advantage of the increased schooling premium in the Eastern European countries during the second period. The larger return migration may be a plausible value for East-West European migration. The interesting fact is that in this case, too, increased international mobility is beneficial to Eastern Europe.

4.3 Extensions

As we have emphasized in section 4.2 above, the presence of a significant share of return migrants does not alter substantially, but attenuates a bit, the incentive effects of migration on education. There is one case, however, in which the possibility of return migration strengthens the positive human capital effects of migration, and this is when the return premium increases with the schooling of migrants. In this case the returnees are the most highly educated among migrants. A second interesting extension is to allow for the immigration policy in the receiving country to distinguish between the high- and low-skilled and to accept less skilled migrants only temporarily and with lower probability. The implications of these two extensions are analyzed next.

4.3.1 Skill-Dependent Return Premium

A very important parameter in determining the incentives for return migration is $\boldsymbol{\kappa}$, the wage premium upon return to the Home country. In the basic model (equation 5) this premium is independent of the schooling of the migrant, while the premium to stay abroad increases with the schooling level of the migrant (since it depends on $(\eta_F - \eta_H)h_i$). Hence, among migrants, only those with little schooling would rather receive this premium than stay abroad. The empirical literature, however, is unclear about the specific form of the return premium. Some studies (mentioned in section 2) suggest that such a premium could be larger in percentage terms for more skilled (educated) workers. Moreover, if we think of policy measures to encourage the return of educated migrants, a tax relief that makes taxes less progressive for returnees would look like a premium which increases proportionately with the level of education. In this extension, we analyze the effect of assuming a return premium proportional to schooling. That is, the wage of a returnee would be $\ln(w^2_{FHi}) = \ln(A_H) + \eta_H h_i + \kappa h_i$ with $\eta_H + \kappa > \eta_F$ so that there is a positive percentage of returnees. In this case, returnees are positively selected among emigrants (who continue to be positively selected among the total source country population) and, as a consequence, they have the highest human capital and contribute positively to average schooling and wages of the country of origin upon return[18].

Table 6: Scenario with return premium increasing with schooling.

p	**0**	**0.05**	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**
			Schooling				
$\bar{h}_1$, young	8	8.34	8.68	9.03	9.37	9.78	10.03
$\bar{h}_2$, old	8	8.39	8.84	9.32	9.84	10.39	10.97
$\bar{h}$, overall	8	8.37	8.76	9.18	9.61	10.06	10.53
			Wages				
$\bar{w}_1$, young	1	1.01	1.03	1.05	1.06	1.08	1.10
$\bar{w}_2$, old	1	1.03	1.08	1.14	1.22	1.33	1.45
$\bar{w}$, overall	1	1.02	1.05	1.09	1.15	1.21	1.29
$\bar{w}_L$, less educated	0.75	0.75	0.75	0.75	0.74	0.74	0.74
$\bar{w}_M$, medium educated	1.01	1.01	1.01	1.01	1.01	1.01	1.01
$\bar{w}_{H1}$, highly educated. young	1.31	1.33	1.36	1.38	1.41	1.44	1.47
$\bar{w}_{H2}$, highly educated. old	1.31	1.43	1.56	1.71	1.87	2.05	2.26
			Migration Rates				
Share of emigrants	0	0.041	0.083	0.126	0.169	0.213	0.258
Share of returnees among emigrants		0.177	0.228	0.274	0.314	0.351	0.383

In Table 6 we show the average, overall human capital and wages, and then also separately for the three groups of workers, as the probability of migrating

[18]In Appendix C, we show the details of the model modified to incorporate a return premium that is increasing in schooling.

p varies between 0 and 0.3. We choose $\kappa = 2.4$ to match a return-migration rate of around 20 to 30%. As in the baseline, workers with less than 3 years of schooling ($h_s = 2.88$) do not pursue migration. Now, however, those with schooling between 2.88 years and 14.44 years pursue permanent migration while those with more than 14.44 years will pursue migration and, if they are able to leave the country when young, they will return to the home country when old (values are reported in the footnote to Table 6). The threshold h_{RM} now denotes the schooling level *above which* migrants choose to return after one period of working life spent abroad. This schooling threshold corresponds to the ability threshold ν_{RM} as defined in Appendix C. If a country rewards the human capital accumulated abroad with a return premium that is increasing in schooling (κh_i), it may generate an important positive effect on migrants' schooling, wages and decision to return.

