# CREA
# Discussion
# Paper
## 2017-15

### Economics

# Understanding the Impact of Tuition Fees in Foreign Education: the Case of the UK

*available online : http://wwwfr.uni.lu/recherche/fdef/crea/publications2/discussion_papers*

Michel Beine, CREA, Université du Luxembourg,IZA, CREAM and CES-Ifo,
Marco Delogu, Université du Luxembourg et Université catholique de Louvain
Lionel Ragot, Université Paris Nanterre, EconomiX and CEPII,France

August, 2017

UNIVERSITÉ DU
LUXEMBOURG

# Understanding the Impact of Tuition Fees in Foreign Education: the Case of the UK.

Michel Beine[a] , Marco Delogu[b] and Lionel Ragot[c]

[a] University of Luxembourg, IZA, CREAM and CES-Ifo,162a, avenue de la Faiencerie, L-1511 Luxembourg,

[b] University of Luxembourg and University of Louvain,

[c] University Paris Nanterre, EconomiX and CEPII.

August 31, 2017

## Abstract

This paper studies the determinants of international students' mobility at the university level, focusing specifically on the role of tuition fees. We first develop an original Random Utility Maximization model of location choice for international students in the presence of capacity constraints of the hosting institutions. The last layer of the model gives rise to a gravity equation. This equation is estimated using new data on student migration flows at the university level for the U.K. We control for the endogeneity of tuition fees by taking benefit of the institutional constraints in terms of tuition caps applied in the UK to European students at the bachelor level. The estimations support a negative impact of tuition fees and stress the need to account for the endogenous nature of the fees in the empirical identification of their impact. The estimations also support an important role of additional destination-specific variables such as host capacity, the expected return of education and the cost of living in the vicinity of the university.

**JEL Classification:** F22, H52, I23, O15.

**Keywords**: Foreign students; Tuition fees; Location choice; University Quality.

# 1 Introduction

International mobility of students has significantly increased over the last 40 years. Between 1975 and nowadays, the number of foreign students across all countries of the world has been multiplied by more than 6. The proportion of foreign students as a share of all students at the tertiary educated level has increased in all developed countries. In some countries such as Australia and the UK, this proportion amounts to more than 15% overall, and more than 50% in some topics such as economics or business. Such a phenomenon is obviously related to factors both at the demand and the supply sides.

The attraction of foreign students yields significant benefits for many actors in the destination countries. First, it is increasingly important for universities. Given the institutional arrangements, universities are often constrained by tuition caps applied to domestic students. In contrast, they are often allowed to charge higher tuition fees to foreign students, generating an important additional source of funding. For instance, the average share of the budget due to the tuition fees paid by the foreign students amounts nowadays to 40% across Australian universities. The attraction of foreign students allow also the development of specific education programs that could not be organized only with domestic students. Foreign students are also important for the economic development of regions and cities. Many cities favor the development of their university, and try to benefit from the various spillovers that these institutions generate for the public and private sectors. For governments too, attracting foreign students is also an important objective in the global race for talented workers. Governments attract promising students and provide, through foreign education, the skills needed and valued by their domestic labor market. In this respect, the immigration policies devoted to foreign students have increasingly favoured their arrival by relaxing the conditions needed to obtain a student visa. Foreign students are furthermore increasingly allowed to work in order to cover their educational costs. Some countries also introduced special transition visas favouring the integration of the foreign graduates in the domestic labour market. Given the various advantages yielded by the inflow of foreign students, it is crucial to understand the role of the various determinants of location choice for prospective students. This is what this paper does, both from a theoretical and an empirical point of view.

This paper contributes to the literature on the identification of factors influencing students' decision regarding the choice of a specific university once they have decided to study abroad. We look at the issue from a theoretical and an empirical point of view. At the theoretical level, we develop an original Random Utility Maximization model of location choice for international students. The model is adapted to specific aspects regrading the attraction of the students. The inflow of foreign students is often subject to quotas set up at the university level. The model therefore accounts for the existence of such quotas and derive, under some assumptions, an equilibrium condition that satisfies these constraints. Our RUM model also integrates other factors that are specific to the future students such as the prospects of jobs after graduation. These prospects are in turn related to the perceived quality of the university and the state of the economy of the area where the university is located. At the empirical level, we use the equilibrium condition of our model to assess the

importance of the potential determinants of the location choice for students. To that aim, we use data for the U.K. at the university level and estimate the impact of factors such as the tuition fees, quality of the university, expected income in the vicinity of the university and capacity constraints. Such an analysis, conducted at the university level, is new to the literature.[1]

In the empirical part of the paper, we assess the importance of various determinants of foreign students, using data at the university level for the U.K. for the academic year 2011-2012. Unlike the countries from Continental Europe such as France, Belgium or Germany (except Italy), the U.K. universities exhibit significant variation in the tuition fees across its higher education providers. This in turn allows us to study the role of fees for foreign students when choosing one specific location. This is in addition to other institutional characteristics such as the quality of education, host capacity, expected income and the cost of living. We compile and use data on foreign student flows between all countries of the world and each U.K. university under investigation. Our econometric framework, derived from a traditional Random Utility Model (RUM), adapted to student migration, pays special attention to the role of tuition fees. In the econometric investigation, we explicitly take into account the endogenous nature of these fees.

Our model considers tuition fees as a component of the education cost, and derives a negative impact of the level of fees on the size of the inflow of foreign students in a given university. When endogeneity is properly taken into account in the econometric analysis through the use of tuition caps for first cycle students, our empirical results show support of such a theoretical prediction in the case of the U.K.. Like the Italian case (Beine et al. (2017a)), we show that accounting for the endogeneity nature of fees is key to uncover such a result. This is something new in the literature devoted to the determinants of foreign students. Previous investigations that did not find any impact of fees or even a positive influence on the attractiveness are likely to be plagued by the endogeneity issue of tuition fees. In parallel, we find support for the role of the quality of the university, a result already found in some previous work (Beine et al. (2014); Van Bouwel and Veugelers (2013)). We also find that the host capacity of the university plus the expected return on education in the city where the education is acquired are important, in line with the spirit of the migration model of foreign education (Rosenzweig (2008)).

While our paper conducts the analysis with universities as the destination, most of the literature makes use of country-level data. A part of the existing literature using cross-country data considers multiple origins of these foreign students.[2] While a cross-country analy-

---

[1] See nevertheless Beine et al. (2017a) that propose a companion paper to this one. The current version of this paper is indeed the result of a split from a larger working-paper that conducted such an investigation for Italy and the U.K. (see Beine et al. (2016)) . The econometric approach used in the companion paper for Italy ( Beine et al. (2017a)) is nevertheless quite different. In particular, the way endogeneity is addressed in Beine et al. (2017a) relies on a classical IV strategy using the status of the university. In contrast, as explained below, this paper makes use of the institutional caps on fees in place in different regions of the U.K. The results are nevertheless qualitatively similar.

[2] Bessey (2012) focuses on foreign students in Germany, finding that the stock and the flow of students of the same nationality are positively correlated. Dreher and Poutvaara (2008) and Rosenzweig (2006) look at the determinants of foreign education in the United States. The papers stress the importance of

sis is important to understand the reasons for the uneven distribution of students across destination countries, information at the country level conceals significant variation among universities of the same country. For instance, the average national quality of universities might not accurately reflect the attractiveness of the country as a provider of tertiary education. Foreign students might concentrate, for instance, on the upper tier of universities in the country. The distribution of foreign students across U.K. Universities confirms that it is definitely the case. Therefore, the fact that a country hosts many universities of relatively modest quality might not be an important factor, at least for explaining inflows of foreign students to that country. This in turn stresses the need for using information at the university level. The same applies to fees. The average level of fees might not mean anything for students since they might end up relatively good universities charging relatively higher fees. To overcome this limitation, we study the role of these factors, observed at the university level. Such an investigation is unique in the literature in that respect.

