Brücker, Herbert; Defoort, Cécily; Gruen, Carola

Conference Paper

Does migration stimulate human capital investment Theory and evidence

Proceedings of the German Development Economics Conference, Zürich 2008, No. 15

Provided in Cooperation with:
Research Committee on Development Economics (AEL), German Economic Association

Does migration stimulate human capital investment? Theory and evidence

Herbert Brücker* Cecily Defoort Carola Gruen

February 2007

Abstract

This paper investigates whether international migration stimulates additional investment in human capital in host countries. First, a simple theoretical model is developed, showing that if migration were allowed, additional human capital investment is possible. Whether human capital endowment in host countries will rise or fall, is an open problem. This result differs from traditional theories of brain drain which typically assume an exogenous level of human capital investment. The empirical part of the paper employs a newly collated data set. First results show that the share of the population investing in education increases with the share of highly qualified emigrants.

Keywords: International migration, Human capital, Labour market, Panel data econometrics.
JEL code: F22.

*IAB Nürnberg and IZA Bonn. The authors would like to thank participants at the research seminar University of Louvain and the Limburg seminar for valuable comments.

1 Introduction

The classic brain drain literature investigates the relationship between migration and human capital in great detail. As shown by Bhagwati and Hamada (1974), Grubel and Scott (1966) and Kwok and Leland (1982), migration of qualified workers can reduce level and growth rate of per capita income of host countries. Furthermore, public investment in human capital are lost to the home countries. Theories like these assume a constant level of human capital. More recent studies, however, examine whether migration stimulates human capital accumulation (Beine et al. 2001, Stark et al. 1997, Mountford 1997). There are basically two channels through which migration can affect investment in human capital: On the one hand, higher level of human capital will enhance the probability to migrate. On the other hand, the acquired human capital will be more productive in the guest country. Either way, the returns to human capital investment will be higher as without migration. Not all individuals who have invested in higher levels of human capital will in fact migrate. This and the fact that many migrants return to their home countries leave the overall effect of migration on the level of human capital in the home countries ambiguous: it can be positive and negative. Consequently, from a theoretical point of view growth rate and level of production in the host countries can rise or fall (Beine et al. 2001, Stark et al. 1997, Mountford 1997).

This paper will present a simple model of human capital investment when migration is possible. We model the probability to invest in human capital assuming different returns to education in the home and guest countries. The probability to migrate depends on the level of human capital acquired by individuals. Agents have heterogeneous abilities, hence face different cost of education and have heterogeneous preferences regarding the guest country. The model predicts a higher incentive to invest in human capital when migration is possible. The paper will also test this hypothesis empirically. Section 3 will derive an empirical model from the theoretical model developed in section 2. The analysis will be based upon a newly compiled data set which allows us to differentiate migrants from 143 host countries to six OECD countries by their level of qualification. Hence, the data seems tailor made to answer the question whether the possibility to migrate stimulates investment in human capital. Section 4 describes the data set in more detail. Section 5 presents the results and section 6 concludes.

2 Theoretical background

2.1 The model

We consider the (small) economy of a host country with heterogeneous agents living for 2 periods. In the first period, young agents decide whether or not to invest in their human capital. In period 2 the accumulated human capital can be used productively. The agents differ in two respects: their ability to qualify and cost of migration. In the first period, every individual receives a base wage w_0 and a "take-it-or-leave-it" offer to qualify. If the agent takes up the offer, she has to spend proportion λ of her resources on the qualification. Parameter λ with the density function $f(\lambda)$ is uniformly distributed between $[0, 1]$. Thus, in the first period income either equals $(1-\lambda)w_0$ if the individual decided to invest in human capital or simply w_0 if the offer to qualify was declined. Excluding the option to migrate for now, unqualified agents receive wage w in the second period whereas qualified individuals receive $(1+\sigma)w$ with $\sigma > 0$ being the return to qualification in the home country.

At the beginning of their second period, agents can migrate to a high income country where $w^* > w$ and $\sigma^* > 0$. Cost incurred when migrating are monetary cost like communication and transport cost as well as non-monetary cost related to leaving behind one's social network and known environment. We will model these cost as iceberg cost, i.e. the wage obtained abroad will be multiplied by the factor δ. Factor δ has a density function g(δ) and is uniformly distributed between $[0, 1]$. It also reflects varying individual preferences with respect to the guest country.