Simulations in Table 6 show that such a premium produces, even for $p = 0.15$, an average schooling of 9.2 years (plus 0.4 years relative to the baseline) and an average wage of 1.09 (plus 5% relative to the baseline case). Overall, the average schooling of the population in the sending country increases by 2.5 years going from no international mobility to significant freedom to move, $p = 0.3$, while the average wage increases by almost 30%. The additional positive effect generated in this scenario is mainly due to a positive net effect on the schooling of the highest skilled, who now return. However, there is also an increased effect on average human capital and schooling of the young, as the education incentive effect is greater now than before (compare (15) and (45)). The share of returnees among emigrants is now increasing in p (instead of decreasing, as in the baseline): with an increase in the likelihood of migration, the threshold for return migration ν_{RM} decreases and it becomes profitable for a larger share of the population to get the highest level of education and, conditional on succeeding in the application process, migrate and return.

Notice, importantly, that the increase in average wages is mainly driven by the very large expansion of the group of highly educated who come back and receive a high wage premium. The average wage of this group is now different for the young and for the old (reported in the rows of Table 6 headed by w_{H1} and w_{H2}), as the latter include the emigrants who return. In contrast, the average wage for the medium-skilled is the same when young and old because when they emigrate they now remain abroad.

4.3.2 Skill-dependent Migration Policies

It is plausible to assume that migrants with different schooling face different probabilities of migration. Several rich countries (notably Canada, Australia and New Zealand) have a point-based immigration system that makes it easier for people with more schooling to immigrate. Several Western European countries are also moving in that direction (Germany, for instance, approved a "blue card" system to speed up admission of highly educated immigrants). Therefore, it makes sense to include in the model a probability term such that those workers with low schooling levels (and ability $\nu_i < \nu_{MM}$) have a lower probability p_1 of succeeding in their application process and those with higher levels of schooling (and ability $\nu_i \geqslant \nu_{MM}$) have a higher probability p_2 ($p_2 > p_1$). We still maintain the form of random rationing (via probability), as even for the highly educated there are hurdles and uncertainty during the process. This modifies the optimal schooling functions for people of high skill levels who migrate permanently, h_i^{MM*}, and for people of intermediate skill levels who migrate and return, h_i^{MR*}. The effect of such a change can be understood by looking at Figure 1. In particular, the schedule h_i^{MM*} becomes a steeper function of ν (for higher p) so that the threshold ν_{MM} decreases and more people (with lower abilities) choose higher education, migration, and to stay abroad, while the schedule h_i^{MR*} becomes a less steep function of ν (because of a lower value of p) so that the threshold ν_S increases and fewer people (with higher abilities) choose temporary migration. Intuitively, the option of migrating and staying abroad now becomes appealing for a greater range of abilities because it carries a higher probability of occurring. Conversely, fewer people will opt to migrate and return as they would rather stay at home (if their ability is low) or migrate and stay abroad (if their ability is high). Notice that the assumption of the model is that individuals self-sort into one of the two application forms (for temporary or permanent migration) and that the sorting is done optimally, in the sense that each person chooses the application strategy that maximizes expected utility for a given probability of succeeding[19].

Table 7 shows average schooling and wages for the population in the sending country in the case of different migration probabilities. In particular, we illustrate two types of immigration policies, both tilted towards the admission of skilled workers but to a different degree. The first, illustrated in columns 2 and 3, shows only a mild preference for the highly skilled. The difference between p_2 and p_1 is equal to 0.10 and we increase p_1 from 0.1 to 0.25. This policy is probably similar to the one that currently exists in the US and in most of Western Europe, which provides some special visa categories for the highly

[19] If we were to allow an individual to participate in both probabilities at the same time and choose the preferred outcome, then we should modify the analysis slightly. The qualitative implications, however, would be the same.

educated (such as the H1B) but with a general admission policy that is not heavily tilted in favor of education requirements. In contrast, the cases illustrated in columns 4 to 6 reflect an immigration policy that is very much biased in favor of highly educated immigrants (as in Canada or Australia). In this case the preference for the highly educated is very strong and, keeping a very low probability of admission of the less educated (at 0.10), we consider increases in the probability of admission of the highly skilled from p_2 =0.5 to p_2 =0.9.