Our paper is obviously related to an important part of the literature devoted to international migration. The recent literature devoted to the location choice of international migration has relied extensively on micro-founded Random Utility Maximisation (RUM). RUM models have been mostly used to uncover the decision of location of economic migrants.[3] This framework has been used to uncover the role of various determinants such as wage levels (Grogger and Hanson (2011)), networks (Beine et al. (2011)), business cycles (Beine et al. (2017b)) or multilateral resistance to migration (Bertoli and Fernández-Huertas Moraga (2013)). The RUM model has also been sparsely used to derive estimable equations for the inflows of foreign students in a gravity framework. In that respect, Beine et al. (2014) derive an equilibrium condition leading to an econometric specification of the location choice of foreign students across countries. The current paper extends on that by integrating in the RUM models an important feature of the process governing the intake of foreign students, namely the existence of quotas set up at the university level. That feature is particularly important for understanding the inflow of foreign students in the U.K., as emphasized by Machin and Richard (2017). Our theoretical model is the first one accounting for the exis-

---

networks (Dreher and Poutvaara (2008)) and skill premium (Rosenzweig (2006)). Other studies combine various origins and destinations, carrying out estimations with a gravity model. Perkins and Neumayer (2014) consider many origin (151) and destination countries (105) over a couple of years and evaluate the role of geographic factors. Van Bouwel and Veugelers (2013) look at student migration among 18 European countries and assess the role of university quality, which was evaluated through the number of institutions appearing in the most widely known international university rankings. They show that quality matters but tend to find a positive impact of tuition fees. Beine et al. (2014) derive a gravity specification and focus on the 13 main destinations for foreign education. They estimate the role of determinants such as networks, quality and fees in explaining the extent of the bilateral flows of foreign students. Regarding fees, while they fail to identify a negative impact of tuition fees, they do show that the positive impact of fees obtained in "*naive*" regressions might be due to endogeneity. Other interesting papers of the literature using dyadic flows include Abbott and Silles (2015), Jena and Reilly (2013), González et al. (2011), Kahanec and Králiková (2011). Gravity models have also been used to explain student mobility between regions of the same country. See for instance Agasisti and Dal Bianco (2007) for Italy. Alecke and Mitze (2013) and Bruckmeier et al. (2013) exploited German data and give a special attention to the role of tuition fees. Bertrand-Cloodt et al. (2017) look at the joint choice of migrating and starting a Phd for Dutch graduates.

[3]See Beine et al. (2015) for a survey.

tence of quotas to derive an equilibrium equation of the choice of migrants across a set of potential destinations.

Another important contribution is our focus on the role of tuition fees in the choice of location by foreign students. The literature has failed to find a clear negative impact of fees on the size of foreign student inflows.[4] This global result might on the one hand be rationalized in a theoretical way if fees are seen as a signaling device in the presence of asymmetric information. If quality of a given university is difficult to assess, higher fees might signal better quality, attracting further students. On the other hand, while this mechanism is not to be ruled out, we nevertheless think that tuition fees is mainly a component of the education cost for foreign students. Embedding this idea in our RUM model, we derive an expected negative impact of tuition fees on the attractiveness of the university. Using U.K. data at the university level, we find some empirical support for this negative impact when endogeneity of fees is accounted for. Our approach to deal with endogeneity relies on the use of regional caps for first cycle foreign students coming from the European Union. Universities located in regions such as Scottland imposing lower fees receive more European students than their counteparts in teh U.K., for a given level of quality, host capacity and cost of living. Furthermore, we show that a careful causal identification is key: failure to use a sample of students subject to tuition fees does not yield the negative impact of tuition fees.

The paper is structured as follows. Section 2 presents our theoretical model of location choice for foreign students. Section 3 is devoted to the exposition and clarification of the data that we use in the econometric estimation. Section 4 presents the estimable gravity equations, discusses the main econometric issues and presents the results. Section 5 concludes.

# 2    A RUM model of foreign students

This section derives a tractable students' migration equation from a simple theoretical model based on the human capital literature and on the random utility maximization approach to migration. Education is considered 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 in a university at home with the present value of future earnings if education is obtained at a university abroad. If the increase in the present value of the future income is greater than the cost of migrating (plus the other education costs), students would move to the university yielding the highest net present value. This is conditional because each university might face capacity constraints or impose quotas on foreign students. Therefore, there is a role for capacity constraints.

In the model, studying at home does not rule out migration after graduation for the sake

---

[4]This contrasts with the literature focusing on native students.Alecke and Mitze (2013) study how an increase in the level of tuition fees charged in Germany affected the internal mobility of students. Bruckmeier and Wigger (2015) address the same increase, focusing on how it relates to the time of graduation.

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. A student's location decisions before and after education are not independent but are taken sequentially. We develop here the decision process in terms of education location.

## 2.1 Students' Choice

The set of destination countries is $D = \{d_1, ..., d_{n_d}\}$ with $n_d$ denoting the number of destination countries ($j$ is the index for destination country). The set of origin countries is $O = \{o_1, ..., o_{n_o}\}$ with $n_o$ the number of origin countries ($o$ is the index for the origin country). Countries can be both inside $D$ as well as inside $O$. The set of universities in country $d$ is $U^d = \{u_1^d, u_2^d, ..., u_{n_u^d}^d\}$ with $n_u^d$ the total number of universities in country $d$ ($u^d$ is the index for university in country $d$). The set of young people in each country $o$ who want to pursue studies in higher education is $S^o = \{s_1^o, s_2^o, ..., s_{N_s^o}^o\}$, with $N_s^o$ the total number of young people in country $o$ who wish to study. The index for student is $s$.

Let the utility derived from studying in university $u^d$ located in country $d$ of student $s$ from country $o$ ($VS_{o,d,u^d}^s$) be expressed as:

$$VS_{o,d,u^d}^s = VS_{o,d,u^d}\left(IW_{d,u^d}^s, CM_{o,d}, CS_{u^d}, CL_{u^d}, A_d\right) + \epsilon_{o,d,u^d}^s \tag{1}$$

where $IW_{d,u^d}^s$ is the intertemporal expected value of labor income after graduating from university $u^d$, $CM_{o,d}$ a vector of country-pair migration costs; $CS_{u^d}$ the cost of education (here the fees of university $u^d$); $CL_{u^d}$ the cost of living in the city of university $u^d$ and $A_d$ some country-specific unpriced amenities. Utility is separated into two parts. One part is deterministic and varies by origin and university destination pair $VS_{o,d,u^d}\left(W_{d,u^d}^s, CM_{o,d}, CS_{u^d}, CL_{u^d}, A_d\right)$. The other part is stochastic and captures unobserved components of the individual utility associated with each university choice ($\epsilon_{o,d,u^d}^s$).

Although decisions to migrate for educational purposes and for work are taken sequentially, the student forms (simplistic) expectations about working period when he/she decides on the educational location. The expected wage indeed depends on the level and the quality of education which is university-specific. We suppose that students form myopic expectations about the expected wages by referring to the wages prevailing in the local labor market of the university.

The expected intertemporal labor income of student $s$ from country $o$ studying in university $u^d$ located in country $d$ ($IW_{o,d,u^d}^s$) is defined by:

$$IW_{o,d,u^d}^s = \int_{\underline{T}^s}^{\overline{T}} e^{-\rho t} W_{o,d,u^d}^s(.)dt \tag{2}$$

with $\underline{T}^s$ as the age of student $s$ upon graduating and $\overline{T}$ as a fixed retirement age. $e^{-\rho t}$ is a discount factor with $\rho$ the rate of time preference. Individuals have the same rate of time

preference and the same indirect utility functions.[5] $W^s_{o,d,u^d}(.)$ is the annual expected labor income.

