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The Determinants of International Mobility of Students

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The Determinants of International Mobility of Students

Abstract

This paper analyzes the determinants of the choice of location of international students. Building on the documented trends in international migration of students, we develop a small theoretical model allowing to identify the various factors associated to the attraction of migrants as well as the costs of moving abroad. Using new data capturing the number of students from a large set of origin countries studying in a set of 13 OECD countries, we assess the importance of the various factors identified in the theory. We find support for a significant network effect in the migration of students, a result so far undocumented in the literature. We also find a significant role for cost factors such as housing prices and for attractiveness variables such as the reported quality of universities. In contrast, we do not find an important role for registration fees.

JEL-Code: F220, O150.

Keywords: student mobility, network effect, migration costs, higher education policy.

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1 Introduction

Globalization of higher education, through mobility of students, has grown considerably over the past 40 years. In 2008, more than 3.3 million students were enrolled in a country from which they were not citizens, including 2.7 million in OECD countries. This figure has been steadily rising since 1970's. It has been multiplied by a factor of 4 between 1975 and 2008. This increase accelerated over the recent period with a rise of 70%, between 2000 and 2008, which corresponds to an average annual growth rate of 9%. Among the various categories of migrants, international students are the ones who have experienced the most rapid increase in relative terms.

Developed countries are highly interested in attracting foreign students for several reasons. First, foreign students represent an important source of income for universities. In a lot of OECD countries, institutions providing higher education face adverse domestic demographic trends in terms of number of potential students. By attracting foreign students, for instance from populous countries, they relax the demographic binding constraints related to the domestic market. Furthermore, in some countries, international students tend to pay higher fees compared to domestic students.[1] This allows to circumvent some of the legal constraints faced by public institutions in terms of registration conditions, including fees. Second, colonial powers have always favored the migration of students from former colonies as part of the global package of foreign aid. Higher education provided to foreign students is one important channel allowing host countries to diffuse cultural, economic and political norms abroad. For instance, Spilimbergo [2009] shows that foreign education promotes democracy in the origin countries of the students, especially when education has been acquired in democratic countries.

Third and maybe more importantly, the international mobility of students is highly related to another form of migration, the one concerning skilled and highly skilled workers. Unlike other forms of migration (forced migration, low skilled workers, family reunification), the migration of skilled workers (the so called brain drain phenomenon) has been part of the worldwide process of globalization (Docquier and Rapoport [2011]). It reflects the growing interest of countries to attract talents and skills needed to spur their growth process. International students are likely to stay and work in the host country once they have completed their studies (Rosenzweig [2008]).[2] They represent therefore a potential valuable source of educated labor force for countries providing higher education, especially because they became familiar with the customs and the culture of the country while studying. It is not therefore surprising that some countries have explicitly implemented policies favoring the integration of foreign students in the labor market.[3]

[1] For instance, it is the case in the UK where British universities are worrying about the loss of public funding they could be subjected to, following the willingness of the government to reduce the number of foreign students by half by 2015. Indeed, fees paid by overseas students are very higher than fees paid by natives or EU members.

[2] In Australia, about 18.7 % of all foreign graduates remained in the country in 2002. In Canada, between 15% and 20 % of international students can be expected to establish and work in the country. 27% of foreign graduates from a UK institution of the academic year 2004/05 were employed in the United Kingdom. In the USA, 23% of persons with an H-1B visa are estimated to have had prior student visa (OECD [2009b]). Former international students represented, in 2007, 68% of permanent labor migration in France. Despite the fact that data is not available for all countries, OECD [2009a] expected that stay rates of foreign students is between 15 and 35 % for most countries. The stay rates of students having a PhD in the United States seem to be higher. According to Finn [2003], the stay rate after two years is about 70% in 1999 with strong disparities across fields of study (from 75% in physical and computers sciences and engineering to 45% in economics and agricultural sciences). Rosenzweig [2008] shows that the differences in skill prices between the origin and destination countries is a major determinant of stay rates of students.

[3] This is for instance illustrated by the recent policy debate about student visa policy in the UK. To quote Damian Green, the Immigration Minister of the United Kingdom (The Guardian, Tuesday 1 February 2011): "I believe attracting talented students from abroad is vital to the UK, but we must be more selective about

Policies concerned with the management of international students can act on two complementary grounds. First, policy can focus on the attraction of foreign students. Second, one can attempt to influence the retention of students, once they have graduated to ensure a highly-skilled workforce. With respect to the attraction of international students, OECD countries tend to consider various solutions. Countries can be quite liberal in issuing student visas compared to other types of visas. They can regulate tuition fees. Alternatively, policy can aim at lowering some costs such as housing expenses through subsidies. They can also offer English-language courses, facilitate the credit transfers between universities and allow the part-time work while studying. This last policy allows students to cover part of the costs they have to support and also to acquire some specific knowledge of the local job market.[4]

The identification of the key determinants of international student mobility is central to design efficient policies aimed at attracting foreign students. Those determinants pertain both to origin and destination countries. Focusing on the migration of foreign students to the US, Rosenzweig [2008] looks at the determinants in the origin countries. He shows that among many factors, the provision of undergraduate higher education and the low level of skill prices in the origin countries tend to favor emigration of students. Low skill prices at origin also increase the stay rates of students once they have completed their education in the US. Bessey [2007] provides a similar analysis for Germany. In contrast, the literature is so far much more silent on the identification of the key factors at destination influencing the location of students. By analyzing international student mobility in a multi-origin and multi-destination framework, this paper contributes to the identification of the key determinants at destination.[5] In turn, this identification allows to shed some light of the potential policies that can be implemented by countries willing to attract more foreign students. We first develop a simple theoretical model capturing the main driving forces for students keen to study abroad. Those forces include the costs and attractiveness of foreign education. Then using new OECD data on students in mobility, we assess the impact of the various key variables on the dyadic flows of students.

Our paper is related to previous studies devoted to international student migration. First, compared to Rosenzweig [2008, 2006] who focus on student migration in the US, our analysis integrates a set of alternative destinations. The 13 OECD destinations that are covered in our sample represent more or less 75% of the flows of international students, compared to 20% for the US. It allows to capture the substitution and the relative attractiveness between alternative destinations, a key feature for designing policies at destination. While the literature devoted to student migration is quite limited, our paper is obviously related to a large literature devoted to the explanation of international migration flows. There is an extensive and fast growing literature on international migration. Our paper is specifically tied to the macroeconomic analyzes combining a large set of origin and destination countries, including the recent works of Beine et al. [2011] and Grogger and Hanson [2011].

The paper is organized as follows. Section 2 describes the trends in migration of foreign

who can come here and how long they can stay". The UK is indeed about to review its immigration policies concerning overseas students (those outside the European economic area) and wants to reduce the number of overseas students from 200 000 to fewer than 100 000 by 2015. According to the Immigration office, two-thirds of the non-EU migrants who enter the UK come on student visas and the government wants to redefine the post-study access to the labor market. Only those graduating with a job offer already in hand will be authorized to stay in the UK.

[4]For example, in France, international students can work while studying without work authorization provided employment does not exceed 60% of their total annual workload. Norway allows students to work 20 hours a week. In Luxembourg, first-year students may apply for a work permit if their paid employment is within the University. Other students may work outside the university and the permit of work is renewable if the student re-registers in the university. The permit may be withdrawn if the student does not attend classes on a regular basis.

[5]See also Perkins and Neumayer [2012] for a recent similar approach.

students in the OECD countries and reviews the relevant literature. Section 3 presents a simple theoretical framework allowing to identify the important determinants. Section 4 presents the data necessary to estimate the determinants of the choice of location of international students. Key data captures the flows of students in mobility, i.e, students who migrated explicitly for educational purposes. The data is available annually for 13 OECD countries and for students coming from 216 origin countries from 2004 to 2007. Additional specific destination countries variables were collected to capture quality in higher education systems and costs supported by students. Section 5 presents the econometric approach and exposes the results. Two important results emerge from the estimations. We find a strong network effect, which has not been reported in the literature so far and we show that this effect is stronger for the skilled diaspora. Regarding destination specific features, the quality of universities is a significant magnet for foreign students whereas living costs in the destination country play a deterrent effect. The level of tuition fees does not seem to play a significant role. Section 6 concludes.

2 Descriptive evidence and literature

2.1 Some stylized facts

Globalization of higher education, through international mobility students, has grown considerably over the past 10 years. In 2008, more than 3.3 million students were enrolled in a country from which they were not citizens, including 2.7 million in OECD countries.[6] This figure has been steadily rising since 1970's and it was multiplied by 4 between 1975 and 2008. This growth accelerated over the recent period with a rise of 70%, between 2000 and 2008, which corresponds to an average annual growth rate of 9% (cf. figure 1).

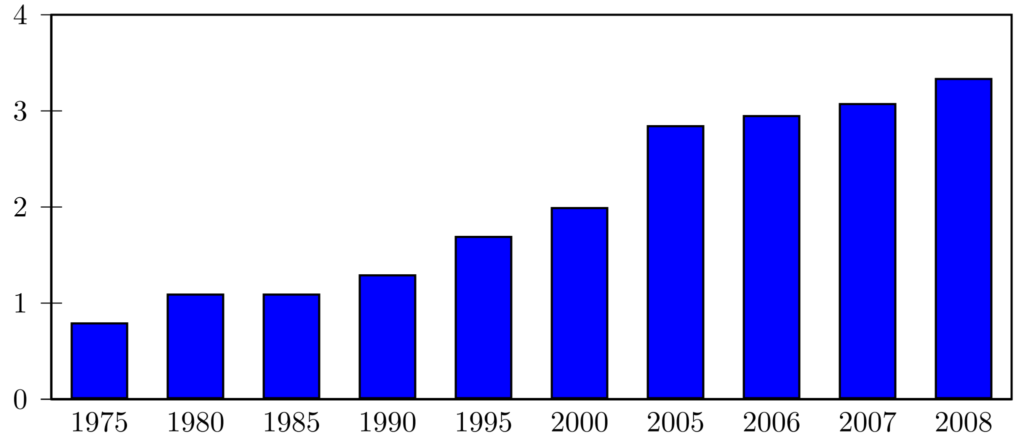

Figure 1: Students enrolled outside their country of citizenship (million, source: OECD, 2010)

In 2008, Asian students formed the largest group, accounting for nearly half of the total (49.9%). Asian students are followed by the Europeans with 23.0% and by students from

[6] We distinguish foreign students from international students in the analysis. Foreign students are students who are not citizens of the reporting country whereas international students are those who migrate for the specific aim of completing their education. Because all OECD countries do not report data on international students, figures exposed in this section refer both to foreign and international students and are called foreign students. For more information on the definition, see section 4.