Table 7: Different probabilities for low and high-skilled migration

		Mildly skill-biased immigration policies		Strongly skill-biased immigration policies		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
p_1 (Low Skills)	**0**	**0.10**	**0.25**	**0.10**	**0.10**	**0.10**
p_2 (High Skills)	**0**	**0.20**	**0.35**	**0.50**	**0.80**	**0.90**
Schooling						
$\bar{h}_1$, young	8	9.01	9.76	9.75	8.27	6.22
$\bar{h}_2$, old	8	7.90	7.49	6.24	3.19	1.85
$\bar{h}$, overall	8	8.45	8.59	7.98	5.71	4.02
Wages						
$\bar{w}_1$, young	1	1.05	1.09	1.10	1.06	0.97
$\bar{w}_2$, old	1	1.08	1.16	1.12	1.08	0.99
$\bar{w}$, overall	1	1.06	1.13	1.11	1.07	0.98
$\bar{w}_L$, less educated	0.75	0.75	0.75	0.75	0.75	0.75
$\bar{w}_{M1}$, medium educated. young	0.86	0.85	0.84	0.83	0.81	0.81
$\bar{w}_{M2}$, medium educated. old	0.86	0.90	0.98	0.88	0.87	0.86
$\bar{w}_H$, highly educated	1.13	1.21	1.27	1.34	1.50	1.55
Migration Rates						
Share of emigrants	0	0.14	0.27	0.37	0.61	0.70
Share of returnees among emigrants		0.12	0.13	0.02	0.01	0

This could be an example of a point system that strongly rewards education so that each applicant will have a much higher probability of admission if she is in the highly educated category. In both scenarios the share of returning migrants decreases substantially (relative to the baseline case), while the share of permanent migrants in the total population increases. However, the reduction in return rates under the Canadian-style policies is particularly dramatic and highly tilted towards the highly skilled (columns 4-6). This is because most migrants are in the group of highest education for which return is not optimal. In the two most extreme cases - columns 5 and 6 in which the highly educated are admitted with a probability of 0.8 and 0.9 (while the less educated only have a probability of 0.1), we observe the least beneficial effects for Eastern Europe. First, the human capital of both the first and the second generation is reduced since most of the high-ability individuals apply to emigrate and end up abroad. Second, the overall, average wage decreases as a consequence of the highly educated leaving the country. In the case of very strongly selective immigration policies, the sending countries are left worse off in their human capital and average wages. One thing to notice is that the most skill-biased admission policies would induce a very large share of the population (in Eastern Europe) to get an education and emigrate, implying emigration rates of 0.6 or more, which are probably unrealistically large.

On the other hand, the mildly pro-skill selection policies (columns 2 and 3) preserve the net positive effect on average schooling and wages due to the fact that the incentive and return effects offset the drain. For the chosen values of the policy variables we obtain emigration rates below 30% and a net increase in average schooling of half a year. Hence, even in the presence of skill-biased policies with a mild preference for the highly educated, the country of origin of the migrants can benefit. Making immigration policies in Western Europe drastically biased in favor of highly educated immigrants, however, would certainly produce a net brain drain for an Eastern European sending country.

5 Conclusions

This paper presents a novel model of optimal decision-making regarding the level of schooling along with the migration and return of agents with heterogeneous abilities. We parameterize the model in order to obtain quantitative insight into the effect of freer labor mobility between sending and receiving countries on the selection of migrants, average schooling, and wages in the country of origin. In particular, we apply the model to the elimination of barriers to labor mobility that took place between Eastern and Western Europe between 1990 and 2010. The key qualitative and quantitative insight is that, since Western Europe pays a higher return to skill relative to Eastern Europe, the possibility of migration induces potential temporary and permanent migrants in the East to invest more in human capital. This investment, plus the fact that some migrants return while other potential migrants end up staying in the East, has a positive effect on average schooling that more than offsets the negative effect of the brain drain. Using productivity differentials and differences in the wage premium for schooling taken from data in Eastern and Western Europe, we calculate that a loosening of Western European immigration policies of a magnitude great enough to produce an increase in emigration rates from 0 to 20% in Eastern Europe (comparable to the changes experienced between 1990 and 2000), may add about a year to average schooling in Eastern Europe in the long-run. Moreover, while for very high levels of mobility (a probability of migration greater than 70%) there may be a negative net effect on human capital in Eastern Europe, there still seems to be a large scope for increasing East-West mobility and average human capital in Eastern Europe. Finally, we find that even immigration policies in Western Europe that favor the highly educated (an increase in the probability of accepting their applications) may still increase (through incentives and return) average schooling in Eastern Europe, as long as these policies are not overly biased towards the highly skilled.