Assuming that individuals' expectations regarding the arguments in $W^s_{o,d,u^d}(.)$ remain at the values observed at $t = 0$ over the remaining lifetime (myopic expectations), $IW^s_{o,d,u^d}$ writes:

$$IW^s_{o,d,u^d} = \frac{\left(e^{-\rho \overline{T}} - e^{-\rho \underline{T}}\right)}{\rho} W^s_{o,d,u^d}(.) \tag{3}$$

$W^s_{o,d,u^d}(.)$, the annual expected labor income of student $s$ who is a graduate of university $u^d$ in country $d$ is given by:

$$W^s_{o,d,u^d}(w_{u^d}, Q_{u^d}, \bar{Q}_d) = \left(\frac{Q_{u^d}}{\bar{Q}_d}\right)^{\beta_0} w_{u^d}$$

with $w_{u^d}$ the value of average earnings in area $u^d$; $Q_{u^d}$ the quality of education where the higher education has been attained; and $\bar{Q}_d$ the average quality of education in the country $d$. $\beta_0$ is a strictly positive parameter. A positive difference between the quality of education obtained ($Q_{u^d}$) and the average quality of education in country $d$ ($\bar{Q}_d$) implies a skill premium (the effective earnings will be greater than the local average earnings). Conversely, a negative difference will result in smaller effective earnings. The expected intertemporal labor income is then defined by:

$$IW^s_{o,d,u^d} = B \left(\frac{Q_{u^d}}{\bar{Q}_d}\right)^{\beta_0} w_{u^d} \tag{4}$$

with our assumption that $B = \frac{\left(e^{-\rho \overline{T}} - e^{-\rho \underline{T}}\right)}{\rho}$ is a constant, and the expected intertemporal labor income is not specific to an individual ($IW^s_{o,d,u^d}(.) = IW_{o,d,u^d} = (.)$).

The deterministic and observable component of utility is logarithmic:

$$VS_{o,d,u^d} = ln\left(\frac{(IW_{o,d,u^d})^{\beta_1} A_d^{\gamma_1}}{\delta_{o,d,u^d}}\right) \tag{5}$$

with $\delta_{o,d,u^d} > 1$ an iceberg total cost factor ($\delta_{o,d,u^d} = \delta(CM_{o,d}, CS_{u^d}, CL_{u^d})$). Migration from country $o$ to university $u^d$ in country $d$ involves country-pair specific costs and localization specific costs that reduce utility in an iceberg-type way.

We assume that the migration costs depend only on the destination country and not on the specific location within the country. We further assume that $CM_{o,o} = 0$. These

---

[5]In the absence of individual information in our database, we assume thereafter $\forall s \; \underline{T}^s = \underline{T}$.

migration costs, $CM_{o,d}$ are composed of two parts: fixed costs ($C_o$) and variable costs ($C_{o,d}$). The fixed part measures the costs of moving, independent of the destination country (home-specific costs) whereas the variable part depends both on origin and on destination (like transportation costs, assimilation costs). The variable migration costs depend on dyadic factors such as physical distance $d_{o,d}$; the cultural and linguistic proximity of the origin and destination countries, such as the use of a common official language ($l_{o,d}$) or the existence of colonial links ($col_{o,d}$). The migration cost function is given by:

$$CM_{o,d} = C_o + C(d_{o,d}, l_{o,d}, col_{o,d}) \tag{6}$$

We assume a fairly simple specification of the total factor cost $\delta_{o,d,u^d}$:

$$
\begin{aligned}
\ln(\delta_{o,d,u^d}) = \; & \gamma_2 \ln(C_o) + \alpha_1 \ln(d_{o,d}) + \alpha_2 \ln(l_{o,d}) + \alpha_3 \ln(col_{o,d}) + \beta_3 \ln(CS_{u^d}) + \\
& \beta_4 \ln(CL_{u^d}) - \beta_5 \ln(E_{o,u^d})
\end{aligned}
\tag{7}
$$

We then have:

$$
\begin{aligned}
VS_{o,d,u^d} = \; & \ln(B) + \beta_2 ln\left(Q_{u^d}\right) - \beta_2 ln\left(\bar{Q}_d\right) + \beta_1 ln\left(w_{u^d}\right) + \gamma_1 \ln(A_d) - \gamma_2 \ln(C_o) - \alpha_1 \ln(d_{o,d}) - \\
& \alpha_2 \ln(l_{o,d}) - \alpha_3 \ln(col_{o,d}) - \beta_3 \ln(CS_{u^d}) - \beta_4 \ln(CL_{u^d})
\end{aligned}
\tag{8}
$$

with $\beta_2 = \beta_0 \beta_1$.

A student $s$ migrates from country $o$ to study in university $u^d$ in $d$ if her utility of choosing $u^d$ is bigger than for all possible universities of any country (including $d$ and $o$), $VS^s_{o,d,u^d} > VS^s_{o,i,u^i} \; \forall u^i \neq u^d$ and $\forall i \in D$ (including $d$) .

Following the random utility approach to discrete choice problems (McFadden (1984)), the probability that student $s$ from country $o$ chooses university $u^d$ in country $d$ is defined by:

$$
\begin{aligned}
P_{o,d,u^d} \; &= \; Prob[VS^s_{o,d,u^d} > VS^s_{o,i,u^i}], & \forall u^i \neq u^d \text{ and } \forall i \in D \\
&= \; Prob[VS_{o,d,u^d} + \epsilon^s_{o,d,u^d} > VS_{o,j,u^i} + \epsilon^s_{o,i,u^i}], & \forall u^i \neq u^d \text{ and } \forall i \in D \\
&= \; Prob[VS_{o,d,u^d} - VS_{o,j,u^i} > \epsilon^s_{o,i,u^i} - \epsilon^s_{o,d,u^d}], & \forall u^i \neq u^d \text{ and } \forall i \in D \quad (9)
\end{aligned}
$$

with $\epsilon$ being an iid extreme-value distributed random term.

Following Train (2003), this probability can be decomposed into three logits. Indeed, a convenient way to represent the student's university choice is given by the decision tree (see Figure 1). The set of alternatives facing the student is divided into subsets (nests) and subsubsets (subnests). There are three levels in this tree structure. In the upper level, the

9

student decides whether to study at home (h=*Stay*) or abroad (h=*Move*). If the choice of this upper-level decision is to move abroad, there is a subsubset (a subnest) of destination countries (*Foreign country $d_1$* to *Foreign country $d_{n_d}$*) from which the student must choose his or her location (middle level of the tree). This choice is trivial for the Stay branch (nest $h = s$) as the origin country is the only choice (the subnest is defined by $o$). At the lower level, the student chooses the university where he or she would like to study. This lower-level decision consists of all the alternatives of this decision tree, denoted by $u = u_1^o, \cdots, u_{n_u^{n_d}}^{n_d}$.

We assume that the ratio of probabilities of two universities that are in the same nest ($h = s$ or $h = m$) and in the same country is independent of the characteristics of all other universities. (This corresponds to the IIA hypothesis.) For two universities in the same nest $h = m$, but in different foreign countries, this ratio of probabilities is independent of the characteristics of universities in the home country but depends on the characteristics of universities in the same nest ($h = m$) that are located in the same destination country. Finally, the ratio of probabilities of two universities in different nests ($h = s$ or $h = m$) depends on the characteristics of all the other universities in those nests. (IIA does not necessarily hold for alternatives in different nests.) With these assumptions and also assuming that the random terms follow an iid extreme-value distribution, this three-stage discrete choice model can be estimated using a nested logit (Train (2003)).
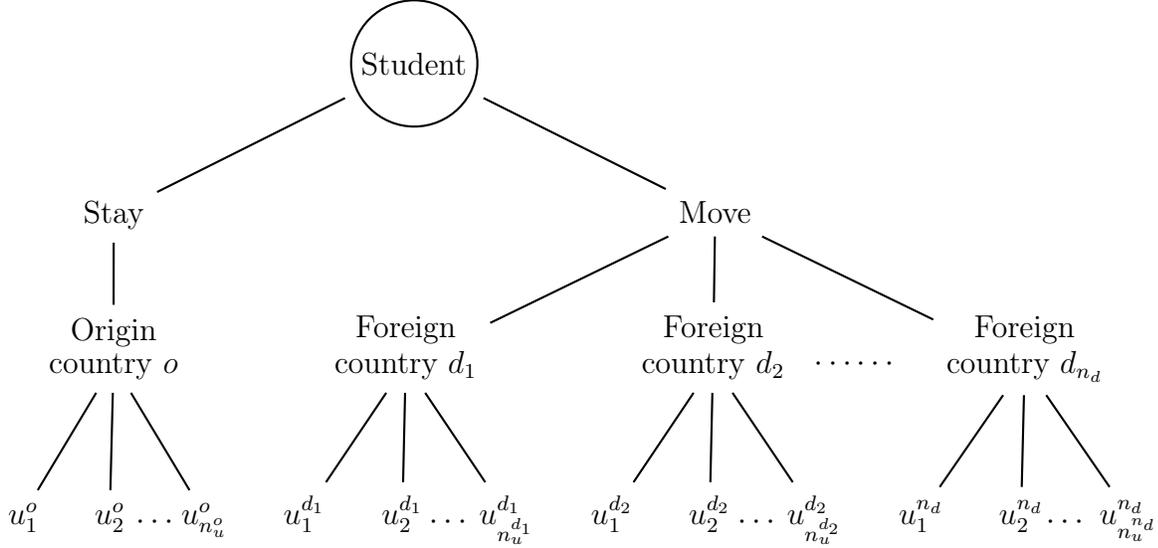
Figure 1: Decision Tree for Student's University Choice