Africa (11.6%). South American and North American students only account for 6.0% and 3.1% of the total aggregate flows (see Figure 2 and Table 7 in appendix). This distribution is essentially unchanged if we restrict the geographic area of destination to OECD countries, with respectively 48.9%, 24.5%, 10.1%, 5.3% and 3.7% of total flows. We compare the distribution of the geographic origin of international students with the one of continents in the world population (respectively 60.4%, 10.8%, 14.6%, 8.6% and 5.1%). The figures reflect the strong mobility of European students. Except for Europe, the distribution in terms of origins is relatively proportional to the share in the world population.

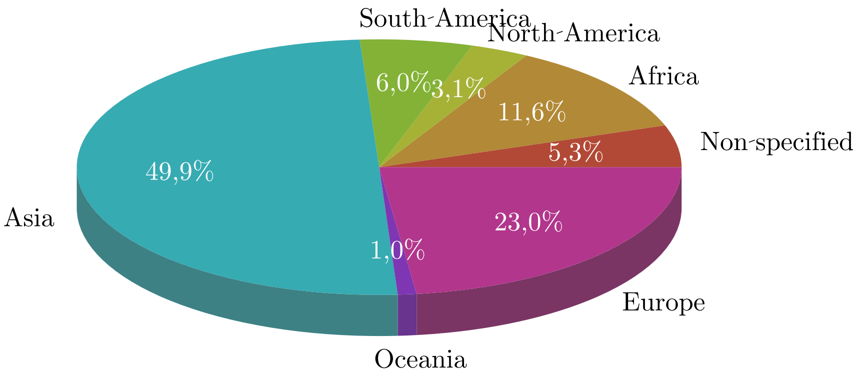

Figure 2: Distribution of foreign students by geographic region of origin, 2008 (source: OECD, 2010)

Since 2005, there has been a larger increase of students moving to non-OECD countries compared to those going to an OECD country (20.8% of total flows in 2008 against 16.8% in 2005). A refined analysis of this geographic distribution of foreign students flows (cf. Figure 3) suggests a high concentration in terms of destinations. About 50% go only to five countries: the United States, the United Kingdom, Germany, France and Australia. More than 83.4% of the total of foreign students enrolled worldwide are concentrated in OECD countries.

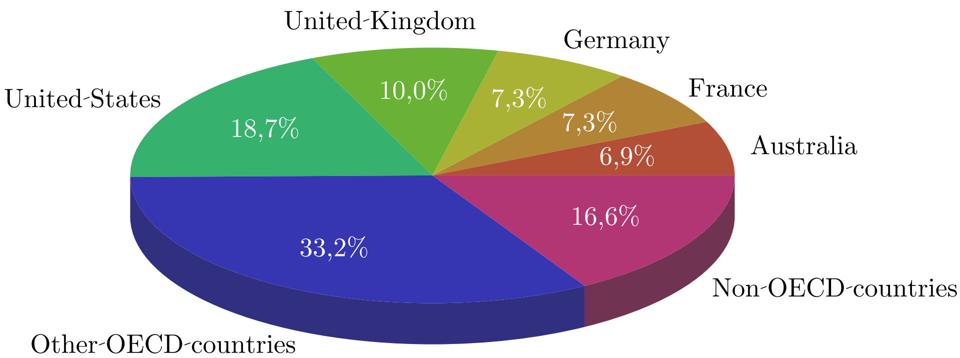

Figure 3: Distribution of foreign students by geographic region of destination, 2008 (source: OECD, 2010)

Figures 4, 5, 6 and 7 highlight the differences in foreign students' origins in 4 of these 5 main countries of destination. It is interesting to notice that a majority of countries (about 75%) send less than 500 (or less than 1500 for US) students to those four destinations, in 2008.

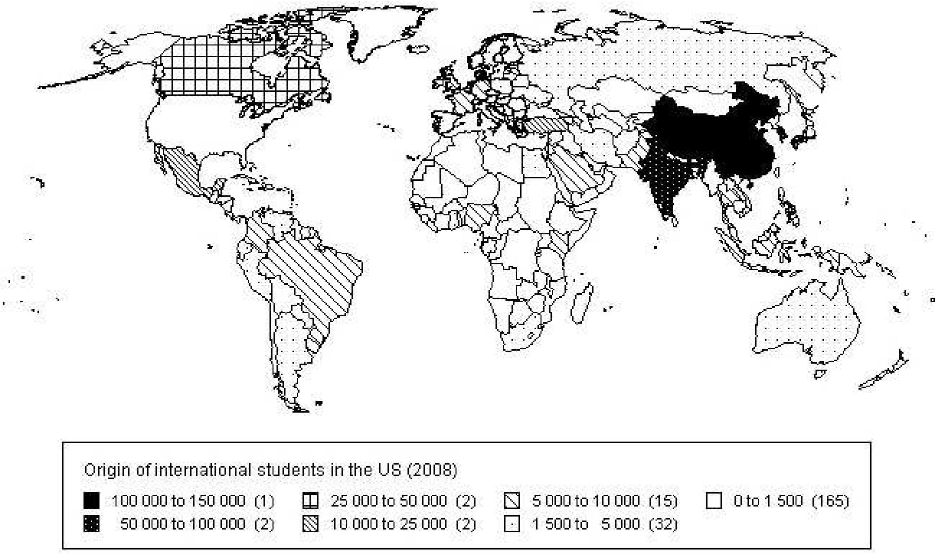

Figure 4: United States: origin of international students (2008)

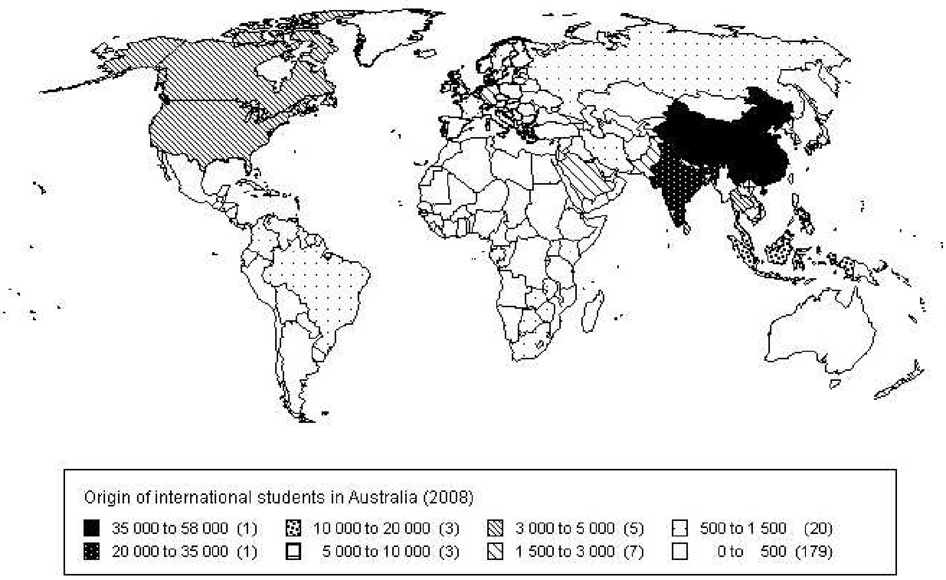

Figure 5: Australia: origin of international students (2008)

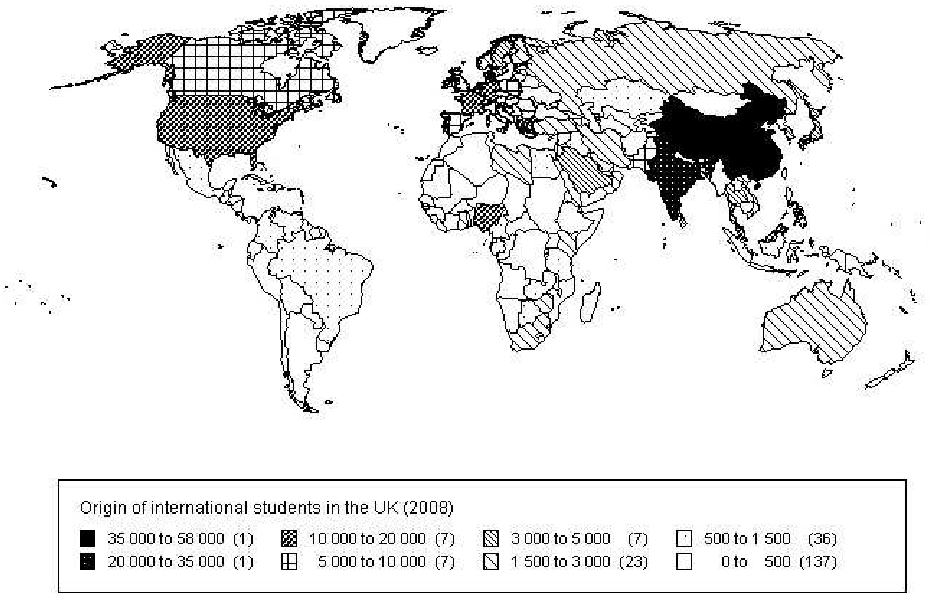

Figure 6: United-Kingdom: origin of international students (2008)