A Appendix: Average Human Capital and Wages when $\nu_{MM} < \nu_S$.

In the case of $\nu_{MM} < \nu_S$, there is no temporary migration: those with ability below ν_{MM} do not opt for emigration and stay at Home, while those with ability above migrate if they can, and then stay abroad (Figure 2). Therefore, average human capital for the young generation is given by:

$$\overline{h}_1 = \overline{h}_2 = \frac{\frac{1}{2} h^{S*}(\nu_{MM})\nu_{MM}}{\nu_{MM} + (1-p)(\overline{\nu} - \nu_{MM})} + \frac{\frac{1}{2}\left[h^{MM*}(\bar{\nu}) + h^{MM*}(\nu_{MM})\right](1-p)(\bar{\nu} - \nu_{MM})}{\nu_{MM} + (1-p)(\overline{\nu} - \nu_{MM})} \tag{30}$$

Substituting the expressions for h^{S*} and h^{MM*} from (15) into (30) we obtain:

$$\overline{h}_1 = \overline{h}_2 = \frac{1}{4\theta} \left[\frac{2+\delta}{1+\delta}\eta_H \frac{\nu_{MM}^2}{\nu_{MM} + (1-p)(\overline{\nu} - \nu_{MM})} + \left[\frac{2+\delta}{1+\delta}\eta_H + \frac{2+\delta}{1+\delta} p(\eta_F - \eta_H)\right] \frac{(1-p)(\bar{\nu}^2 - \nu_{MM}^2)}{\nu_{MM} + (1-p)(\overline{\nu} - \nu_{MM})}\right] \tag{31}$$

B Appendix: Explicit Solutions

If we substitute the expressions for h^{S*}, h^{MR*} and h^{MM*} from (15) into (20) and (21), we obtain the following expressions, linking the average human capital of the young to the parameters and to the threshold values ν_S and ν_{MM} :

$$\begin{aligned}\overline{h}_1 &= \frac{1}{4\theta}\frac{2+\delta}{1+\delta}\eta_H \frac{\nu_S^2}{\nu_S+(1-p)(\overline{\nu}-\nu_S)} \\ &+\frac{1}{4\theta}\left[\frac{2+\delta}{1+\delta}\eta_H + p(\eta_F-\eta_H)\right]\frac{(1-p)(\nu_{MM}^2-\nu_S^2)}{\nu_S+(1-p)(\overline{\nu}-\nu_S)} \\ &+\frac{1}{4\theta}\left[\frac{2+\delta}{1+\delta}\eta_H + \frac{2+\delta}{1+\delta}p(\eta_F-\eta_H)\right]\frac{(1-p)(\bar{\nu}^2-\nu_{MM}^2)}{\nu_S+(1-p)(\overline{\nu}-\nu_S)}\end{aligned} \tag{32}$$

And the average human capital of the old generation would be:

$$\begin{aligned}\overline{h}_2 &= \frac{1}{4\theta}\frac{2+\delta}{1+\delta}\eta_H \frac{\nu_S^2}{\nu_S+(\nu_{MM}-\nu_S)+(1-p)(\bar{\nu}-\nu_{MM})} \\ &+\frac{1}{4\theta}\left[\frac{2+\delta}{1+\delta}\eta_H + p(\eta_F-\eta_H)\right]\frac{(\nu_{MM}^2-\nu_S^2)}{\nu_S+(\nu_{MM}-\nu_S)+(1-p)(\bar{\nu}-\nu_{MM})} \\ &+\frac{1}{4\theta}\left[\frac{2+\delta}{1+\delta}\eta_H + \frac{2+\delta}{1+\delta}p(\eta_F-\eta_H)\right]\frac{(1-p)(\bar{\nu}^2-\nu_{MM}^2)}{\nu_S+(\nu_{MM}-\nu_S)+(1-p)(\bar{\nu}-\nu_{MM})}\end{aligned} \tag{33}$$