The lower-level utility depends on characteristics that vary across universities. The corresponding factors are $X_u = \{Q_{u^d}, w_{u^d}, CS_{u^d}, CL_{u^d}\}$. The middle-level utility depends on factors that vary across countries: $Y_{o,d} = \{\bar{Q}_d, d_{o,d}, l_{o,d}, col_{o,d}\}$. The upper-level utility depends on factors that vary with the choice of migrating ($h = m$) or staying ($h = s$), $Z_h = \{C_o, A_d\}$. Utility can be rewritten as:

$$VS^s_{o,d,u^d} = \ln(B) + VS_h(Z_h) + VS_{o,d}(Y_{o,d}) + VS_u(X_{u^d}) + \epsilon^s_{o,d,u^d} \tag{10}$$

with

$$
\begin{aligned}
VS_u(X_{u^d}) &= \beta' \ln(X_{u^d}) = \beta_2 ln\left(Q_{u^d}\right) + \beta_1 ln\left(w_{u^d}\right) - \beta_3 \ln(CS_{u^d}) - \\
&\qquad \beta_4 \ln(CL_{u^d}) \\
VS_{o,d}(Y_{o,d}) &= \alpha' \ln Y_{o,d} = -\alpha_1 \ln(d_{o,d}) - \alpha_2 \ln(l_{o,d}) - \alpha_3 \ln(col_{o,d}) \\
VS_h(Z_h) &= \begin{cases} \gamma' \ln Z_d = \gamma_1 A_d - \gamma_2 \ln(C_o) & \text{if } h = m \\ \gamma' \ln Z_s = \gamma_1 A_o & \text{if } h = s \end{cases}
\end{aligned}
\tag{11}
$$

where $\beta$, $\alpha$ and $\gamma$ denote parameters vectors.

With this decomposition of utility, the probability associated with (9) can be written as the product of three standard logit probabilities:

$$P_{o,d,u^d} = P_{o,u^d|d,h} P_{o,d|h} P_{o,h} \tag{12}$$

where $P_{o,u^d|d,h}$ is the conditional probability of choosing a university $u^d$ given that an alternative in subnest $d$ is chosen; $P_{o,d|h}$ is the conditional probability of choosing a country $d$, given that an alternative in nest $h$ is chosen; and $P_{o,h}$ is the unconditional (marginal) probability of choosing to study in a foreign country or in home country $o$. These probabilities can be expressed as:

$$
\begin{aligned}
P_{o,u|d,h} &= Prob[VS_{o,d,u^d} - VS_{o,d,u^i} > \epsilon^s_{o,d,u^i} - \epsilon^s_{o,d,u^d}], & \forall u^i \neq u^d \\
&= Prob[VS_u(X_{u^d}) - VS_u(X_{u^i}) > \epsilon^s_{o,d,u^i} - \epsilon^s_{o,d,u^d}], & \forall u^i \neq u^d \\
&= \frac{\exp(VS_u(X_{u^d}))}{\sum_{u=1}^{n^d_u} \exp(VS_u(X_u))} \\
&= \frac{\exp(VS_u(X_{u^d}))}{\exp I^u(d,h)}
\end{aligned}
\tag{13}
$$

for the conditional probability $P_{o,u|d,h}$, and

$$
\begin{aligned}
P_{o,d|h} &= Prob[VS_{o,d,u^d} - VS_{o,j,u^d} > \epsilon^s_{o,j,u^d} - \epsilon^s_{o,d,u^d}], & \forall j \neq d \\
&= Prob[VS_{o,d}(Y_{o,d}) - VS_{o,d}(X_{o,j}) > \epsilon^s_{o,j,u^d} - \epsilon^s_{o,d,u^d}], & \forall j \neq d \\
&= \frac{\exp(VS_{o,d}(Y_{o,d}) + (1 - \lambda^u)I^u(d,h))}{\sum_{j=1}^{n_d} exp(VS_{o,d}(Y_{o,d}) + (1 - \lambda^u)I^u(j,h))} \\
&= \frac{\exp(VS_{o,d}(Y_{o,d}) + (1 - \lambda^u)I^u(d,h))}{\exp I^d(h)}
\end{aligned}
\tag{14}
$$

for the conditional probability $P_{o,d|h}$. This conditional probability for the degenerate branch (Stay branch), $P_{o,h|s}$, is trivially equal to 1 (a partially degenerate nested logit). And, for the unconditional (marginal) probability:

$$
\begin{aligned}
P_{o,h} &= Prob[VS_{o,h,u} - VS_{o,k,u} > \epsilon^s_{o,k,u} - \epsilon^s_{o,h,u}] & \text{with } k \neq h \\
&= Prob[VS_h(Z_h) - VS_h(Z_k) > \epsilon^s_{o,k,u} - \epsilon^s_{o,h,u}] & \text{with } k \neq h \\
&= \frac{\exp(VS_h(Z_h) + (1 - \lambda^j)I^j(s))}{\exp(VS_h(Z_h) + (1 - \lambda^j)I^j(s)) + \exp(VS_h(Z_k) + (1 - \lambda^j I^j(m))}
\end{aligned}
\tag{15}
$$

The inclusive values $I^u$ and $I^j$ are defined by

$$I^u(d,h) = ln(\sum_{u=1}^{n_u^d} \exp(VS_u(X_u))) \tag{16}$$

$$I^j(h) = ln(\sum_{j=1}^{n_d} exp(VS_{o,j}(Y_{o,j}) + (1-\lambda^u)I^u(j,h))) \tag{17}$$

The inclusive value coefficient $\lambda^u$ measures the correlation among the random terms due to universities' similarity within country $d$, with $\lambda^u = 0$ denoting no correlation and $\lambda^u = 1$ indicating nearly identical unobserved attributes. Similarly, the inclusive value coefficient $\lambda^j$ is a measure of correlation among unobserved country-related attributes.

The nested multinomial logit model[6] defined by (12)-(15) connects the levels of the tree outlined in Figure 1 with each other in the sense that the attributes of the lower-branch alternatives influence the choice among any choice set of upper branches. In a sequential choice model, the levels of the hierarchy would be unrelated.