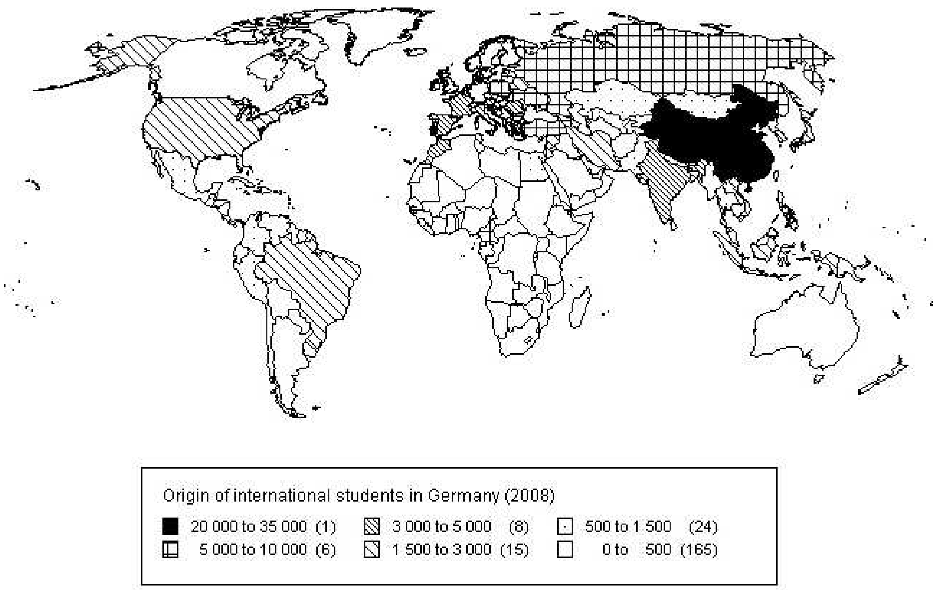

Figure 7: Germany: origin of international students (2008)

Students from Asia make up a significant proportion of the total number of foreign students in Australia and United States (respectively 79% and 67%, see Table 7 in appendix). China is the first sending country for those four destinations. Russia, Turkey and other European countries are second sending countries, after China, to Germany.

The share of foreign students in total enrollment in OECD receiving countries is also of interest. Figures observed for the year 2007 reveal strong disparities. Thus, although the United States was the first destination for 595 900 international students, the share of these students in total enrollment (3,4%) is twice below the OECD average (7.1%). New Zealand and Switzerland received fewer international students (about 30 000) in absolute terms but quite a lot in relative terms, i.e. respectively 13.6% and 14% (see Table 8 in appendix).

In 2007, the size of the flow of international students was comparable to the flows of foreign workers for Austria and Belgium (see Table 8 in appendix). Australia, Japan, New Zealand and the United Kingdom received more international students than foreign workers. In contrast, Canada, Switzerland, Germany and the United States received less students than they received foreign workers. Moreover, the share of international students in the total enrollment in tertiary education is lower than the share of foreign-born workers in the active population in every country except for Switzerland and the United Kingdom.

2.2 Related literature

Two main reasons have been advanced in the literature to explain the migration of students between countries or regions. First, from a human capital perspective, migration is considered as an investment and the decision to move is made to grab better job opportunities and/or to increase the future expected income. Second, migration can also be viewed as a consumption choice. In that case, people move for non-pecuniary reasons. Students not only focus on the returns of higher education in the future, but also take into account the context in which they will study.

In the human capital perspective, Rosenzweig [2006] proposes two models to explain the international mobility of students to developed countries. First, migration takes place because of a lack of educational facilities in the home country regardless the level of education returns (school-constrained model). In that case, students migrate to acquire human capital and return home to reap the benefits of education investment at origin. Second, migration under a student visa could be a mean to enter and stay in a foreign country to escape low returns in education in the origin country. The quest for higher income is the main determinant of student migrations in this so called migration model. Those two models are competing in terms of predictions and implications. In the school-constrained model, an increase in the return from education in the home country leads more students to study abroad, whereas, in the migration model, it rather tends to reduce the flows of students. Moreover, other things being equal, if the quality and the quantity of schools increase, the number of students who seek education abroad will be reduced in the school-constrained model, but the outflows of students in the migration model will increase. The study of the flows of foreign students from a large set of countries (125 countries) to the United States suggests that students come to the US and stay when the returns to education are low in their country of origin. Then, the gap in wages between the US and developing countries motivates people to study abroad. Those results are confirmed by Rosenzweig [2008]. The United States is an attractive destination for international students due to the skill premium paid in the labor market and due to the large number of US universities. Finally, mobility of students can be explained by the same determinants that for migrations of workers including higher wages.

The return rates of foreign students is a key issue analyzed by Rosenzweig [2008]. Return rates of foreign students from the US are higher for countries with higher skill prices. Bratsberg [1995] shows that if educational attainment of a foreign student exceeds the average education level in the home country or if the return to education in the home country is higher, the student is less likely to stay in the United States. Moreover, the composition of students who remain in the US is a function of the skill price differential between the home country and the US.

Haupt et al. [2010] deal with migrations of students from the perspective of brain gain and show that brain drain cannot be only due to individuals from developing countries incentives to acquire human capital but also by incentives in the rich countries to improve their education policy. The need for host countries to retain foreign students indeed leads them to increase the quality of their educational system in order to benefit from the externalities of human capital accumulation. It enhances the human capital of all students, included those who return home. Then, it can generate a brain gain. International mobility of students and its effects have also been studied by Dreher and Poutvaara [2005] where a positive correlation between flows of students and international migration as a whole is found. Borjas [2004] presents two possible crowding-out effects for native students due to arrivals of foreign students.

Other empirical works discuss the motivations and determinants of students in mobility. Those studies concern either international mobility of students or internal mobility, i.e mobility of students between regions or states within a country. They often evaluate the determinants by an augmented gravity equation where data describing amenities are introduced in addition to the traditional determinants such as distance, GDP and population. Distance always plays a deterrent effect but the effect of GDP is more ambiguous. Concerning international migration, Bessey [2007] studies the flows of international students to Germany. The stock of foreign students of a nationality, in the destination country, and the flows of students with the same nationality seem positively correlated. This analysis does not however include variables characterizing the quality of higher education. Some survey analysis which cover the prospective international students as unit of analysis reveal that the discrepancy in education quality between a foreign degree and a domestic one is one of the main motivations for students to go overseas (Gordon and Jallade [1996]; Aslangbengui and Montecinos [1998]; Szelenyi [2006]).

Van Bouwel [2009] introduces two different measures of quality of education: the relative impact of a country's publications relative to the share of a country's citations in world publications and the number of national universities within the top 200 of the Shanghai ranking. Both quality indicators have a positive impact on the size and direction of students flows. The Shanghai ranking has also been used by Thissen and Ederveen [2006]. Other components of higher education system such as educational opportunities or government spending on higher education have been used by Cummings [1984] and McMahon [1992].

Papers on internal migration of students within a country are also useful as references. They either use individuals as unit of analysis (Ono [2001]; McCann and Sheppard [2001]; Kjellstrom and Regner [1998]) or use place-to-place data or data specific to institutions (Mixon and Hsing [1994a,b]; Baryla and Dotterweich [2001]) or aggregate data about states or regions (Mixon [1992a,b]; Sa et al. [2004]; Agasisti and Dal Bianco [2007]).

3 Theoretical background

This section derives a tractable students' migration equation from a simple theoretical model based on the human capital literature. Education is considered as an investment in future earnings and employment (see Becker [1964]) for rational students who seek to maximize their lifetime earnings. The quality of education may affect their expected returns to education (Card and Krueger [1992]). The prospective student migrant compares the present value of future earnings if he/she decides to study at home to the one obtained from studying abroad. If the increase in the present value of the future income is greater than the cost of migrating as well as other education costs, students will move to the country yielding the highest net present value. However studying at home does not rule out to migrate after graduation for the sake of working in another country. Similarly, studying abroad facilitates access to the local labor market, but does not preclude the possibility of returning home or migrating, after graduation, to a third country. Student's location decisions before and after education are not independent but are taken sequentially; first the educational location and then the working location. Students form (myopic) expectations about future income by observing the current skill prices (Freeman [1971]) and the working migrations probabilities. The relevant probabilities are (i) the probability to migrate, once the studies at home are completed; (ii) the probability of getting a job in the destination country in which schooling has been obtained; (iii) the probability of return migration and (iv) the probability to migrate to a third country.

Schooling is an investment in the human capital framework, but it could also yield a non-pecuniary (utility) benefit like the excitement of learning which depends on the quality of the higher education system. Consistent with this approach, the utility of a student born in country $i \in O$ and studying in country $i \in O$ (at home) might be expressed as:

$$u_{ii} = E_i - CE_i + P_i^s W_i + (1 - P_i^s)(\bar{W} + S(Q_i - \bar{Q})) + \epsilon_i \tag{1}$$

where $O = 1, ..., o$ is the set of origin countries with o the number of origin countries, E_i denotes the non monetary educational benefit, CE_i is a vector of tertiary educational costs in country i, P_i^s is the probability of stay and work in country i after graduation in the same country, W_i is the expected present value of future earnings if working in country i, $\bar{W}$ the expected present value of future earnings based on the average (developed countries) skill prices, $S(.)$ a premium which depends on the difference between the quality of education where the higher education has been attained (Q_i) and the quality of education in the working country which is given by the average quality of education abroad $\bar{Q}$.[7] ϵ_i is a iid extreme-value distributed random term.