Not every agent who wants to migrate will be allowed to do so. We assume that the probability to migrate depends on the individual qualification level. In most countries, students and highly qualified agents have a better chance to migrate. Thus, we assume $p > q$ with p representing the probability of a qualified agent to receive an immigration permit and q reflecting the chances of an unqualified agent, respectively. To simplify, we abstract from discounting and write the respective expected utilities as follows:

$$u_{q,m} = (1-\lambda)w_0 + p\delta(1+\sigma^*)w^* + (1-p)(1+\sigma)w, \tag{1}$$

$$u_{q,s} = (1-\lambda)w_0 + (1+\sigma)w, \tag{2}$$

$$u_{u,m} = w_0 + q\delta w^* + (1-q)w, \tag{3}$$

$$u_{u,s} = w_0 + w, \tag{4}$$

If a qualified agent migrates in the second period she will receive the expected utility level $u_{q,m}$, otherwise $u_{q,s}$. If an unqualified agent migrates, the expected utility will equal $u_{u,m}$, otherwise it will be $u_{u,s}$.

Comparing the utility levels, we obtain the following critical values for λ and δ:

$$
\begin{aligned}
u_{q,m} > u_{u,s} \Longleftrightarrow \lambda < \lambda_1(\delta) &\equiv \sigma\frac{w}{w_0} + p\frac{\delta(1+\sigma^*)w^* - (1+\sigma)w}{w_0}, &(5)\\
u_{q,m} > u_{u,m} \Longleftrightarrow \lambda < \lambda_2(\delta) &\equiv \sigma\frac{w}{w_0} + \delta\frac{p(1+\sigma^*)w^* - qw^*}{w_0} \\
&- \frac{p(1+\sigma)w - qw}{w_0}, &(6)\\
u_{q,m} > u_{q,s} \Longleftrightarrow \delta > \delta_1 &\equiv \frac{(1+\sigma)}{(1+\sigma^*)}\frac{w}{w^*}, &(7)\\
u_{q,s} > u_{u,s} \Longleftrightarrow \lambda < \lambda_3 &\equiv \sigma\frac{w}{w_0}, &(8)\\
u_{q,s} > u_{u,m} \Longleftrightarrow \lambda < \lambda_4(\delta) &\equiv \sigma\frac{w}{w_0} - q\frac{\delta w^* - w}{w_0}, &(9)\\
u_{u,m} > u_{u,s} \Longleftrightarrow \delta > \delta_2 &\equiv \frac{w}{w^*}. &(10)
\end{aligned}
$$

2.2 Migration and the investment in human capital

In the following, h $(0 \leq h \leq 1)$ denotes the proportion of agents who will invest in human capital but will not be able to migrate. The share of agents who will invest and will have the option to migrate is h^* $(0 \leq h^* \leq 1)$. Without migration and assuming that qualification cost λ are uniformly distributed between $[0,1]$, the probability that $u_q > u_u$ equals

$$h = \sigma\frac{w}{w_0}.$$

If migration is an option, determining the probability whether an agent will invest in human capital is more complex. Assuming $\sigma < \sigma^*$, the proportion of agents who will invest in human capital is determined by the sum over the following integrals:

$$
\begin{aligned}
h^* &= \int_0^{\delta_1} \sigma \frac{w}{w_0} d\delta \\
&+ \int_{\delta_1}^{\delta_2} \left((\sigma - (1+\sigma)p) \frac{w}{w_0} + \delta (1+\sigma^*) p \frac{w^*}{w_0} \right) d\delta \\
&+ \int_{\delta_2}^{1} \left((\sigma + q - (1+\sigma)p) \frac{w}{w_0} + \delta \left((1+\sigma^*)p - q \right) \frac{w^*}{w_0} \right) d\delta.
\end{aligned}
$$