The aggregate multi-country migration flow equation to university $u^d$ is given by multiplying the number of young people in country $o$ who want to study ($N_s^o$) with the probability of migration to university $u^d$ of a randomly drawn student of country $o$ ($P_{o,d,u^d}$):

$$\begin{aligned} M_{o,d,u^d} &= P_{o,d,u^d}N_s^o \\ &= P_{o,u^d|d,m}P_{o,d|m}P_{o,m}N_s^o \end{aligned} \tag{18}$$

with $M_{o,d,u^d}$ as the number of young people from country $o$ who want to study at university $u^d$ located in country $d$. It follows that the total number of foreign young people who wish to study at university $u^d$ located in country $d$ is given by:

$$\begin{aligned} M_{d,u^d} &= \sum_{o \neq d} P_{o,d,u^d}N_s^o \\ &= \sum_{o \neq d} P_{o,u^d|d,m}P_{o,d|m}P_{o,m}N_s^o \end{aligned} \tag{19}$$

However, as already stated, this number ($M_{d,u^d}$) is not the number of foreign students who will be enrolled in university $u^d$, this is the number of foreign students who want to go on to study at university $u^d$. We call this the *ex ante* enrollment demand. It is not enough

---

[6]More precisely, this is a non-normalized nested logit (NNNL) model (see Hunt (2000)). With the NNNL model, the choice probabilities estimated in system (13-15) are not the same as those given in equation (9). To be identical, we would need to rescale all estimated coefficients associated with low-level alternatives by the estimated inclusive value coefficients ($\lambda^u$ and $\lambda^j$) and rescale all estimated coefficients associated with middle-level variables by the estimated $\lambda^j$ inclusive value coefficient. In what follows, we assume that this rescaling process is done.

that students wish to go to this university, the university must also allow their registration. Universities have enrollment policies that can lead to the number of foreign students enrolled being lower than $M_{d,u^d}$. To know the actual number of foreign students enrolled we need to explain universities' enrollment behavior.

## 2.2 Universities' Behavior

We assume that all universities have the same enrollment behavior and, in the short term, it is determined by three factors:

1. Capacity - The capacity for enrolling foreign students is constrained. This capacity, $EC_{u^d}^{\beta_5}$, is a share (defined by $\beta_5$) of the total enrollment capacity $EC_{u^d}$. Universities set quotas on total foreign enrollment (not at the origin level).

2. Quality - The university quality is also fixed ($Q_{u^d}$).

3. Fees - The fees are fixed in the short term ($CS_{u^d}$). Universities do not use fees as a method of balancing the enrollment demand with their constrained capacity.

Capacity and quality may change over the long term with investment in capital and staff but they are fixed in the short term. Fees in the long run can also be adjusted according to enrollment demand (when they are not regulated). However, these three factors are fixed in the short term. Therefore, the foreign student enrollment capacity could be constrained for university $u^d$, and the actual number of foreign students ($\tilde{M}_{d,u^d}$) should verify:

$$\tilde{M}_{d,u^d} = EC_{u^d}^{\beta_5} \tag{20}$$

$\tilde{M}_{d,u^d}$ is the observed allocation, which corresponds to the *ex post* enrollment.

For each university $u^d$, two configurations are therefore possible:

- $M_{d,u^d} \leq EC_{u^d}^{\beta_5}$ meaning that the *ex ante* enrollment demand for university $u^d$ is lower than its enrollment capacity. The capacity constraint is not binding *ex ante*.

- $M_{d,u^d} > EC_{u^d}^{\beta_5}$ that implies $M_{d,u^d} > \tilde{M}_{d,u^d} = EC_{u^d}^{\beta_5}$ the *ex post* (observed) enrollment is lower than the *ex ante* demand. The constraint is binding, and some students are forced to request enrollment in a university that was not their first preference.

It is well known that many universities have turned away applications from foreign students due to capacity constraints, which supports the assumption that some universities are constrained. In that case, the total allocation is also constrained and the choices based only on preferences (defined by the system (12)-(15)) differ from the observed *(ex post)* allocation consistent with the preferences and with capacity constraints. We should now define how this *ex post* allocation could be done.

## 2.3    Equilibrium Allocation With Enrollment Capacity Constraints

We do not describe in details the computational method to find the equilibrium solution with capacity constraints. We follow the allocation solution developed by De Palma et al. (2007).

The set of constrained universities is $\mathfrak{C}$ and $\bar{\mathfrak{C}}$ is the set of unconstrained universities, with $\mathfrak{C} \cup \bar{\mathfrak{C}} = U^d$. An *ex ante* constrained university is necessarily an *ex post* constrained university. An *ex ante* unconstrained university could stay an *ex post* unconstrained university or become an *ex post* constrained university, depending on the scale of the reallocation.

The existence of a feasible allocation requires the total world enrollment capacity not be binding. It implies:

$$\sum_{o \neq d} \sum_{d} \sum_{u^d} M_{o,d,u^d} < \sum_{d} \sum_{u^d} EC_{u^d}^{\beta_5} \tag{21}$$

Any student who wants to study abroad could be enrolled in a university, but not necessarily in his/her preferred university. As we have assumed that at least one university has an enrollment constraint, the *ex post* total allocation is different from the total *ex ante* allocation. The (*ex post*) probability that student $s$ coming from country $o$ is enrolled in university $u^d$ in country $d$ is denoted by $\tilde{P}_{o,d,u^d}$. The *ex post* allocation[7] is given by:

$$\begin{aligned} \tilde{M}_{o,d,u^d} &= \tilde{P}_{o,d,u^d} N_s^o \\ &= \tilde{P}_{o,u^d|d,m} \hat{P}_{o,d|m} \hat{P}_{o,m} N_s^o. \end{aligned} \tag{22}$$

De Palma et al. (2007) show that, under two simple assumptions (allocation rules), the allocation probabilities can still be written as a multinomial logit model but with an additional *correction factor* that expresses an individual allocation ratio. This allocation ratio is defined by $\pi_{u^d}$, with $\tilde{P}_{o,u^d|d,m} = \pi_{u^d} P_{o,u^d|d,m}$.

The two assumed rules are the *free allocation rule* and the *no priority rule*.

**Free allocation rule:** For an unconstrained university $u^d \in \bar{\mathfrak{C}}$,

$$P(\{s \text{ allocated to } u^d | s \text{ prefers } u^d\}) = 1 \qquad \forall s, \ \forall u^d \in \bar{\mathfrak{C}}$$

**No priority rule:** The second assumption, the *no priority rule*, concerns the allocation in an *ex post* constrained university. With this rule, if a student $s$ has a stronger preference (*ex ante*) for constrained university $u^d$ than another student $s'$, student $s$ will also have a proportionally greater chance to be allocated *ex post* to this University.

---

[7]Without constraints at the country level - for example with quotas on student visas (that implies a $\tilde{P}_{o,d|m}$) or constraints on students emigration (that implies a $\tilde{P}_{o,m}$) - the formula of $P_{o,d|m}$ and $P_{o,m}$ are not modified by constraints at the university level. However, this does not mean that their values are not affected by capacity constraints at the university level. When they are taken into account, the calculus of the inclusive value $I_{d,h}^u$ is also modified, and, therefore, the values of $P_{o,d|m}$ and $P_{o,m}$. These new values are represented by $\hat{P}_{o,d|m}$ and $\hat{P}_{o,m}$.

For an *ex post* constrained university, the individual allocation ratio of university $u^d$, is the same for all students:

$$\frac{\tilde{P}^s_{o,u^d|d,m}}{P^s_{o,u^d|d,m}} = \frac{\tilde{P}^{s'}_{o,u^d|d,m}}{P^{s'}_{o,u^d|d,m}} = \Phi_{u^d} \qquad \forall s, s' = s^o_1, \cdot, s^o_{N_s}, \; \forall u^d \in \mathfrak{C}$$

Under these two assumptions, De Palma et al. (2007) show that the allocation probabilities are given by the adjusted MNL formula:

$$\tilde{P}_{o,u^d|d,m} = \frac{\exp(VS_u(X_{u^d}) + \ln(\pi_{u^d}))}{\sum_{u=1}^{n^d_u} (\exp(VS_u(X_u)) + \ln(\pi_{u^d}))}, \quad \text{with} \tag{23}$$

$$\pi_{u^d} = \begin{cases} \frac{EC^{\beta_5}_{u^d}}{M_{o,d,u^d}} < 1 & \text{if } u^d \in \mathfrak{C} \\[2ex] \Omega = \frac{1-\sum_{u \in \mathfrak{C}} \frac{EC^{\beta_5}_{u^d}}{M_{o,d,u}} P_{o,u|d,m}}{\sum_{v \in \bar{\mathfrak{C}}} P_{o,v|d,m}} > 1 & \text{if } u^d \in \bar{\mathfrak{C}} \end{cases} \tag{24}$$

They propose a solution algorithm for the model and, also for when the utility coefficients are unknown. This algorithm can be used in our nested logit model to find the allocation solution and the estimated coefficients with enrollment capacity constraint. The algorithm iteratively estimates the constraints and the individual and aggregate allocation ratios until they converge. While we do not observe $\tilde{M}_{o,d,u^d}$ for each university in the data, we can use this theoretical model and the solution approach proposed by De Palma et al. (2007), for our database for the U.K. We do this, both by adding the assumption that all the universities in U.K. have their *ex ante* enrollment capacity constrained and by using a sequential estimation procedure.