The utility of studying abroad, in country $j \in D$ with $i \neq j$ can be expressed as:

$$u_{ij} = E_j - CE_j - CM_{ij} + P^f W_j + P^r(W_i + S(Q_j - Q_i)) + (1 - P^f - P^r)(\bar{W} + S(Q_j - \bar{Q})) + \epsilon_j \tag{2}$$

where $D = 1, ..., d$ is the set of destination countries with d the number of destination countries; CM_{ij} captures the cost of migrating for a student who decides to move in country j to complete his education. P^f is the probability of staying in the destination country and P^r the return probability after graduation. We assume that P^f and P^r are not country specific.[8]

Following the random utility approach to discrete choice problems (McFadden [1981]) and assuming that the hypothesis of irrelevant alternatives holds, the probability that student from country i chooses foreign country $j \in D$ to attain higher education is defined by:

$$\begin{aligned} P_{ij} &= Pr\{u_{ij} = \max_{l \in D} u_{il}\} \\ &= Pr\{u_{ij} > u_{il}, \forall l \neq j \in D \quad\} \\ &= \frac{exp[E_j - CE_j - CM_{ij} + P^f W_j + P^r(W_i + S(Q_j - Q_i)) + (1 - P^f - P^r)(\bar{W} + S(Q_j - \bar{Q}))]}{\sum_{l \in D} exp[E_l - CE_l - CM_{il} + P^f W_l + P^r(W_i + S(Q_l - Q_i)) + (1 - P^f - P^r)(\bar{W} + S(Q_l - \bar{Q}))]} \\ &= \frac{N_{ij}}{N_i} \end{aligned}$$

[7]By definition, this premium is not taken into account when the educational country will also be the working country. It can be negative if the difference in quality is negative.

[8]There are two main arguments in favor of this assumption. First, agents need to form expectations about P^f and P^r. To that aim, they need to rely on the available information. In that respect, there is so far no information available across a whole range of origin and destination countries. As a result, agents are more likely to form expectations based on average levels. Second, stay rates of students in a limited number of OECD countries have not been found to differ significantly, ranging from 14.7% to 29.5% (see in particular OECD, 2010, Page 45, Table I.8).

with N_{ij} is the number of students from country i studying in country j and N_i the total number of students born in country i.

Furthermore, the ratio N_{ij}/N_{ii}, where N_{ii} is the number of students from country i studying at home, is given by the following expression:

$$\frac{N_{ij}}{N_{ii}} = \frac{exp[E_j - CE_j - CM_{ij} + P^f W_j + P^r(W_i + S(Q_j - Q_i)) + (1 - P^f - P^r)(\bar{W} + S(Q_j - \bar{Q}))]}{exp[E_i - CE_i + P_i^s W_i + (1 - P_i^s)(\bar{W} + S(Q_i - \bar{Q}))]} \tag{3}$$

The non monetary education utility benefit, E, depends on the quality of education (Q) and the host country capacity (HC). Tertiary educational costs, CE_j are composed of registration fees and living costs. Migration costs, CM_{ij} are composed of two parts, fixed costs (C_i) and variable costs (C_{ij}). The fixed part measures the costs of moving, independently of the destination country (home-specific costs) whereas the variable part depends both on origin and destination (like transportation costs, assimilation costs ...). The variable migration costs depend on dyadic factors such as physical distance d_{ij}, origin and destination countries' cultural and linguistic proximity such as the use of a common official language (l_{ij}) or the existence of colonial links (col_{ij}) and the size of the migrants' network at destination (M_{ij}). In line with the empirical literature on migration networks, networks at destination lead to a decrease in migration costs (see Beine et al. [2011] and McKenzie and Rapoport [2011]:

$$CM_{ij} = C_i + C(d_{ij}, l_{ij}, col_{ij}, M_{ij}) \tag{4}$$

For the sake of simplicity, we assume a linear premium function $S(Q_i - Q_j) = a(Q_i - Q_j)$.

With these assumptions and taking logs equation (3) becomes:

$$\begin{aligned} \ln[N_{ij}] &= E_j - E_i - (CE_j - CE_i) - CM_{ij} + P^f W_j + W_i(P^r - P_i^s) + aQ_i(P_i^s + P^r - 1) \\ &\quad + aQ_j(1 - P^f) + (\bar{W} - a\bar{Q})(P_i^s - P^f - P^r) + ln(N_{ii}) \end{aligned} \tag{5}$$

4 Data

4.1 International students versus foreign students

To study the determinants of the choice of location of mobile students, the explained variable has to represent students who migrated for the sake of education and not for other reasons such as family migration. Moreover, the institutional migration like ERASMUS or SOCRATES programs is not suitable for this paper because the choice of location is constrained by the number of agreements a university in the host country may have abroad. Thus, some destination countries could not be chosen by students because of the absence of agreement, which could bias our analysis. Moreover, a semester or a year abroad could be compulsory in some curriculum, which does not reflect the willingness of students to migrate by themselves in a foreign country.

UNESCO, OECD and EUROSTAT (UOE) collect data on the students enrolled outside their country of birth or citizenship. Two types of data are available. First, data on foreign students where the criterion used is the citizenship of the student. This definition is not suitable for this paper because it often includes a number of students who either migrated with their parents or have been resident in the host country since birth. Second, UOE collects data on international students. International students are those who migrate solely for the purpose of education. It is exactly what we study in this paper.

To measure the number of international students settled in one country, two criteria could be used. The first one is the permanent residence criterion. If students are not permanent residents of the country, they are considered as mobile. The second criterion involves the place of prior education (Table 9, in appendix, presents the criterion used to define international students by country). Thereby, students enrolled in an OECD country who were registered in another country the year before are considered as students in mobility. Whatever the definition used to define the international students, data include a small group of non-resident nationals who have returned to their country of citizenship. However, this part of international students is less important than the gap between foreign students and international students. Table 10 presents both figures for international students and foreign students for the year 2007. On average, international students represent 71% of the stock of foreign students. Because this paper studies the individual migration of students for the aim of study, we focus on the number of international students in OECD countries. Data on international students is not available for all OECD countries and our analysis is limited to 13 of them : Australia, Belgium, Canada, Denmark, Germany, Ireland, the Netherlands, New Zealand, Spain, Sweden, Switzerland, the United Kingdom and the United States. Other countries either report data on foreign students and not on international students or do not give data for the period considered (from 2004 to 2007). As UOE collected data for students registered for the full academic year, it does not include students who migrate through an institutional program like ERASMUS or SOCRATES.

4.2 Other data

Following our theoretical framework, we relate the flows of mobile students to a set of different determinants. These can be classified into different categories. First, we need to capture the attractiveness of destination countries in terms of higher education. Three determinants fall into that category: skill prices at destination defined as the return to education, wages peculiar to skilled workers and the number of universities ranked in the top 500 Shanghai ranking as a ratio of the total number of students. Using the Shanghai ranking as a measure of quality could be open to criticism because of the criteria used to built this ranking. However, this ranking is well known from students who want to migrate and is harmonized between countries.

The second set of determinants are dyadic variables influencing the cost of student mobility. Migration costs are supposed to depend on distance between the two countries, language proximity captured by a dummy variable stating whether the two countries share a common official language, the existence of a colonial link and the size of the network at destination. Network is defined as the stock of migrants from the origin country living at destination. Those migrants are likely to provide assistance and information to students from their country and therefore decrease their migration costs.[9]

A final set of variables includes destination specific variables that influence the cost of education for students. We include the cost of housing and the average fees at destination. The cost of living in a country materially impacts the affordability of education in that it increases the total amount of money required to complete each year of study. The data found in Usher and Cervenan [2005] includes the costs of rent and food for an academic year. Because data on fees paid by mobile students is, to our knowledge, not available, we collect data on fees paid by natives. We also include the total population at destination as a proxy for the host capacity of destination countries.

In order to capture the wage conditions at destination (W_j), we use two alternative measures. First, following Rosenzweig [2008], we use the skill premia at destination. Those are nevertheless estimated and collected for the destination countries from Psacharopoulos and Patrinos [2002].

[9] They can also provide information regarding job opportunities after studying. In that respect, network could also enter in terms of modeling in the benefit side of migration. Nevertheless, what matters is the net gain associated to each choice, which implies both modeling approaches yield equivalent observational implications.

Second, as an alternative to the skill premia, we use wage data from the OECD. Those capture the average annual gross wages for skilled workers (workers with tertiary education level). The reference year is 2008 or 2009 depending on the destination country. Note that the data is not available for Switzerland but based on auxiliary information, we use the wage level in Luxembourg as a proxy.

Table 1: Data presentation

Variable	**Definition**	**Source**	**Available Years**
	Mobile students		
N_{ij}	Number of mobile students from an origin country i to the destination country j	UNESCO OECD EUROSTAT (UOE)	2004-2007 except the year 2005 for Canada
	Migrants network		
M_{ij}	Total migration stock from origin country i to destination country j	Docquier and Marfouk database (DM06)	2000
$\underline{M_{ij}}$	Stock of migrants without upper secondary education from origin country i to destination country j	DM 06	2001
$\overline{M_{ij}}$	Stock of migrants with a post-secondary education from origin country i to destination country j	DM 06	2001
	Dyadic cost variables		
d_{ij}	Distance from origin country i to destination country j	CEPII database	-
l_{ij}	Existence of a common official language	CEPII database	-
col_{ij}	Existence of a colonial link after 1945	CEPII database	-
	Destination specific variables		
$skillp_j$	Skill price estimated by private return to schooling	Psacharopoulos and Patrinos [2002]	2002
pop_j	Population in million for the destination and origin countries	FMI	2004-2007
$efftotd$	Number of students pursuing education in a higher education institution	UNESCO	2004-2007
$rank500$	Number of universities classified in the Shanghai top 500 ranking	Shanghai ranking	2004-2007
$rank_j$	$\frac{rank500}{efftotd}$	UNESCO and Shanghai ranking	2004-2007

...