In the opposite case, i.e. if $\sigma > \sigma^*$, it follows that:

$$
\begin{aligned}
h &= \int_0^{\delta_2} \sigma \frac{w}{w_0} d\delta \\
&+ \int_{\delta_2}^{\delta_1} \left((\sigma + q) \frac{w}{w_0} - \delta q \frac{w^*}{w_0} \right) d\delta \\
&+ \int_{\delta_1}^{1} \left((\sigma + q - (1+\sigma)p) \frac{w}{w_t} + \delta \left((1+\sigma^*)p - q \right) \frac{w^*}{w_0} \right) d\delta.
\end{aligned}
$$

Solving both equations yields the same result. Hence, we can state the following proposition:

Proposition 1: *If migration is possible, i.e. if $p > 0$ and $q > 0$, the proportion of agents investing in human capital equals*

$$
h = \sigma \frac{w}{w_0} + \frac{1}{2} \frac{p \left((1+\sigma^*) w^* - (1+\sigma) w \right)^2 - q (1+\sigma^*)(w^* - w)^2}{(1+\sigma^*) w^* w_0}. \tag{11}
$$

If migration is not possible, i.e. $p = q = 0$ the proportion of agents investing in human capital equals

$$
h = \sigma \frac{w}{w_0}, \tag{12}
$$

and hence is smaller than in the case where migration is possible.

Assuming that the wage level abroad is higher regardless of the level of qualification, i.e. $(1+\sigma^*)w^* > (1+\sigma)w$ and $w^* > w$, the share of agents investing in human capital increases with p, σ, σ^* and w^*. The share is negatively correlated with q. The effect of the domestic wage w is ambiguous. See appendix for proof.

2.3 Self-selection and endogenous human capital investment

Let's turn to the question whether the possibility to migrate stimulates or dampens human capital investment in the home countries. The probability of a qualified agent to migrate is defined by

$$\bar{p} \equiv p\frac{(1+\sigma^*)w^* - (1+\sigma)w}{(1+\sigma^*)w^*}.$$

This leads us to the second proposition.

Proposition 2: *The number of qualified agents living in the home country is higher when migration is an option if*

$$h^* - h > \bar{p} * h^*, \tag{13}$$

i.e. the share of agents investing in human capital due to the migration option is higher than the share of qualified agents living abroad.

See appendix for proof.

3 Econometric model

Central to the empirical analysis is the question whether with more people migrating, agents in the home countries invest more in human capital. The probabilities p and q are not directly observable. We already defined the probability of qualified agents to migrate as $\bar{p} \equiv p\frac{(1+\sigma^*)w^*-(1+\sigma)w}{(1+\sigma^*)w^*}$ and we can similarly derive the probability of an unqualified agent to migrate: $\bar{q} \equiv q\frac{w^*-w}{w^*}$. This allows us to re-write equation 11 as follows:

$$h^* = \sigma\frac{w}{w_0} + \frac{1}{2}\left(\bar{p}\frac{(1+\sigma^*)w^*-(1+\sigma)w}{w_0} - \bar{q}\frac{w^*-w}{w_0}\right)$$

with $\bar{p}$ and $\bar{q}$ being the observable proportions of agents with high and low qualification, respectively.

Base wage w and w^* as well as the returns to qualification σ and σ^* are likewise difficult to observe. Let $\bar{w}$ and $\bar{w}^*$ present the average wage in the home and guest country. Furthermore, let $(1+\epsilon)\bar{w}$ and $(1+\epsilon^*)\bar{w}^*$ denote the wage qualified agents will receive in their home and guest country, respectively, and similarly for unqualified agents who will receive either $(1-\epsilon)\bar{w}$ or $(1-\epsilon^*)\bar{w}^*$ depending on whether they are staying in the home country or migrating. Using these expressions, we can re-formulate equation 11 once more:

$$h^* = 2\epsilon\frac{\bar{w}}{w_0} + \frac{1}{2}\left(\bar{p}\frac{(1+\epsilon^*)\bar{w}^*-(1+\epsilon)\bar{w}}{w_0} - \bar{q}\frac{(1-\epsilon^*)\bar{w}^*-(1-\epsilon)\bar{w}}{w_0}\right). \quad (14)$$