## 2.4   Estimable Equilibrium Equation

The estimation of a nested multinomial logit model can be done by FIML (full information maximum likelihood) or through a sequential procedure. Due to data constraints, the sequential procedure is often favored. Our contribution can be seen as the first step of the procedure for the unconstrained solution, that is, to estimate the coefficients $\beta$ of probability $P_{o,u^d|d,h}$ (equation 13). For estimating the (constrained) coefficient in the first step, we need to use the iterative procedure proposed by De Palma et al. (2007), which requires us to carry out all the steps. This is because the *ex post* allocation in an *ex ante* non-constrained university in country $d$ can be modified by the reallocation implied by the constraints on universities in country $d$ or other countries. However, this is not possible due to data constraints. Nevertheless, this limitation can be overcome if we assume that each university in one country faces a binding enrollment capacity constraint.

Consequently, if we assume that in country $d$ we have:

$$\sum_{o \neq d} P_{o,u^d|d,m} P_{o,d|m} P_{o,m} N^o_s = M_{d,u^d} > EC^{\beta_5}_{u^d} = \tilde{M}_{d,u^d} \qquad \forall u^d \in U^d \tag{25}$$

which implies that

$$\tilde{M}_{d,u^d} = EC_{u^d}^{\beta_5} \qquad \forall u^d \in U^d$$

$$\sum_{o \neq d} \tilde{P}_{o,u^d|d,m} \hat{P}_{o,d|m} \hat{P}_{o,m} N_s^o = EC_{u^d}^{\beta_5} \qquad \forall u^d \in U^d$$

and

$$\tilde{P}_{o,u^d|d,m} = \frac{\exp(VS_u(X_{u^d}) + \ln(\pi_{u^d}))}{\sum_{u=1}^{n_u^d} \left( \exp(VS_u(X_u)) + \ln(\pi_{u^d}) \right)}, \quad \text{with} \qquad (26)$$

$$\pi_{u^d} = \frac{EC_{u^d}^{\beta_5}}{M_{d,u^d}} \qquad \forall u^d \qquad (27)$$

With this allocation rule, equation (22), which determines the *ex post* number of students coming from country $o$ and studying in university $u^d$ in country $d$, is written as:

$$
\begin{aligned}
\tilde{M}_{o,d,u^d} &= \tilde{P}_{o,u^d|d,m} \hat{P}_{o,d|m} \hat{P}_{o,m} N_s^o \\
&= \tilde{P}_{o,u^d|d,m} \hat{M}_d^o \\
&= \pi_{u^d} P_{o,u^d|d,m} \hat{M}_d^o \\
&= \frac{EC_{u^d}^{\beta_5}}{M_{d,u^d}} \frac{\exp(VS_u(X_{u^d}))}{\sum_{u=1}^{n_u^d} \exp(VS_u(X_u))} \hat{M}_d^o \qquad (28)
\end{aligned}
$$

with $\hat{M}_d^o$ being the number of students who would like to study in country $d$, taking into account the capacity constraints. Using (18), this last equation identifies the factors that reduce the *ex ante* flow of students from country $o$ to university $u^d$ in country $d$:

$$\tilde{M}_{o,d,u^d} = M_{o,d,u^d} \frac{\hat{P}_{o,d|m}}{P_{o,d|m}} \frac{\hat{P}_{o,m}}{P_{o,m}} \frac{EC_{u^d}^{\beta_5}}{M_{d,u^d}} \qquad (29)$$

The discrepancy between the *ex post* and the *ex ante* flows is greater, the higher enrollment capacity constraint $(\frac{EC_{u^d}^{\beta_5}}{M_{d,u^d}})$; the higher its impact on the probability that students from country $o$ decide to go to country $d$ $(\frac{\hat{P}_{o,d|m}}{P_{o,d|m}})$; and the higher its impact on the probability that students from country $o$ decide to go abroad to study $(\frac{\hat{P}_{o,m}}{P_{o,m}})$.

Taking logs of equation (28) and substituting $VS_u$ by (11), we obtain the following structural gravity equation:

$$
\begin{aligned}
\ln(\tilde{M}_{o,d,u^d}) = {} & \beta_1 ln\left(w_{u^d}\right) + \beta_2 ln\left(Q_{u^d}\right) - \beta_3 \ln(CS_{u^d}) - \beta_4 \ln(CL_{u^d}) + \\
& \beta_5 \ln(EC_{u^d}) - \ln(M_{d,u^d}) - \ln(\sum_{u=1}^{n_u^d} \exp(VS_u(X_u))) + \ln(\hat{M}_d^o) \qquad (30)
\end{aligned}
$$

.

Before proceeding to the econometric specification corresponding to equation (30), some comments are in order. First, $\beta_5$ is the average propensity of all universities to apply the capacity constraint to foreign students. Theoretically, this average propensity should be between 0 and 1. Second, the term $\ln(\sum_{u=1}^{n_u^d} \exp(VS_u(X_u)))$ does not vary across universities and will be captured by the constant. Third, $\hat{M}_d^o$ is specific to the origin country and could be included in a fixed effect controlling for all factors that are specific to the foreign student's country of origin. Finally, $\ln(M_{d,u^d})$, the *ex ante* demand from foreign students to each university of country $d$ is not observed by the econometrician. We will therefore discuss the implications of its omission in the context of the econometric estimation of equation (30).

# 3 Data and Descriptive Statistics

This section presents the data used to estimate equation (30). The section details the sources and the development of some indicators such as the one capturing university quality, and provides descriptive statistics for each of them. Table 11 in the Appendix A provides a summary of the data used in the econometric analysis.

## 3.1 International Students flows

To measure $\tilde{M}_{o,d,u^d}$ in equation (30), we take advantage of the data on bilateral flows of international students from all countries of the world to th U.K. for the academic year 2011-2012. Following Beine et al. (2014), the international students we consider are the ones who migrated exclusively for the sake of education. Those who spent either one or more semesters abroad in institutional programs, such as the ERASMUS students, do not comply with our definition of international students and are therefore excluded from the data. We omit these students from the analysis for two reasons. First, bilateral agreements constrain the student's choice in terms of location. Second, in some curricula, attending a period of study abroad can be compulsory.

Data on foreign students in the U.K. comes from the Higher Education Statistical Agency (HESA), which provides data on international student flows for 163 U.K. universities.[8]

Table 1 reports some descriptive statistics on the number of foreign students studying in the U.K.. The U.K. hosts more than the 10 per cent of foreign students at the world level (OECD (2015)) and represents the second-most-popular destination after the United States. Consequently, international students, who come from 210 origin countries, represent a consistent percentage of students enrolled in U.K. higher institutions - 13.55 per cent of all students. The foreign students origin from 210 different countries.[9]

---

[8]Specifically, data are available for institutions located in England, Northern Ireland, Scotland and Wales.

[9]In the empirical part, we pay attention to not loosing the information relative to the empty corridors, i.e. origin-destination pairs with zero migration flow. The total number of observations is then equal to the number of universities multiplied by the number of origin countries.

Table 1: Descriptive Statistics of Foreign Student Flows in the U.K. (2011)

| | |
|---|---|
| Number of universities (a) | 163 |
| Origin countries (b) | 210 |
| Number of observations (axb) | 34230 |
| % of zeros** | 60.16% |
| Total number of students (host capacity)* (c) | 2518640 |
| Number of foreign students* (d) | 341389 |
| Foreign student as share of total students* (d/c) | 13.55% |

*Numbers are computed aggregating all origin countries.