Table 1 – suite

Variable	Definition	Source	Available Years
$fees_j$	Annual average tuition fees charged by tertiary-type-A educational institutions for full-time native students in US dollars	OECD [2006, 2007]	Academic year 2003-2004 except for Ireland, Netherlands (academic year 2004-2005). No data for Germany.
$wage_j$	Gross annual wage for workers with tertiary education level	OECD: education at a glance	2008 or 2009
$housingcost_j$	The cost of living (in US dollars 2003) in a country materially impacts the affordability of education in that it increases the total amount of money required to complete each year of study. Living costs include the cost of rent and food for an academic year.	Usher and Cervenan [2005]	2003. Data for Switzerland, Spain and Denmark are missing

5 Measuring determinants of student's migration

5.1 Econometric approach

5.1.1 Implied specifications

Starting from equation (3) and integrating equation (4), the benchmark estimable relationship between international student migration flows and their determinants is the following:

$$ln(N_{ij}) = \alpha + \alpha_i + \alpha_j + \beta_1 * ln(d_{ij}) + \beta_2 * ln(col_{ij}) + \beta_3 * ln(l_{ij}) + \beta_4 * ln(M_{ij}) + \nu_{ij} + \epsilon_{ij} \quad (6)$$

where ν_{ij} captures the unobserved bilateral factors and ϵ_{ij} is an error term and $\alpha = (\bar{W} - a\bar{Q})(P^f - P^r)$. In this specification, unobserved factors that are origin and destination specific are captured by α_i and α_j. More precisely, we have :

$$\alpha_i = C_i - E_i + CE_i + W_i(P^r - P_i^s) + aQ_i(P_i^s + P^r - 1) + P_i^s(\bar{W} - a\bar{Q}) + ln(N_{ii}) \quad (7)$$

Similarly, we have:

$$\alpha_j = E_j - CE_j + P^f W_j + aQ_j(1 - P^f) \quad (8)$$

The aim of this particular specification is to maximize the fit of the model to the data and to focus on the role of the dyadic factors such as flying distance (d_{ij}), the existence of a colonial link (col_{ij}), the use of a common official language (l_{ij}) and the network effect (M_{ij}).

In contrast, specification (6) does not allow to capture the role of factors that are destination specific. In the context of international competition between countries for young talents, such an analysis is very important to shed some light of the determinants of the attractiveness of each country as a supplier of higher education and therefore to issue policy recommendations to increase this attractiveness. To this aim, we replace α_j by destination specific observable variables involved in its definition. Following equation (8), we consider 5 variables: skill prices (in the destination country) ($skillp_j$) or wages for workers with a tertiary education level (($wage_j$) as an incentive for students to work at destination after they have completed their education (a proxy of W_j), the number of universities ranked in the top 500 Shanghai ranking ($Rank_j$) as a measure of prestige and quality of the universities (a proxy of Q_j), the average fees ($fees_j$) and the average cost of housing ($housingcost_j$) as education cost variables (proxies for CE_j) and population (Pop_j) as a proxy for the host capacity of the country (a proxy for E_j).

The implied specification becomes :

$$
\begin{aligned}
ln(N_{ij}) = \alpha_i + \beta_1 * ln(d_{ij}) + \beta_2 * ln(col_{ij}) + \beta_3 ln * (l_{ij}) + \beta_4 ln(M_{ij}) + \beta_5 * ln(Pop_j) + \\
\beta_6 * ln(Rank_j) + \beta_7 * ln(housingcost_j) + \beta_8 * ln(fees_j) + \beta_9 * ln(skillp_j) + \nu_{ij} + \epsilon_{ij} \qquad (9)
\end{aligned}
$$

5.2 Results

5.2.1 Benchmark regressions at the bilateral level

We first start with the regressions allowing to capture the impact of bilateral factors (equation (6)). In a first step, we leave out a discussion about the role of the unobservable bilateral factors (ν_{ij}) and the impact of their omission. We address this issue specifically later on. In specification 6, the role of country specific variables are captured by destination and origin country fixed effects. This specification yields in general a better fit and is suited to uncover in a more precise way the role of factors that are specific to each migration corridor. Among those factors, we include the role of linguistic links, of the colonial links, of the migrants' network at destination and of the euclidean distance between the origin and the destination. We have actually 4 waves of data: 2004, 2005, 2006 and 2007. Nevertheless, we do not pool the data. The reason is two-fold. First, pooling the data and accounting for unobserved heterogeneity would lead to the inclusion of country pairs specific effect. In turn, this would absorb the role of bilateral factors that are constant over time like colonial links, linguistic links and distance. Second, for the network, we have only data for 2000 and we use that information in each regression period. Pooling the data therefore would introduce some redundant information and like for the other bilateral factors, their impact would be absorbed by the bilateral fixed effect.

One of the econometric issue at stake in this analysis is related to high proportion of zeros. Depending on the period, the proportion of zero values in the stock of students at the dyadic level varies between 18% and 30%.[10] Like in other analyses involving international flows such as trade and FDI, the high prevalence rate of zeros creates specific issues that prevent the use of OLS estimates. The first issue is that taking the log of the flows values drops the observations with zero students. This in turn induces a selection bias since the country pairs with zero values are likely to have a population distribution that differs from the underlying one of the pairs with positive flows. Using the log of the observed flows plus one instead of the log or using some Tobit estimator prevents such a bias. Nevertheless, as shown by Santos Silva and Tenreyro [2006], in presence of heteroskedasticity, the presence of zeros creates some correlation between the covariates and the error term, leading to inconsistency of OLS estimates. The solution they propose is to use the Poisson maximum likelihood estimator which minimizes the bias in Monte Carlo simulations under a set of alternative stochastic processes. Therefore, we rely on

[10]Starting from the full sample involving only N_{ij}, the proportion of zeros is 17.9%, 27.09%, 24.42% and 29.97% respectively for the years 2004, 2005, 2006 and 2007.

the Poisson ML estimates to estimate models (6) and (9).[11] We make sure the standard errors are adjusted using robust estimates. Table 2 reports the estimation results for the benchmark regressions for the 4 years.

Table 2: Determinants of student's migration -
Bilateral regressions

Years	(2004)	(2005)	(2006)	(2007)	(2004)	(2005)	(2006)	(2007)
Variables	Total network				Skilled network			
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Distance	-0.672***	-0.705***	-0.669***	-0.691***	-0.587***	-0.606***	-0.591***	-0.609***
	(0.077)	(0.067)	(0.067)	(0.066)	(0.058)	(0.072)	(0.061)	(0.060)
Colony	0.028	0.021	0.112	0.104	-0.091	-0.103	-0.004	-0.015
	(0.219)	(0.225)	(0.193)	(0.187)	(0.216)	(0.219)	(0.187)	(0.178)
Language	1.131***	0.909***	1.044***	1.130***	1.007***	0.784***	0.924***	1.003***
	(0.203)	(0.178)	(0.178)	(0.180)	(0.194)	(0.166)	(0.168)	(0.168)
Network	0.272***	0.281***	0.275***	0.282***	0.406***	0.418***	0.405***	0.415***
	(0.049)	(0.053)	(0.045)	(0.042)	(0.049)	(0.051)	(0.045)	(0.043)
# obs	2442	2256	2432	2444	2442	2252	2432	2444
# orig c	203	203	203	203	203	203	203	203
# dest c	13	12	13	13	13	12	13	13
Pseudo R^2	0.927	0.933	0.934	0.934	0.932	0.938	0.939	0.939
Orig FE	yes	yes	yes	yes	yes	yes	yes	yes
Dest FE	yes	yes	yes	yes	yes	yes	yes	yes

Notes: Years refer to the estimation period. Poisson ML estimates. Robust standard errors between parentheses.
*, ** and *** denote significance at the 10, 5 and 1% significance levels.
For all regressions, network refers to the stock of migrants observed in 2000.
Columns (2)-(5): network equals stock of all migrants.
Columns (6)-(9): network equals stock of migrants with tertiary education.

From column (2) to (5), we use the total stock of migrants (M_{ij}) observed in 2000 as a measure of the network while the last four columns report the results with the stock of migrants with tertiary education level only ($\overline{M_{ij}}$). Table 2 shows that there is a strong convergence in the results between the four years under investigation, both from qualitative and quantitative point of view. Distance turns out to be a strong determinant of the number of students going abroad. Distance usually picks up the impact of transportation costs and psychological costs of being abroad. Likewise, language proximity between the origin and the destination impacts positively the flows of students studying abroad. This is consistent with the hypothesis of skill transferability (Chiswick [1978]) where linguistic abilities seem important for (future) skilled workers. Our estimates support also a strong network effect which has not been documented in the existing literature so far. The elasticity of the total network is around 0.28. Interestingly, this elasticity, around 0.41, is stronger for the skilled diaspora (column (6) to (9)), favoring the view that students in higher education benefit more from support of skilled migrants at destination. Additional unreported results confirm that the education level of the diaspora induces a different impact in network effect for students. For instance, for 2007, the elasticity associated to the unskilled diaspora (migrants with primary education level, ($\underline{M_{ij}}$)) is equal to 0.156, showing that the variation of the network elasticity is more or less linear with respect to

[11]For the sake of information, Appendix 2 presents the results obtained from alternative regression techniques. We use 4 alternative methods: OLS on the dependent variable (log of number students) which drops out the zero observations, OLS on the log of (1+number of students), which includes the zero observations, a two-step Heckman procedure and finally Tobit estimation method. Two-step Heckman method assumes a selection process for the pairs with a positive number of students. Note that following Santos Silva and Tenreyro [2006], all those four methods yield biased estimates in the presence of zero observations.

education of the network. Furthermore, the effects of network tends to absorb the traditional role of colonial relationships. This suggests that students tend to choose the former colonizer as their preferred destination not because of past colonial relationships but because they can rely on people from their origin country.

The network effect could be nevertheless the result of the fact that model (6) includes ν_{ij}. If the migration network is correlated with the non observable factors of international students, this creates a correlation between the network and the composite error term $\nu_{ij} + \epsilon_{ij}$, biasing the ML estimates. In the literature dealing with international migration, this is called the problem of correlated effects (Manski [1993]). Nevertheless, this might be relevant in our context, too. For instance, it could be the case if destination countries that conduct some privileged migration policies with respect to some origin countries (thereby favoring a high value for M_{ij}) are also keen to favor the arrival of students from those countries. Put differently, if the bilateral student migration policies tend to follow the general pattern of migration policies concerning economic migrants or family reunification programs, then the estimates of model (6) can be biased.