When differentiating equation 14 (see Appendix), we obtain a positive sign for $\bar{p}$ and a negative sign for $\bar{q}$, whereas the effects of wages and returns to qualifications remain undetermined. However, when interacting with the probabilities to migrate, we derive unambiguous hypotheses which can be tested in the empirical analysis:

$$
\begin{aligned}
\frac{\partial h^*}{\partial(\bar{p} * (\bar{w}^* - \bar{w}))} &> 0,\\
\frac{\partial h^*}{\partial(\bar{p} * (\epsilon^* - \epsilon))} &> 0,\\
\frac{\partial h^*}{\partial(\bar{q} * (\bar{w}^* - \bar{w}))} &< 0,\\
\frac{\partial h^*}{\partial(\bar{q} * (\epsilon^* - \epsilon))} &< 0.
\end{aligned}
$$

Furthermore, we assume that income inequality measured by the Gini coefficient is positively correlated with the returns of human capital investments. In other words, we assume that the difference in income between agents who invested in human capital and those who did not increases with a more unequal income distribution. Keeping that in mind, we derive the following econometric model:

$$
\begin{aligned}
h^*_{it} &= \alpha + \beta_1 h^*_{it-1} + \beta_2 ln(y_{it}) + \beta_3 Gini_{it} + \\
&\quad \beta_4 \bar{p}_{it}[ln(y_{jt}) - ln(y_{it})] + \beta_5 \bar{p}_{it}[Gini_{jt} - Gini_{it}] + \\
&\quad \beta_6 \bar{q}_{it}[ln(y_{jt}) - ln(y_{it})] + \beta_7 \bar{q}_{it}[Gini_{jt} - Gini_{it}] + u_{it}
\end{aligned} \tag{15}
$$

As before, h^*_{it} represents the share of qualified agents of home country i ($i = 1, 2, \ldots, 143$) at point t ($t = 1, 2, \ldots, 6$). Per capita income of the guest and home country at point t are denoted by y_{jt} and y_{it}, respectively. $Gini_{jt}$ and $Gini_{it}$ correspond to the particular Gini coefficients. Finally, $\bar{p}_{it}$ and $\bar{q}_{it}$ are the shares of migrants having high and low levels of human capital, respectively. The error term u_{it} is specified as a simple error component model. i.e.

$$u_{it} = \mu_i + \epsilon_{it}$$

with μ_i being a country specific fixed effect and $\epsilon_{it} \sim N(0,1)$ (Hsiao, 1986). Dynamic panel estimations will be performed.

4 Data

The empirical analysis is based upon a new data set which records human capital accumulation of migrants from 143 host countries to six OECD countries capturing 75% of migrants living in OECD countries (Australia, Germany, France, Canada, USA and UK) (Defoort and Docquier, 2005). For the period 1975 to 2000, the data have been collated in intervals of five years, i.e. for each country there are six observations. Migrant workers are born outside the current country of residence.[1] Human capital accumulation is measured in a standardized way. Individuals with nine and more years of schooling are classified as highly qualified, individuals with less than nine school years are treated as unqualified. Only individuals aged 25 years and above are considered. The data on human capital accumulation have been retrieved from census data.[2]

The level of human capital of the home countries was taken from the data set by Barro and Lee (2000). Approximately 70 home countries which are part of Defoort and Docquier sample are not covered in their data set. For those countries observations were extrapolated from neighboring countries

[1]For Germany, citizenship has to be relied upon due to missing information.

[2]Information for all six points in time are only available for Australia. For all other countries, census data is available for 1980, 1990, and 2000. Missing data points have been estimated and extrapolated. For more information please refer to Defoort and Docquier (2005) and Docquier and Marfouk (2004, 2005).

with the most similar Human Development Index. This allows for a rather accurate approximation of the brain drain rate. Data on population was taken from the United Nations.[3]

Our dependent variable is the share of highly qualified individuals $h_i = H_i/P_i$ on the total population of home country i. H_i represents the number of highly qualified individuals and P_i corresponds to total population comprising individuals who stayed in home country N_i and number of people living abroad M_i. The probability that a highly qualified individual from home country i will migrate into one of the OECD member states is modeled as the ratio between qualified migrants M_i^s and qualified total population of home country i: $\bar{p}_i = M_i^s/(M_i^s + N_i^s)$ with $\bar{p}_i$ being the proportion of highly qualified individuals living within the OECD area. Similarly, the probability that an unqualified individual will migrate can be expressed as $\bar{q}_i = M_i^u/(M_i^u + N_i^u)$ with M_i^u and N_i^u representing unqualified migrants and unqualified locals of home country i, respectively.