As for the average wages of each group, we can calculate them for the low-, middle- and high-skilled in (26)-(29), obtaining the following expressions:

$$\overline{w}_L = \frac{1}{\nu_S}A_H\frac{1}{\eta_H\frac{\eta_H}{2\theta}\frac{2+\delta}{1+\delta}}\left[e^{\eta_H\frac{\eta_H}{2\theta}\frac{2+\delta}{1+\delta}\nu_S}-1\right] \tag{34}$$

$$\begin{aligned}\overline{w}_{M1} &= \frac{1}{(\nu_{MM}-\nu_S)}A_H\frac{1}{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)} \\ &\left[e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)\nu_{MM}}-e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)\nu_S}\right]\end{aligned} \tag{35}$$

$$\begin{aligned}\overline{w}_{M2} &= \frac{(1-p)}{(\nu_{MM}-\nu_S)}A_H\frac{1}{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)} \\ &\left[e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)\nu_{MM}}-e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)\nu_S}\right] \\ &+ \frac{p}{(\nu_{MM}-\nu_S)}A_H\frac{1}{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)} \\ &\left[e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)\nu_{MM}+\kappa}-e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+p(\eta_F-\eta_H)\right)\nu_S+\kappa}\right]\end{aligned} \tag{36}$$

$$\overline{w}_H = \frac{1}{(\bar{\nu}-\nu_{MM})}A_H\frac{1}{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+\frac{2+\delta}{1+\delta}p(\eta_F-\eta_H)\right)} \left[e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+\frac{2+\delta}{1+\delta}p(\eta_F-\eta_H)\right)\bar{\nu}}-e^{\eta_H\frac{1}{2\theta}\left(\frac{2+\delta}{1+\delta}\eta_H+\frac{2+\delta}{1+\delta}p(\eta_F-\eta_H)\right)\nu_{MM}}\right] \quad (37)$$

C Appendix: The Case of Return Premium Increasing in Schooling

The model behind the simulations in section 4.3.1 is described in this Appendix. The wage specification after return has a premium that increases with schooling:

$$\ln(w_{FHi}^2)=\ln(A_H)+\eta_H h_i+\kappa h_i \quad (38)$$

Then, we get the return migration decision

$$q^*(h_i)=\begin{cases}1 & \text{if} \quad h_i>\frac{\ln(A_F)-\ln(A_H)-M_2}{\eta_H+\kappa-\eta_F}\\ 0 & \text{if} \quad h_i<\frac{\ln(A_F)-\ln(A_H)-M_2}{\eta_H+\kappa-\eta_F}\end{cases} \quad (39)$$

i.e., positive selection of return migrants. Note that now we need $\ln(A_F)-\ln(A_H)+\kappa-M_2>0$ for permanent migration to exist (such that some people stay abroad). Whereas in the baseline case above, we need $\ln(A_H)-\ln(A_F)+M_2>0$ for temporary migration to exist (such that some return).

The decision to participate in the lottery:

$$l_i^*=\begin{cases}1 & \text{if} \quad h_i>\frac{M_1(1+\delta)+M_2(1-q_i^*)-(\ln(A_F)-\ln(A_H))(2+\delta-q_i^*)}{(\eta_F-\eta_H)(2+\delta)+(\eta_H+\kappa-\eta_F)q_i^*}\\ 0 & \text{if} \quad h_i<\frac{M_1(1+\delta)+M_2(1-q_i^*)-(\ln(A_F)-\ln(A_H))(2+\delta-q_i^*)}{(\eta_F-\eta_H)(2+\delta)+(\eta_H+\kappa-\eta_F)q_i^*}\end{cases} \quad (40)$$

The schooling thresholds for workers to choose to stay at Home (hence $l_i^*=0$, $q_i^*=0$) in both periods.:

$$h_i<\frac{M_1(1+\delta)+M_2(1-q_i)-(\ln(A_F)-\ln(A_H))(2+\delta-q_i)}{(\eta_F-\eta_H)(2+\delta)+(\eta_H+\kappa-\eta_F)q_i}\equiv h_S \quad (41)$$