The solution to the correlated effect problem lies in the use of instrumental variables estimates. Instrumenting the network with a variable correlated with the network in 2000 but uncorrelated with the subsequent flows of students allows to get rid of that potential problem. We follow that strategy to assess whether our estimate of the network effect is not affected by the correlated effect problem. Given the presence of zeroes, one need nevertheless to combine Poisson and instrumental variable estimation. This has been suggested by Tenreyro [2007] in the context of the GMM framework. The idea is to start from the underlying orthogonality condition associated to the Poisson estimator. Aggregating all explanatory variables α_i, α_j, d_{ij}, col_{ij}, l_{ij} and M_{ij} into the x_{ij} vector, the Poisson estimator γ solves the following moment condition:

$$E([N_{ij} - exp(x_{ij}\gamma)]x_{ij} = 0) \tag{10}$$

In order to instrument x_{ij}, one can use as an alternative the following GMM estimator denoted by ψ:

$$E([N_{ij} - exp(x_{ij}\psi)]z_{ij} = 0) \tag{11}$$

in which z_{ij} represent the vector of exogenous variables and of the instruments, i.e. variables that are supposed to be correlated with M_{ij} but uncorrelated with N_{ij}. For the choice of the instrument, we follow Beine et al. [2011] and use the existence of guest worker programs in the 60's and 70's as an instrument for M_{ij}. Guest worker programs were implemented after the second world war in a lot of industrialized countries to attract economic migrants for the explicit purposes of working in specific industries like coal mines or steel factories. They were mostly dropped at the beginning of the 70's. Those bilateral agreements led to the building of important diasporas in the destination countries and are good predictors of the value of the migrant networks in 2000. In contrast, those bilateral agreements did not change the subsequent bilateral migration policies in general, and certainly not the one concerning students.

The results of that estimation for the year 2007 are reported in Table 3. Once again we consider two measures of the migrants network. In column (2) we report the results with the total network while in column (3) we use only the skilled network. The results are in line with those of Table 2 and suggest that the network effect is not an artefact associated to the correlated effect problem. In particular, we find a positive elasticity of the students flows with respect to the stock of migrants. We also find that the elasticity is higher for the skilled network, although the difference is less important.

Table 3: Determinants of student's migration -
GMM estimates instrumenting network

Variables	Total network (2)	Skilled network (3)
Distance	-0.361***	-0.458***
	(0.045)	(0.040)
Colony	-0.009	0.111***
	(0.189)	(0.143)
Language	0.503***	0.288***
	(0.136)	(0.114)
Network	0.412***	0.482***
	(0.036)	(0.033)
# obs	2301	2301
Origin FE	yes	yes
Destin FE	yes	yes

Notes: Estimation period : 2007
Column (2): network equals stock of all migrants
Column (3): network equals stock of migrants with tertiary education.
Robust standard errors in GMM estimates
Instrument : presence of guest worker programs

5.2.2 The role of destination specific variables

The previous analysis does not allow to capture factors that are specific to destination countries. Among those factors, variables that are related to attractiveness such as the prestige of the universities at destination can be of tremendous importance. Also, since cost of living and education fees vary a lot across destinations, this should play a significant role in the decision made by students about moving abroad to complete their education.

Therefore we estimate model (9) and focus on the role of destination specific variables. Given that the inclusion of observable destination specific factors leaves out unobserved factors that were previously captured by the destination fixed effects, this specification is sub-optimal from a pure statistical point of view. We should expect that the goodness of fit is lower and that the role of bilateral variables such as the network is not so well captured in this estimation. In contrast, the model allows to recover the impact of destination specific factors. We consider five destination specific factors: population size which is a proxy of the host capacity for students in general; fees and living costs that are the most important cost components for students; ranking of university as a variable capturing quality of the universities of that country; skill prices prevailing in destination countries.

The estimation of the impact of destination specific factors yields interesting insights. Ranking, as a proxy of the average quality of the universities, is clearly significant as a powerful magnet for foreign students. The positive impact is robust across all specifications included in Table 4. It is also robust to the choice of the exact ranking (Top 100 vs Top 500) we refer to. The results support the idea that housing costs play an important role in the migration and enrollment of foreign students. In contrast to fees which embed several possible effects, living expenses are clearly an important cost component of foreign education.[12]

Table 4: Determinants of student's migration -
Regressions with destination specific factors

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Constant	43.078***	41.714***	41.554***	43.137***	38.821***	39.821***
	(3.499)	(3.893)	(3.784)	(4.354)	(3.911)	(3.643)
Distance	-0.372***	-0.474***	-0.426***	-0.361***	-0.552***	-0.515***
	(0.063)	(0.076)	(0.062)	(0.059)	(0.066)	(0.066)
Colony	-0.691***	-0.348	-0.477***	-0.477***	-0.178	-0.327*
	(0.201)	(0.212)	(0.179)	(0.187)	(0.166)	(0.179)
Language	1.090***	1.070***	1.045***	1.008***	1.540***	1.531***
	(0.189)	(0.207)	(0.198)	(0.174)	(0.143)	(0.140)
Network	0.465***	0.388***	0.421***	0.462***	0.353***	0.381***
	(0.048)	(0.053)	(0.048)	(0.051)	(0.030)	(0.029)
Population	0.493***	0.527***	0.479***	0.498***	-0.270***	-0.465***
	(0.073)	(0.071)	(0.069)	(0.071)	(0.099)	(0.146)
Ranking	0.262***	1.199***	1.294***	1.306 ***	0.387*	-0.157
	(0.093)	(0.210)	(0.177)	(0.165)	(0.213)	(0.306)
Living cost	-6.452***	-5.010***	-4.914***	-5.211***	-10.876***	-12.317***
	(0.714)	(0.606)	(0.548)	(0.698)	(0.791)	(1.297)
Fees	0.072*	0.148***	0.130***	-	0.003	-0.056
	(0.039)	(0.041)	(0.034)	-	(0.028)	(0.044)
Fees*Quality	17.39***	-	-	-	-	15.765***
	(4.84)	-	-	-	-	(6.65)
Skill prices	-	-0.051	-	-	-	-
		(0.048)	-	-	-	-
Wages	-	-	-	-	5.498***	5.537***
	-	-	-	-	(0.813)	(0.786))
# observations	2068	2068	2068	2256	1880	1880
Pseudo R^2	0.930	0.928	0.927	0.912	0.933	0.935
Origin FE	yes	yes	yes	yes	yes	yes
Destination FE	no	no	no	no	no	no

Notes: Estimation period : 2007. Poisson ML estimates.

Robust standard errors between parentheses.

Network refers to the stock of migrants observed in 2000.

Regarding the incentives to study for the sake of working afterwards in the country, we do not find any significant role for skill prices at destination (see results in column (2)). This might be due to the low variation of skill premia estimates across destination countries. Also, those skill premia are not directly observed but rather estimated, which implies that they are plagued with measurement errors. As an alternative, we use the wage level at destination, as proxied

[12]The inclusion of living costs is only possible as destination specific components in model (9). The use of the differential in living costs between the origin and destination countries would require data on living cost indexes in developing countries, which is not available worldwide. Furthermore, when available, the measures of living costs for a subset of origin countries are not comparable across countries. In contrast, the living costs in destination countries are highly comparable, which is important in a multi-destination framework like ours.

by the average wage of workers with tertiary education level. Note that, due to missing data, the number of observations is reduced, which induces a sample effect with respect to the other specifications. Nevertheless, we find support for a positive impact of wage on the destination choice. This is line with some support in favor of the migration model of Rosenzweig [2008].

The estimation results reflect some unexpected sign for the effect of enrollment fees. The direct estimation of model (9) (columns (2) and (3)) yield positive impact for the fees. This positive impact is robust to the inclusion or not of the skill prices as well as various measures of quality for the university. Clearly, the impact of fees goes well beyond a pure cost component. We therefore need to explore some alternative interpretations of the explicit channel by which fees impact the attraction of foreign students.

First, fees can also exert a signal for quality. High fees might reflect high quality, which attracts further students. To shed light on the possibility of such a signaling channel for fees, we add to the controls in model (9) an interaction term between fees and quality of universities in the country (measured by the relative presence in the Top 500 ranking). Column (1) of Table 4 displays the results. The result for the direct impact of fees remains similar, with a positive impact, albeit less significant than in the benchmark estimations (columns (2) and (3)). The interaction term between fees and quality displays a highly significant impact, which shows some support for a signaling effect of quality for fees. For countries with a high perceived quality of the tertiary education system, higher fees tend to attract further students. This result is also confirmed with wages included as potential determinants.

A second complementary interpretation of the direct positive impact of fees might be related to reverse causality. A positive impact might indeed be driven by reverse causality in the sense that countries like the United States whose universities turn out to be attractive for foreign students can afford to charge higher fees. In some universities, acceptation of foreign students might only occur if those students pay significant fees. Otherwise, there is little incentive to accept students from abroad. In universities which benefit from a good reputation of high quality and turn out to be quite attractive on a sustained basis, the university authorities can afford to set fees to high levels. This is especially true if those universities have the possibility of setting fees freely, which is more the case if they are private. In turn, grants and financial aids can be obtained by students more easily if they get admitted in universities enjoying high reputation. To test for such an interpretation, we need to instrument the fees to get rid of the possible bias triggered by the feedback effect exerted by the number of foreign students.

To address the issue of potential reverse causality from number of students to fees, we reestimate model (9) combining IV and Poisson estimators. We employ the GMM estimator (equation (11)) and use the share of the private sector in the total expenditures in the higher education system as an instrument for the fees. This ratio is clearly positively correlated with the average amount of fees. In contrast, we do not see any a priori relationship with the total number of incoming students.[13] The results are reported in Table 5. We estimate model (9) for both education levels of network. In both cases, we find that fees become insignificant in explaining the magnitude of foreign students. It is worth pointing out that this is due to a large drop in the value of the coefficient and not only to a blow-up of the standard errors associated to the instrumentation process.