As control variables we will use GDP per capita adjusted for purchasing power parity as well as Gini coefficients of home and guest countries (WDI, 2006). The income variable will serve as a proxy for wage levels. Missing data on income distribution were estimated using regression results obtained from a (country) fixed effects regression.

We calculate the Gini-index for the guest country as the average of Gini coefficients for OECD countries weighted by the proportion of migrants of each host country. We proceed in a similar way when calculating the income per capita variable. Regarding the interaction terms, the difference between the mean incomes and Gini coefficients, respectively, were weighted by the proportions of qualified and unqualified migrants from each host country to

[3]For a more detailed discussion, see Defoort and Docquier (2004) as well as Docquier and Marfouk (2004, 2005).

Table 1: **Summary statistics**

	Obs.	Average	Std. dev.	Minimum	Maximum
h^*_{it}	858	0.28	0.20	0.01	0.94
$ln(y_{it})$	858	8.00	1.16	5.20	10.88
$Gini_{it}$	858	42.90	9.94	20.84	77.15
$\bar{p}_{it}[ln(y_{jt}) - ln(y_{it})]$	858	0.16	0.26	-0.03	1.52
$\bar{p}_{it}[Gini_{jt} - Gini_{it}]$	858	-0.90	1.78	-14.07	1.26
$\bar{q}_{it}[ln(y_{jt}) - ln(y_{it})]$	858	0.04	0.09	-0.04	0.67
$\bar{q}_{it}[Gini_{jt} - Gini_{it}]$	858	-0.32	0.83	-5.60	0.45

Summary statistics

	Obs.	Average	Std. dev.	Minimum	Maximum
h^*_{it}	715	0.31	0.20	0.01	0.94
$ln(y_{it})$	715	8.14	1.14	5.70	10.88
$Gini_{it}$	715	43.04	9.93	21.16	77.15
$\bar{p}_{it}[ln(y_{jt}) - ln(y_{it})]$	715	0.16	0.26	-0.03	1.27
$\bar{p}_{it}[Gini_{jt} - Gini_{it}]$	715	-0.88	1.74	-13.31	1.26
$\bar{q}_{it}[ln(y_{jt}) - ln(y_{it})]$	715	0.04	0.08	-0.04	0.65
$\bar{q}_{it}[Gini_{jt} - Gini_{it}]$	715	-0.33	0.82	-5.42	0.45

the guest countries.

Only countries which had observations on the level of qualification of migrants for all six years were considered. In total, we have data from 143 host countries covering the period 1975-2000 in five year intervals.

As apparent from the descriptive statistics shown in Table 1, countries in the sample are rather heterogeneous. On average, the share of highly qualified individuals is 24%, but it varies between almost zero (Mozambique) and 94% (USA). Mean per capita income amounts to almost 3,000 US$ ranging between 200 and 53,000 US$. Finally, our measure of inequality lies between 21 and 78.

5 Results

Table 2 presents the results. The first two columns show the results of simple fixed effects regressions. The fixed effects are individually and jointly significant at the 1 percent level. The Hausman test supports the chosen fixed effects specification rather than the random effects approach. The first column shows the results without the interaction terms. The coefficients for both income per capita and Gini coefficient of the host country are positive and highly significant. As expected, a higher per capita income and income inequality are positively related with higher human capital investments. The second regression is augmented by the interaction terms. The theoretical expectations are met again. The interactions are highly significant as well indicating that a higher probability of qualified agents to migrate together with an increasing income difference and greater income inequality between guest and home country is associated with higher investments in human capital. A rising probability of unqualified agents to migrate together with rising monetary incentives, however, is negatively correlated with investment in human capital.