For human capital between the values:

$$\frac{M_1(1+\delta)+M_2(1-q_i)-(\ln(A_F)-\ln(A_H))(2+\delta-q_i)}{(\eta_F-\eta_H)(2+\delta)+(\eta_H+\kappa-\eta_F)q_i} < h_i < \frac{\ln(A_F)-\ln(A_H)-M_2}{\eta_H+\kappa-\eta_F} \tag{42}$$

workers choose to enter the migration lottery and, conditional on emigrating, they stay in the destination country ($l_i^*=1$, $q_i^*=0$). For values of human capital:

$$h_i > \frac{\ln(A_F)-\ln(A_H)-M_2}{\eta_H+\kappa-\eta_F} \equiv h_{RM} \tag{43}$$

they choose to apply for emigration and, conditional on emigrating, they return ($l_i^*=1$, $q_i^*=1$). The schooling decision, then, is:

$$h_i^* = \left[\frac{2+\delta}{1+\delta}\left(\eta_H + l_i^* p(\eta_F-\eta_H)\right) + \frac{1}{1+\delta} l_i p q_i^*(\eta_H+\kappa-\eta_F)\right]\frac{\nu_i}{2\theta} \tag{44}$$

with the three schooling functions given by:

$$\begin{aligned} h_i^{S*} &= \frac{1}{2\theta}\frac{2+\delta}{1+\delta}\eta_H\nu_i \quad \text{for} \quad l_i^*=0 \\ h_i^{MM*} &= \frac{1}{2\theta}\frac{2+\delta}{1+\delta}(\eta_H+p(\eta_F-\eta_H))\nu_i \quad \text{for} \quad l_i^*=1, q_i^*=0 \\ h_i^{MR*} &= \frac{1}{2\theta}\left[\frac{2+\delta}{1+\delta}\left(\eta_H+p(\eta_F-\eta_H)\right)+\frac{1}{1+\delta}p(\eta_H+\kappa-\eta_F)\right]\nu_i \quad \text{for} \quad l_i^*=1, q_i^*=1 \end{aligned} \tag{45}$$

and ability thresholds, via substitution of the schooling thresholds (41) and (43) into the schooling functions (45), given by:

$$\nu_S \equiv \frac{2\theta}{\frac{2+\delta}{1+\delta}(\eta_H+p(\eta_F-\eta_H))}\frac{M_1(1+\delta)+M_2-(\ln(A_F)-\ln(A_H))(2+\delta)}{(\eta_F-\eta_H)(2+\delta)} \tag{46}$$

$$\nu_{RM} \equiv \frac{2\theta}{\frac{2+\delta}{1+\delta}(\eta_H+p(\eta_F-\eta_H))+\frac{1}{1+\delta}(\eta_H+\kappa-\eta_F)}\frac{\ln(A_F)-\ln(A_H)-M_2}{\eta_H+\kappa-\eta_F} \tag{47}$$

Table A1: Lower cost of migration in the first period

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$\bar{h}_1$, young	8	8.35	8.70	9.06	9.41	9.76	10.11
$\bar{h}_2$, old	8	8.26	8.52	8.77	9.00	9.21	9.41
$\bar{h}$, overall	8	8.31	8.61	8.91	9.20	9.48	9.74
Wages							
$\bar{w}_1$, young	1	1.01	1.03	1.05	1.06	1.08	1.10
$\bar{w}_2$, old	1	1.02	1.04	1.06	1.08	1.10	1.12
$\bar{w}$, overall	1	1.01	1.03	1.05	1.07	1.09	1.11
$\bar{w}_L$, less educated	0.72	0.72	0.72	0.72	0.72	0.72	0.72
$\bar{w}_{M1}$, medium educated. young	0.83	0.82	0.82	0.82	0.82	0.82	0.82
$\bar{w}_{M2}$, medium educated. old	0.83	0.85	0.88	0.90	0.93	0.95	0.98
$\bar{w}_H$, highly educated	1.13	1.15	1.17	1.19	1.21	1.23	1.25
Share of emigrants	0	0.047	0.095	0.143	0.190	0.239	0.287
Share of returnees among emigrants		0.369	0.351	0.334	0.319	0.305	0.292