[13]Furthermore, statistically speaking, this variable has only one dimension (destination specific) while the dependent variable N_{ij} is dyadic. This should lead to a low correlation.

Table 5: Determinants of student's migration -
Accounting for reverse causality in fees

Variables	Total network (2)	Skilled network (3)
Distance	0.002	-0.232***
	(0.129)	(0.052)
Colony	-0.688	-0.277
	(0.434)	(0.203)
Language	0.706*	0.119
	(0.366)	(0.176)
Network	0.589***	0.557***
	(0.056)	(0.045)
Population	0.333***	0.241***
	(0.103)	(0.078)
Ranking	1.624***	1.246***
	(0.217)	(0.169)
Living cost	-8.864***	-7.937***
	(1.457)	(1.219)
Fees	0.032	0.047
	(0.075)	(0.029)
# obs	1770	1770
Origin FE	yes	yes
Destination FE	no	no

Notes: Estimation period : 2007.
Column (2): network equals stock of all migrants.
Column (3): network equals stock of migrants with tertiary education.
Robust standard errors in GMM estimates.
Instrument : share of private sector in education expenditures.

The insignificance of fees along with the strong impact of the living costs might be rationalized by the fact that foreign students often benefit from grants. For instance, in the US, foreign students often benefit from stipends or fellowships paying for registration fees, which they receive from their government or some other organizations (e.g., the Ford Foundation), from their employer back home, or even from the universities themselves.[14] Housing costs may matter possibly because the financial support does not always cover living expenses. The use of international grants could potentially be interesting in the econometric analysis to test for the validity of this conjecture. Unfortunately, data on international grants are difficult to find in a comparable form across destination countries.

[14] The Open Doors Report of the Institute of International Education (IEE [2010]) shows that the international students in the US must rely on their own funds to pay for their education - 63,5% of their primary source of funds come from personal and family sources and 36,5% from financial aid like grants and scholarships or fellowships. The amount of financial aid from U.S. college or universities stands at 24% of the total primary source of financing. These figures should not hide a large heterogeneity among foreign students in the US : The share of financial aid drops to 16% for undergraduates and rises to 49.4% for graduates.

5.2.3 Alternative regression methods

Our econometric estimations rely on Poisson estimates. As argued before, the choice of this approach is motivated by the particular pattern of student flow data, including the significant proportion of zero values for those flows. Other estimation methods have been used in the migration and trade literature. In Appendix 2, we present the results obtained by four of the most popular methods used by researchers.

It should be emphasized that depending on the statistical context, alternative methods might exhibit some problems. Simple OLS method applied to the log of flows induce a selection bias and some correlation between the covariates and the error term in the presence of heteroskesaticity (Santos Silva and Tenreyro [2006]). The use of the log of 1 plus the observed flow gets rid of the selection bias but not of the the second issue. Heckman two-step regressions take explicitly the selection bias into account but are also less suited to account for the correlation with the error term; Tobit regressions also deal with zero values but assumed a truncation process. If the recorded zero values are true zeroes and do not result from some truncation process, then the estimates are also likely to suffer from estimation bias. To sum it up, our benchmark regression method, namely ML Poisson, assumes that the observed zeroes are true, does not suffer from a selection bias due to the zeroes and takes care of some correlation between covariates and the error term in presence of heteroskedastic errors. The possible diverging results between the four alternative methods and the ML Poisson partly reflect the issues mentioned here above.

Table 11 in Appendix 2 gives the results for the bilateral determinants. All in all, the results are quite consistent with the Poisson estimates. Networks, distance and linguistic links produce similar effects. Interestingly, in all regression methods, skilled networks display a higher elasticity than total network. Table 12 also gives the results for destination specific results. There is some degree of divergence with respect to Poisson regression results. For instance, ranking does not come out with the intuitive positive sign, which casts some doubt on the consistency of these estimates. Also, when combined with our measures of skilled wages, population does not display the expected positive impact. Note however that measures of wages for skilled workers are not available for all destination countries, which significantly reduces the number of country pairs. In contrast, we have consistent results regarding the influence of living costs and fees. In particular, tuition fees do not display the negative impact that would be associated to the natural interpretation of fees as a component of education cost. In that regard, those results support the ones obtained for fees with Poisson regressions. In all regressions, living costs appear to be significant cost factors for students, which is fully in line with benchmark regressions.

5.2.4 Cost Subsidy Equivalent Measures

Networks and quality of universities have been found to be statistically significant determinants of student migration. For policy purposes it is also interesting to get an idea of the order of magnitude of the effects of those variables. One way of quantifying (in monetary terms) these effects is to apply a methodology similar to the *tariff-equivalent* measures used in international trade literature to quantify the impact of non-tariff barriers. This tariff-equivalent is defined as the tariff that would produce the same effect, usually on the quantity of imports, as the non-tariff barrier (Anderson and van Wincoop [2004]).

In the same perspective, our objective is to measure here in monetary terms the effects of network and ranking on the number of international students attracted in the destination. To that aim, we compute *living costs subsidy-equivalent measures.* Our econometric results confirm that network and the quality of the higher education system have a positive impact on the attractiveness of a destination country. This effect is similar to the the one obtained by reducing the living costs through a subsidy. This *living costs subsidy-equivalent* measure is therefore defined as the subsidy rate needed to achieve the living costs level needed to compensate the absence of any network effect given the observed stock of migrants.[15] We do that for the network including all migrants[16] (or alternatively only migrants with tertiary education[17]) from an origin country. We compute the same living costs subsidy-equivalent measure to compensate for the loss of one university of the destination country in the Shanghai top 500 ranking[18].

Table 6: *Living cost subsidy-equivalent* of network and ranking

Destination	Total network$^{(a)}$	Skilled network$^{(b)}$	Ranking$^{(c)}$
Australia	48.62%	34.90%	1.04%
Belgium	50.52%	27.44%	2.42%
Canada	48.44%	40.02%	-
Denmark	42.09%	21.23%	4.01%
Germany	48.43%	39.68%	0.44%
Ireland	40.04%	32.55%	5.13%
Netherlands	52.20%	28.64%	1.46%
New Zealand	44.30%	26.02%	3.29%
Spain	48.41%	34.85%	1.91%
Sweden	43.36%	37.61%	1.58%
Switzerland	48.47%	28.78%	2.13%
United Kingdom	49.41%	37.50%	0.43%
United States	49.63%	45.59%	0.11%

(a) Aggregate subsidy rate needed to attain the living costs level that would offset the absence of network effect associated to all migrants.
(b) Aggregate subsidy rate needed to attain the living costs level that would offset the absence of network effect associated to skilled migrants.
(c) Subsidy rate needed to attain the living costs level that would offset the loss of one university in the in the top 500 Shanghai ranking.

Since migrants network is a dyadic variable, we compute for each country pair and for both types of network the living costs subsidy-equivalent . Then, starting from the subsidy rate to be applied for each origin country, we can calculate the aggregate subsidy for each destination by summing up the bilateral measures and weighting by the numbers of international students. This aggregate subsidy-equivalent measure shows the importance of network effect in the attractiveness of all these countries. It amounts to a living cost subsidy ranging from 40% in Ireland to 52.2% in the Netherlands, when we take into account the total stock of migrants. It also applies to the skilled network: we obtain subsidy rates between 21.2 % in Denmark to 45.6% in the USA. This subsidy rate is lower than the rate obtained for total immigration but we should bear in mind that skilled immigrants represent only 17% of total immigration in Denmark and up to 58% in Canada. Thus, in relative terms, the effect is larger for skilled network.

While the coefficient of university ranking is positive and significant, the computation of the living costs subsidy-equivalent yields a moderate effect: one less University in the Shanghai top 500 is offset by a subsidy rate of 0.1% for the USA and 5.1% for Ireland. This limited effect of higher education quality was also established in Perkins and Neumayer [2012].

[15] This subsidy rate measures the decline in relative terms that would be required to have the same number of international students in a country in the absence of network effect or one less university in the Shanghai ranking.

[16] Column 2 of table 6.

[17] Column 3 of table 6.

[18] Column 4 of table 6.

6 Conclusion

In this paper, we have analyzed the determinants of international student mobility. Unlike the previous literature, we use a multi-origin multi-destination framework to identify the main factors at stake. Relying on a small theoretical model of human capital investment, we focus on two types of factors: those affecting the migration costs such as distance and migrants' network at destination and those affecting the attractiveness of the destination such as the quality of universities, education costs and host capacity. We estimate the importance of those factors using data covering more than 180 origin countries and 13 destination countries. Our data cover more than 75 % of the total international student migration flows.

In the estimation, we control for the high prevalence of zero values for the bilateral flows as well as the potential econometric problems affecting the quality of our estimates. Those problems are the correlated effects between network and the dyadic unobserved determinants of flows as well the reverse causality running from education fees to student flows at equilibrium. This calls for the use of econometric techniques combining Poisson estimates and instrumental variables.

Our main findings are the following ones. First, we find a strong network effect for international students. The presence of country nationals at destination tends to act as a magnet for international students. Interestingly, this effect is found to increase with the level of education of the network at destination. Second, we find that quality of education at destination is a (moderated) attractor for international students. Furthermore, in contrast with living costs, education fees do not seem to act purely as a cost component of foreign education. We find some support for a signaling effect of quality for fees. This might be explained by the fact that fees are very often covered by grants benefiting to international students. Integration of data on grants to international students would be a desirable extension of this work to dig further into this interpretation. Another complementary explanation is that countries with high reputation universities can afford to raise fees as the demand exceeds the number of vacant slots. Our instrumental variable estimation also supports this interpretation.