The regression results might suffer from endogeneity if there exist a relationship between the probability to migrate and the level of human capital in the host countries. Therefore, we instrumented the interactions in regression 3. Push factors which are known to motivate migration were used as instruments. In particular, we used the Freedom house civil and political rights index, institutional variables like freedom of movement within the EU, bilateral guest worker agreements and socio-economic variables like the proportion of the urban population of the home country which could influence the willingness to migrate. Due to missing observation regarding the instrumental variables, the sample size was reduced a little.

Test statistics confirm that (i) the variables in regression 2 are endogenous and (ii) the instruments used are orthogonal (see C-Tests in Table 2). Also, the null hypothesis of no over-identification is not rejected by the Hansen's J-Test statistics. This can be interpreted as a joint significance of the instruments. Compared with simple panel estimations, the results of the instrumental variables estimations are close to the ones obtained using the fixed effects estimator.

When estimating a dynamic panel with fixed effects based on a relatively small T, i.e. only few observations over time, a simultaneous equation bias is likely (Nickell, 1981) and both size of the coefficients and significance levels may be affected (Judson and Owen, 1999). Arellano and Bond (1991) suggest a GMM estimator which estimates the first difference of the equation using the lagged differences as instruments. Column 4 shows the results of the GMM estimation. Robust standard errors are calculated to take heteroscedastic error terms into account. Results confirm the signs previously obtained, however, some coefficients are no longer significant. In addition, the Hansen's J-Test statistic suggests that the model is over-identified.

The less significant results of the GMM estimation may be caused by weak instruments. In the literature, the efficiency of the Arellano-Bond estimator is often rated has problematic. As an alternative, Arellano and Bover (1995) and Blundell and Bond (1998) propose an augmented version of the difference GMM estimator, the so-called system GMM estimator. In addition to the first differences, the system estimator also uses lagged levels as instruments. Results obtained when applying this estimator are shown in column 5. They basically confirm the results obtained by the fixed effects estimation. Higher per capita income and a more unequal distribution of income are associated with higher human capital investments. The interaction terms show that (i) a higher probability of high qualified agents to migrate together with larger income differences as well as larger degree of income inequality between the home and guest countries will lead to more investment in human capital and (ii) a higher probability of unqualified agents to migrate together with increasing income differences and greater inequality is correlated with less investment in human capital. Regarding the chosen specification, the Hansen's J-Test statistic does not reject that the model is not over-identified. Tests for autocorrelation confirm that the residuals follow an AR(1) process but not an AR(2) process. This is also in line with the expectations of the GMM model. Thus, the estimation results confirm the hypotheses derived from the theoretical model. Furthermore, the results seem to be rather robust.

6 Conclusion

The question whether or not international migration is associated with brain drain is discussed in the literature on migration since the 1970s. The traditional brain drain literature assumes a constant stock of human capital. In contrast, models endogenizing the decision to investment in human capital suggest that international migration can lead to additional investments in human capital. This paper introduces a simple model of endogenous human capital investment with heterogeneous agents with regards to cost of qualification and cost of migration. It can be shown that in the equilibrium, the proportion of the population investing in human capital depends on the probability to migrate with respect to the qualification level. If the probability that qualified agents will migrate increases, people invest more in human capital, whereas an increasing probability of unqualified agents to migrate is