**The flow of students coming from country $o$ and studying in university $u^d$ is nil.

Figure 2 shows the distribution of the share of foreign students across universities in the U.K. Most universities' share of foreign students is over the 5 per cent level with respect to their total student population. Table 2 shows that foreign students represent more than 20 per cent of the total student population in a large proportion of institutions. The two British institutions with the largest proportion of foreigners are the London School of Economics and Political Science and the London Business School where the share of foreign students is greater than 60 per cent. This illustrates the importance of the phenomenon of foreign education in the U.K.
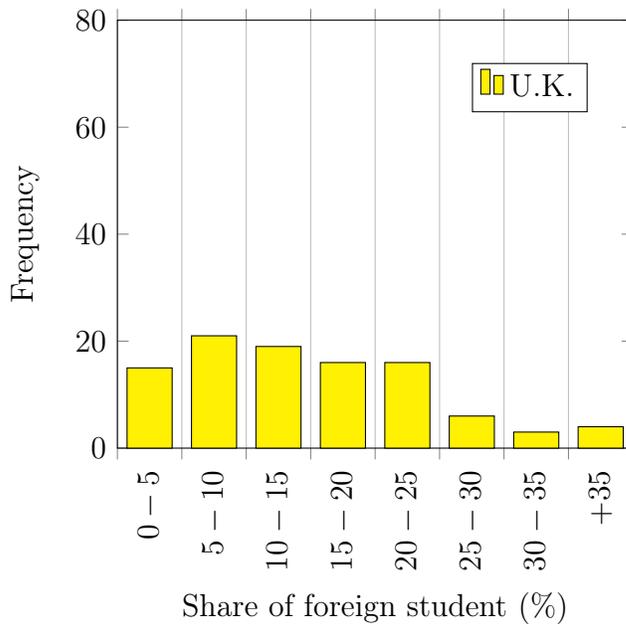


Figure 2: Share of Foreign Students

| | |
|---|---|
| Mean | 15.33% |
| Median | 12.95% |
| Standard deviation | 9.35% |
| Min | 0.07% |
| 1st Quintile | 6.48% |
| 2nd Quintile | 10.58% |
| 3rd Quintile | 16.87% |
| 4th Quintile | 22.77% |
| Max | 63.51% |

Percentage of total students

Table 2: Share of foreign students

To gauge the diversity of the foreign student population across U.K. universities, we refer to four multi-group segregation measures. Since we are more interested in the location choice of students than the universities' recruitment policies, we focus on diversity across institutions for each origin country, rather than diversity across origins for each institution.

The four multi-group segregation measures of Table 3 are presented and evaluated in Reardon and Firebaugh (2002). The first two measures, *dissimilarity index* and *gini index*, view segregation as a disproportion in the proportions of each origin across universities. This also refers to the measurement of inequality. The higher the index, the greater the segregation. The index indicates that the U.K. displays a significant variation in foreign students by origin across institutions.[10] Figure 3 provides the distribution of the dissimilarity index for each origin-country birthplace of international students. This evenness index varies between 0 (similar distribution of each origin country and the total student population distribution) and 1 (maximum segregation). It could be interpreted as the share of the students from each origin country that would have to move (to another university) to match the dispersion of the total student population. The large share of origin groups with a high dissimilarity index (between 0.9 and 1) is due to the large number of origin countries with very few individuals.

Entropy is another way to measure segregation. It is given by the last two indices in Table 3, that is, the information theory criterion and the relative diversity. In contrast to the previous indicators, segregation is decreasing with the index value. Again, these two other indices suggest that there is a significant degree of segregation in the U.K.

---

[10]The multigroup dissimiliraty index is a weighted average of origin indices.
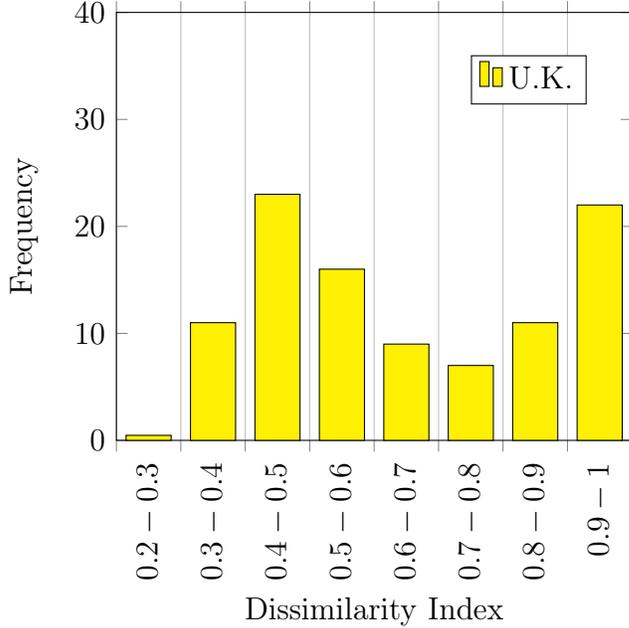
| Dissimilarity (Sakoda (1981)) | 0.333 |
|---|---|
| Gini (Reardon (1998)) | 0.451 |
| Information theory (Theil (1972)) | 0.963 |
| Relative diversity (Carlson (1992)) | 6.119 |

The reference is the original citation for multi-group form

Figure 3: Dissimilarity Indices across U.K. universities

Table 3: Multigroup Segregation Measures across U.K. universities

## 3.2 Covariates

### 3.2.1 Tuitions Fees

The cost of education $CS_{u^d}$ in equation (30) is captured by the level of tuition fees. U.K. is one of the few European countries in which tuition fees vary across institutions. The European Commission (European Commission (2012)) reports key information on tuition fees charged by European universities during the academic year 2011-2012.

For the U.K., tuition fees charged to European students were subject to a cap, equal to £3,375, for institutions based in England[11], Wales and Northern Ireland.[12] This level is set by the central government. The institutional setting was different in Scotland. The government covered first-degree tuition fees for both Scottish and EU students. Students coming from the rest of the U.K. were subject to a fee equal to £1,800. In contrast, universities in the U.K. were allowed to set tuition fees in U.K. institutions without any cap for non-European students.

The Reddin Survey of University Tuition Fees provides information only on first-cycle tuition fees charged by U.K. universities, differentiating between the ones charged for European students and those charged for non-European ones. Data are available for 115 institutions

---

[11]The only important exception is the University of Buckingham, which is considered as the only private higher education in the U.K. (Baskerville (2013)). This institution charged EU students an amount close to £9,000.

[12]As of September 2012, the level was increased in England to an amount between £6,000 and a maximum of £9,000 . See European Commission (2012) for more details.

of the 163 that make up the baseline data set. Table 4 compares the restricted sample consisting of first-cycle students only with the baseline one that includes all foreign students. To account for the endogeneity of tuition fees, the empirical analysis for the U.K. focuses only on first-cycle international students. Figure 4 and Table 5 report the distribution of fees across the universities.

Table 4: U.K. - Benchmark and Restricted Samples (2011)

|  | All institutions (163) | | Restricted sample (115) | |
| --- | --- | --- | --- | --- |
|  | All degrees | First degree | All degrees | First degree |
| Host capacity | 2518640 | | 2066290 | |
| Foreign students | 341389 | All=185208 EU=63237 | 309406 | All=171696 EU=56692 |
| % of zeros | 60.1% | All = 68.1% EU=38% | 52.1% | All = 61.6% EU = 16.72% |

Note. Numbers refer to number of students enrolling in 2011.