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Appendix1: data

Table 7: Origin of students in mobility in 2008 (shares by continent)

Destination	Total from Africa	Total from Asia	Total from Europe	Total from North America	Total from Oceania	Total from South America	Not specified	Total from all countries	Total from OECD countries
Australia	3,2	79,3	4,4	3,2	1,8	1,2	6,9	100	12.5
Belgium	16,5	8,6	70,9	0,7	n	2,4	0,9	100	68,6
Canada	11,3	47,6	11,1	9,5	0,4	7,4	12,7	100	22,1
Denmark	2,6	21,4	72,1	1,7	0,2	1,3	0,6	100	68,4
Germany	9,1	33,0	43,6	1,9	0,2	4,1	8,0	100	33,4
Iceland	1,8	8,9	79,2	7,1	1,0	2,1	n	100	75,1
Ireland	4,6	27,5	30,2	26,4	n	0,9	10,4	100	56,3
Netherlands	2,2	10,4	55,9	0,6	0,1	1,8	29,0	100	54,1
New Zealand	1,0	66,9	10,1	8,8	12,2	1,1	n	100	29,8
Slovak Republic	1,4	15,6	81,9	0,5	n	0,6	n	100	73,9
Spain	6,5	1,4	22,7	1,2	n	28,3	39,8	100	26,3
Sweden	4,6	27,7	20,8	1,3	0,2	1,6	43,9	100	19,8
Switzerland	2,8	4,1	28,5	1,1	0,1	2,1	61,3	100	27,2
United Kingdom	9,6	47,9	33,3	5,7	0,7	2,3	0,6	100	39,6
United States	5,7	67,2	11,2	4,7	0,8	10,3	n	100	34,7
Total OECD countries	10,1	48,9	24,5	3,7	0,8	5,3	6,8	100	31,0
Total countries	11,6	49,9	23,0	3,1	1,0	6,0	5,3	100	25,9

Source : OECD [2010]

Table 8: Students in mobility compared to the flows of foreign workers (2007)

Destination	Students in mobility as a % of total enrolment	Per 1 000 population	International students (stock) (1)	Inflows of foreign-born labour (2)	(1)/(2)
Australia	19,5	10,1	211 500	148 100	1,43
Austria	12,4	3,9	32 400	29 600	1,09
Belgium	7,5	2,4	25 200	23 000	1,10
Canada	7,7	2,1	68 500	164 900	0,42
Denmark	5,5	2,3	12 700	17 200	0,74
Finland	4,1	2,4	12 700	23 000	0,55
Germany	-	2,5	206 900	380 300	0,54
Ireland	8,8	4	16 800	23 600	0,71
Japan	2,9	0,9	115 100	77 900	1,48
Netherlands	4,7	1,7	27 400	50 000	0,55
New Zealand	13,6	7,8	33 000	12 400	2,66
Norway	2,2	1	4 800	54 800	0,09
Spain	1,8	0,7	32 300	102 500	0,32
Switzerland	14	2,4	29 800	74 300	0,40
United Kingdom	14,9	5,8	351 500	88 000	3,99
United States	3,4	2	595 900	666 100	0,89

Source : OECD [2010]

Table 9: Category of students and criterion used (by country)

Category of students and criterion used	
International students	
Australia	Non-resident students of reporting country
Belgium	Non-resident students of reporting country
Canada	Non-resident students of reporting country
Denmark	Non-resident students of reporting country
New Zealand	Non-resident students of reporting country
Slovak Republic	Non-resident students of reporting country
Spain	Non-resident students of reporting country
Sweden	Non-resident students of reporting country
United Kingdom	Non-resident students of reporting country
United States	Non-resident students of reporting country
Germany	Students with prior education outside the reporting country
Ireland	Students with prior education outside the reporting country
Netherlands	Students with prior education outside the reporting country and non-resident of the reporting country since 2005
Switzerland	Students with prior education outside the reporting country
Foreign students (non-citizen students of reporting country)	
Austria	
Czech Republic	
Finland	
France	
Greece	
Hungary	
Iceland	
Italy	
Japan	
Korea	
Luxembourg	
Norway	
Poland	
Portugal	
Turkey	

Table 10: International students versus foreign students (2007)

Destination	International students (1)	Foreign students (2)	(1)/(2)
Australia	211 500	244 300	0,87
Austria	32 400	43 600	0,74
Belgium	25 200	41 400	0,61
Canada	68 500	132 200	0,52
Denmark	12 700	20 900	0,61
Finland	12 700	10 100	1,26
Germany	206 900	258 500	0,80
Ireland	16 800	-	-
Japan	115 100	125 900	0,91
Netherland	27 400	37 600	0,73
New Zealand	33 000	65 000	0,51
Norway	4 800	15 600	0,31
Spain	32 300	59 800	0,54
Switzerland	29 800	41 100	0,73
United Kingdom	351 500	460 000	0,76
United States	595 900	-	-
Mean	-	-	0,71

Source : OECD

Appendix2: Alternative estimation methods

Table 11: Bilateral determinants: alternative regression methods

	Total network				Skilled network			
Method	(OLS)	(OLS)	(Heckman)	(Tobit)	(OLS)	(OLS)	(Heckman)	(Tobit)
Variables	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	5.386***	9.568***	12.259***	13.063***	12.259***	7.901***	11.595***	12.432***
	(0.650)	(0.612)	(0.631)	(0.625)	(0.581)	(0.628)	(0.629)	(0.624)
Distance	-0.874***	-0.728***	-0.866***	-0.919***	-0.698***	-0.587***	-0.839***	-0.894***
	(0.055)	(0.049)	(0.050)	(0.054)	(0.055)	(0.048)	(0.050)	(0.053)
Colony	0.792***	0.671***	0.800***	0.794***	0.716***	0.571***	0.722***	0.717***
	(0.139)	(0.144)	(0.134)	(0.137)	(0.137)	(0.141)	(0.132)	(0.135)
Language	0.859***	0.612***	0.784***	0.913***	1.130***	1.007***	0.856***	0.830***
	(0.101)	(0.086)	(0.091)	(0.097)	(0.166)	(0.194)	(0.091)	(0.097)
Network	0.236***	0.224***	0.256***	0.243***	0.299***	0.406***	0.317***	0.304***
	(0.018)	(0.015)	(0.015)	(0.018)	(0.021)	(0.018)	(0.017)	(0.020)
# obs	1929	2444	2444	2444	1929	2442	2444	2444
# orig c	203	203	203	203	203	203	203	203
# dest c	13	13	13	13	13	13	13	13
R^2	0.811	0.835	-	0.398	0.812	0.841	-	0.402
Orig FE	yes	yes	yes	yes	yes	yes	yes	yes
Dest FE	yes	yes	yes	yes	yes	yes	yes	yes

*, ** and *** denote significance at the 10, 5 and 1% significance levels.
For all regressions, network refers to the stock of migrants observed in 2000.
Columns (2) and (6): dependent variable: log of number of students
Columns (3) and (7): dependent variable: log of (number of students+1)

Table 12: Destination specific determinants: alternative regression methods

	Total network				Skilled network			
Method	(OLS)	(OLS)	(Heckman)	(Tobit)	(OLS)	(OLS)	(Heckman)	(Tobit)
Variables	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	15.059***	9.360***	12.742***	12.365	12.819***	6.642***	10.715***	10.182***
	(2.450)	(2.018)	(2.748)	(2.206)	(2.387)	(1.949)	(2.429)	(2.186)
Distance	-0.874***	-0.466***	-0.650***	-0.756***	-0.572***	-0.472***	-0.651***	-0.756***
	(0.055)	(0.051)	(0.059)	(0.054)	(0.052)	(0.048)	(0.052)	(0.052)
Colony	0.792***	0.668***	0.641***	0.780***	0.618***	0.667***	0.666***	0.789***
	(0.139)	(0.148)	(0.173)	(0.136)	(0.137)	(0.142)	(0.152)	(0.134)
Language	1.125***	0.885***	1.300***	1.366***	1.337***	0.979***	0.745***	1.190***
	(0.125)	(0.095)	(0.123)	(0.110)	(0.121)	(0.115)	(0.092)	(0.111)
Network	0.327***	0.310***	0.388***	0.235***	0.396***	0.396***	0.459***	0.311***
	(0.019)	(0.016)	(0.020)	(0.020)	(0.020)	(0.020)	(0.019)	(0.022)
Population	-0.019	0.040	-0.090	-0.020	-0.005	0.036	-0.058	-0.043
	(0.070)	(0.055)	(0.075)	(0.068)	(0.068)	(0.052)	(0.065)	(0.065)
Ranking	-0.016	-0.131	-0.162	-0.187*	-0.043	-0.182**	-0.160	-0.252**
	(0.119)	(0.089)	(0.122)	(0.109)	(0.116)	(0.085)	(0.111)	(0.106)
Living cost	-6.473***	-5.381***	-7.127***	-6.881***	-5.542***	-4.359***	-5.855***	-6.093***
	(0.499)	(0.418)	(0.543)	(0.442)	(0.791)	(0.400)	(0.480)	(0.429)
Fees	-0.047**	-0.028**	-0.025	0.050***	-0.042**	-0.020	-0.019	0.050***
	(0.019)	(0.014)	(0.017)	(0.015)	(0.019)	(0.013)	(0.015)	(0.019)
Wages	4.841***	4.397***	5.669***	5.805***	4.158***	3.769***	4.764***	5.291***
	(0.341)	(0.259)	(0.366)	(0.298)	(0.337)	(0.254)	(0.319)	(0.292)
# obs	1455	1880	1880	1880	1455	1880	1880	1880
# orig c	203	203	203	203	203	203	203	203
R^2	0.749	0.779	-	0.365	0.812	0.841	-	0.372
Orig FE	yes	yes	yes	yes	yes	yes	yes	yes
Dest FE	no	no	no	no	no	no	no	no

*, ** and *** denote significance at the 10, 5 and 1% significance levels.
For all regressions, network refers to the stock of migrants observed in 2000.
Columns (2) and (6): dependent variable: log of number of students
Columns (3) and (7): dependent variable: log of (number of students+1)