Table 2: **Estimation results**

	(1)	(2)	(3)	(4)	(5)
h^*_{it}	0.80***	0.81***	0.75***	0.58***	0.75***
	(79.36)	(71.04)	(26.23)	(12.74)	(10.87)
$ln(y_{it})$	0.02***	0.02***	0.03***	-0.01	0.04***
	(10.89)	(8.98)	(4.39)	(-0.74)	(3.25)
$Gini_{it}$	0.01***	0.01***	0.01***	0.00	0.00*
	(6.40)	(6.61)	(3.46)	(1.32)	(1.66)
$\bar{p}_{it}[ln(y_{jt}) - ln(y_{it})]$		0.03***	0.07***	0.11	0.13**
		(3.10)	(2.82)	(0.27)	(2.48)
$\bar{p}_{it}[Gini_{jt} - Gini_{it}]$		0.01***	0.02***	0.02*	0.02**
		(5.53)	(4.66)	(1.87)	(2.53)
$\bar{q}_{it}[ln(y_{jt}) - ln(y_{it})]$		-0.16***	-0.32***	-0.54***	-0.43***
		(-3.82)	(-3.64)	(-4.51)	(-3.03)
$\bar{q}_{it}[Gini_{jt} - Gini_{it}]$		-0.01**	-0.04***	-0.04*	-0.07**
		(-2.02)	(-2.69)	(-1.77)	(-2.00)
Observations	715	715	690	690	690
Hausman χ^2	88.74***	116.68***			
C-Test (p value)			0.02		
Hansen's J-Test (p value)			0.22	0.00**	0.30
AR(1) Test (p value)				0.00**	0.00**
AR(2) Test (p value)				0.14	0.84

followed by less investment. Also, the income gap between home and guest country positively affects the decision to acquire more human capital as does the gap between the returns to human capital investments. The effect of the income per capita of the home country remains ambiguous. Similarly, the impact of migration on the level of human capital of non-migrants could not be determined clearly, it varies with the parameters of the model.

The empirical results confirm the hypothesis that with a higher probability of qualified agents to migrate more people invest in human capital in the home countries. This relationship remains significant when controlling for endogeneity of the probability to migrate.

The empirical results imply that a migration policy which aims at influencing the qualification structure of the population in both the host and guest countries needs to account for the endogeneity of the decision to invest in human capital. The politically equally relevant question whether migration leads to a higher or lower stock of human capital of non-migrants in the home countries, has not been addressed in this paper. However, new data sets like the one used in this analysis allow a more detailed empirical analysis of such questions.

7 Appendix

Proof of **Proposition 1** (Sketch): We assume σ and $\sigma^* > 0$ and $p > q > 0$. Hence,

$$((1+\sigma^*)w^* - (1+\sigma)w)^2 > (1+\sigma^*)\,(w^* - w)^2$$

Therefore, the right hand side of equation (11) is greater than the right hand side of equation (12).

When differentiating equation (11) with respect to p, q, σ, σ^*, w^* and w we obtain

$$\begin{aligned}
\frac{dh}{dp} &= \frac{((1+\sigma^*)w^* - (1+\sigma)w))^2}{2(1+\sigma^*)w^* w_0} > 0, && (16)\\
\frac{dh}{dq} &= -\frac{(w^* - w)^2}{2w^* w_0} < 0 && (17)\\
\frac{dh}{d\sigma} &= \frac{(p(1+\sigma)w + (1-p)(1+\sigma^*)w^*)\,w}{(1+\sigma^*)w^* w_0} > 0, && (18)\\
\frac{dh}{d\sigma^*} &= p\frac{(1+\sigma^*)^2 w^{*2} - (1+\sigma)^2 w^2}{2(1+\sigma^*)^2 w^* w_0} > 0, && (19)\\
\frac{dh}{dw^*} &= \frac{p\left((1+\sigma^*)^2 w^{*2} - (1+\sigma)^2 w^2\right) - q(1+\sigma^*)\,(w^{*2} - w^2)}{2(1+\sigma^*)w^{*2} w_0} > 0, && (20)\\
\frac{dh}{dw} &= \sigma\frac{w}{w_0} - \frac{p(1+\sigma)\left((1+\sigma^*)w^* - (1+\sigma)w\right)}{(1+\sigma^*)w^* w_0} - q\frac{w^*_{t+1} - w}{w^* w_0}. && (21)
\end{aligned}$$

Equations (16) till (20) have unambiguous signs, whereas the sign of equation (21) depends on the individual parameter values. Q.E.D.

Proof of **Proposition 2** (Sketch): The share of migrating qualified agents equals

$$\bar{p} * h^*,$$

the share of non-migrating qualified agents is

$$1 - \bar{p} * h^*.$$

Hence

$$1 - \bar{p} * h^* - h,$$

is the difference of qualified agents in absolute numbers between individuals who choose to stay in the home country with and without the option to migrate, respectively.