Table A2: Higher cost of staying abroad in the second period

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$\bar{h}_1$, young	8	8.26	8.52	8.77	9.02	9.26	9.47
$\bar{h}_2$, old	8	8.23	8.45	8.66	8.85	9.03	9.18
$\bar{h}$, overall	8	8.24	8.48	8.72	8.93	9.14	9.32
Wages							
$\bar{w}_1$, young	1	1.01	1.02	1.03	1.05	1.06	1.07
$\bar{w}_2$, old	1	1.02	1.04	1.05	1.07	1.09	1.11
$\bar{w}$, overall	1	1.01	1.03	1.04	1.06	1.08	1.09
$\bar{w}_L$, less educated	0.77	0.76	0.76	0.76	0.76	0.76	0.76
$\bar{w}_{M1}$, medium educated. young	0.92	0.92	0.91	0.91	0.91	0.91	0.90
$\bar{w}_{M2}$, medium educated. old	0.92	0.95	0.97	1.00	1.03	1.05	1.08
$\bar{w}_H$, highly educated	1.18	1.20	1.22	1.24	1.26	1.28	1.30
Share of emigrants	0	0.038	0.077	0.117	0.157	0.198	0.239
Share of returnees among emigrants		0.398	0.372	0.348	0.327	0.308	0.291

Table A3: Higher returns to schooling at home

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$\overline{h}_1$, young	12	12.05	12.09	12.12	12.14	12.14	12.12
$\overline{h}_2$, old	12	12.01	12.01	11.99	11.96	11.91	11.85
$\overline{h}$, overall	12	12.03	12.05	12.06	12.05	12.02	11.97
Wages							
By Generation Group							
$\overline{w}_1$, young	1	1	1.01	1.02	1.03	1.03	1.04
$\overline{w}_2$, old	1	1.01	1.02	1.03	1.04	1.05	1.06
$\overline{w}$, overall	1	1.01	1.02	1.02	1.03	1.04	1.05
By Skill Group							
$\overline{w}_L$, less educated	0.64	0.64	0.64	0.64	0.64	0.64	0.64
$\overline{w}_{M1}$, medium educated, young	0.77	0.77	0.77	0.77	0.76	0.76	0.76
$\overline{w}_{M2}$, medium educated, old	0.77	0.80	0.82	0.84	0.86	0.89	0.91
$\overline{w}_H$, highly educated	1.35	1.37	1.39	1.40	1.42	1.44	1.46
Emigration Rates and Return Migration Rates							
Share of emigrants	0	0.038	0.076	0.114	0.153	0.192	0.231
Share of returnees among emigrants		0.410	0.400	0.391	0.382	0.373	0.365

Table A4: Increasing returns to schooling at home between period 1 and 2

p	0	0.05	0.10	0.15	0.20	0.25	0.30
Years of Schooling							
$\overline{h}_1$, young	9.6	9.79	9.99	10.17	10.35	10.52	10.67
$\overline{h}_2$, old	9.6	9.76	9.91	10.04	10.16	10.25	10.32
$\overline{h}$, overall	9.6	9.78	9.95	10.10	10.25	10.38	10.49
Wages							
By Generation Group							
$\overline{w}_1$, young	0.89	0.90	0.91	0.91	0.92	0.93	0.94
$\overline{w}_2$, old	1.10	1.13	1.16	1.19	1.22	1.24	1.27
$\overline{w}$, overall	1	1.02	1.04	1.06	1.08	1.10	1.12
By Skill Group							
$\overline{w}_L$, less educated	0.78	0.78	0.78	0.78	0.77	0.77	0.77
$\overline{w}_{M1}$, medium educated, young	0.81	0.81	0.80	0.80	0.80	0.80	0.80
$\overline{w}_{M2}$, medium educated, old	0.97	0.99	1.02	1.05	1.08	1.11	1.13
$\overline{w}_H$, highly educated	1.31	1.34	1.36	1.39	1.41	1.44	1.46
Emigration Rates and Return Migration Rates							
Share of emigrants	0	0.040	0.082	0.123	0.165	0.208	0.250
Share of returnees among emigrants		0.605	0.581	0.559	0.539	0.520	0.502

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