All degrees include bachelor and master students.



| Mean | 10.57 |
| --- | --- |
| Median | 10.14 |
| Standard deviation | 2.03 |
| Min | 7.45 |
| 1st Quintile | 9.10 |
| 2nd Quintile | 9.80 |
| 3rd Quintile | 10.67 |
| 4th Quintile | 11.70 |
| Max | 21.25 |

Tuition fees (in thousands of Euros) for non-EU students in U.K. Universities.
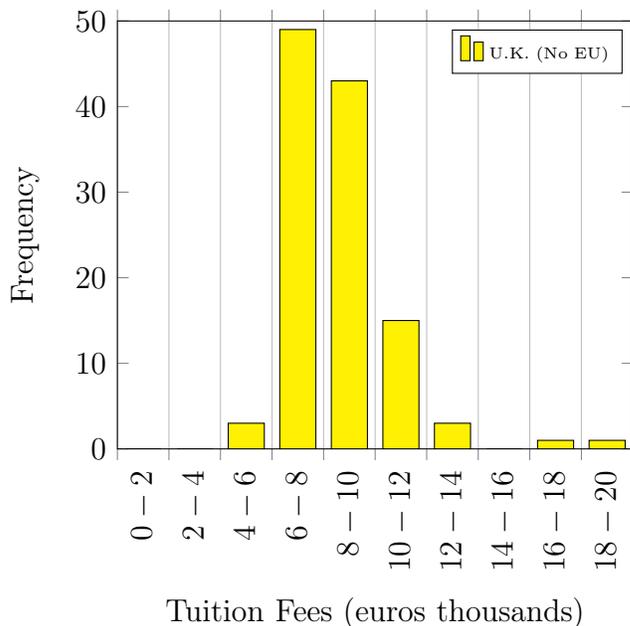
Figure 4: Tuition fees for non EU students across U.K. universities

Table 5: Tuition Fees for non EU students in U.K.

### 3.2.2 Cost of Living

Data on cost of living ($CL_{u^d}$ in equation (30)) come from the *Numbeo* website. This website provides various indexes of the cost of living for each city. We use the "Consumer Price plus Rent index" for the year 2011.[13] *Numbeo* computes the index, relying either on user input data or on data collected manually from authoritative sources such as websites of supermarkets, governmental institutions or other surveys. *Numbeo* applies different techniques to filter out noisy data.

The 163 U.K. universities are based in 87 different locations. *Numbeo* provides information for 39 cities of the 87. For the remaining locations, we compute the closest city in terms of geodesic distance to the ones for which the data are available and we take the respective cost of living index of that city. Figure 5 provides the distribution of the indicator. Table 6 provide the moments and the quantiles of the distribution. Both suggest that the cost of living considerably varies across cities.



| Mean | 69.00 |
| Median | 67.91 |
| Standard deviation | 8.82 |
| Min | 54.94 |
| 1st Quintile | 62.69 |
| 2nd Quintile | 66.29 |
| 3rd Quintile | 69.61 |
| 4th Quintile | 76.41 |
| Max | 98.83 |

Index, base 100 for New-York city
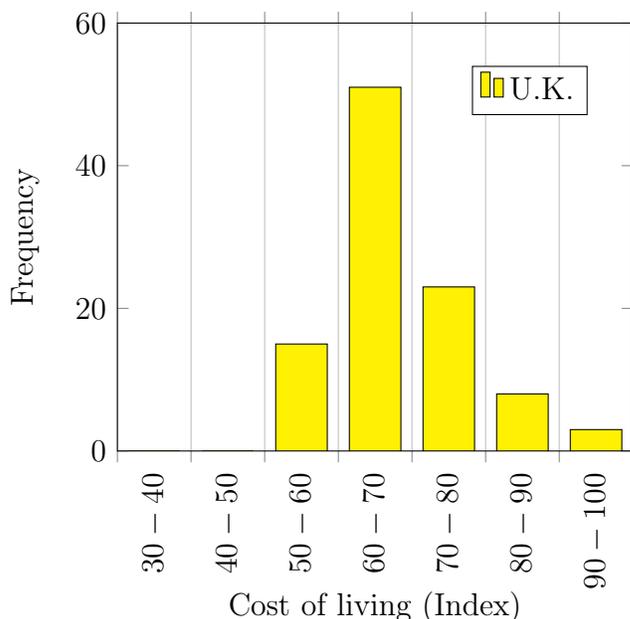
Figure 5: Cost of Living across U.K. cities       Table 6: Cost of Living across U.K. cities

### 3.2.3 Expected Income

We proxy expected income ($w_{u^d}$ in equation (30)) at destination either by using the GDP per capita of the city of destination or, when the data are not available, the one relative to the district in which the city is located. We compute this measure using both GDP and population data provided by EUROSTAT.[14] Figure 6 and Table 7 suggest that the income

---

[13]The indexes are relative to New York city index that is normalized to 100.

[14]We exploit the data provided at the Nuts 3 level of the REGIO dataset.

23

distribution across locations is quite heterogeneous across cities.



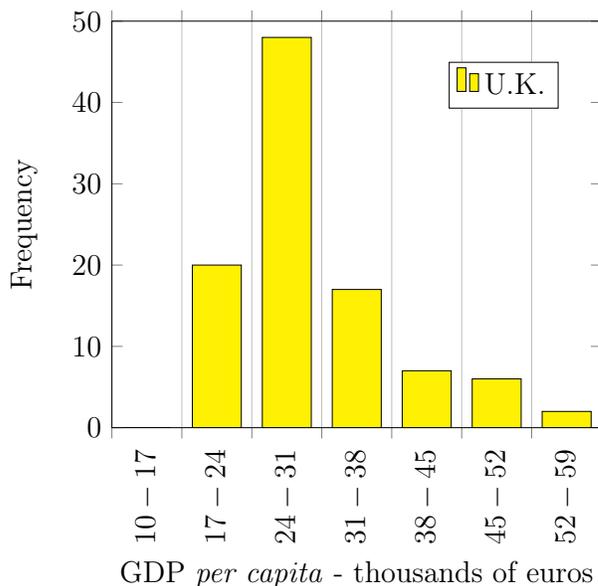| Mean | 30.16 |
| Median | 27.53 |
| Standard deviation | 8.21 |
| Min | 18.09 |
| 1st Quintile | 24.14 |
| 2nd Quintile | 26.61 |
| 3rd Quintile | 28.95 |
| 4th Quintile | 35.70 |
| Max | 54.21 |

GDP *per capita*, thousands of euros

Figure 6: Expected returns of education at destination across U.K. cities

Table 7: Expected returns of education at destination across U.K. cities.

### 3.2.4 University Quality

Equation (30) involves the quality of university ($Q_{u^d}$) as a determinant of expected income generated by education and hence of inflows of foreign students. In line with Beine et al. (2014) and Perkins and Neumayer (2014), we proxy university quality by exploiting the Top-500 Shanghai ranking for the year 2011 (ARWU). This ranking determines the 500 best universities in the world.[15] Although the index is widely known among international students and firms, its use is subject to discussion. The index should basically be interpreted as a measure of how international students perceived quality of education.

For any university appearing in the ranking, we know both its position in the ranking and the relative score that is obtained. By exploiting this information, we compute two quality indexes. The first one is obtained by a simple rescaling of the ARWU ranking. Specifically, if the university does not appear in the ARWU list, our index takes a value equal to 1; if the university is included, the index takes its position into account and is given a value of $(500 + 2) - ranking$. The implicit assumption is that the index increases in a linear fashion along with the ranking.

The ranking indicator, nevertheless, has some limitations. It assumes that quality is reflected in a linear way by the position of the university in the ranking. In other terms, it

---

[15]The ARWU considers every university that has any Nobel Laureates, Fields Medalists, highly cited publications or papers published in Nature or Science. 1000 universities are considered and the best 500 are included in the ranking. For a full explanation on the index development, please see http://www.shanghairanking.com/ARWU-Methodology-2011.html.

disregards the fact that the score on which the ranking is based might be quite similar in a set of universities.[16] So, to account for the specific empirical distribution of the score, we also use the score of the Shanghai ranking of the position. Our quality measure takes a value equal to the *score* if the university appears in the top-500 ranking. Otherwise, the index is simply equal to 0. Thirty-one universities from the U.K. were included in the top-500 ARWU ranking for the year 2011.
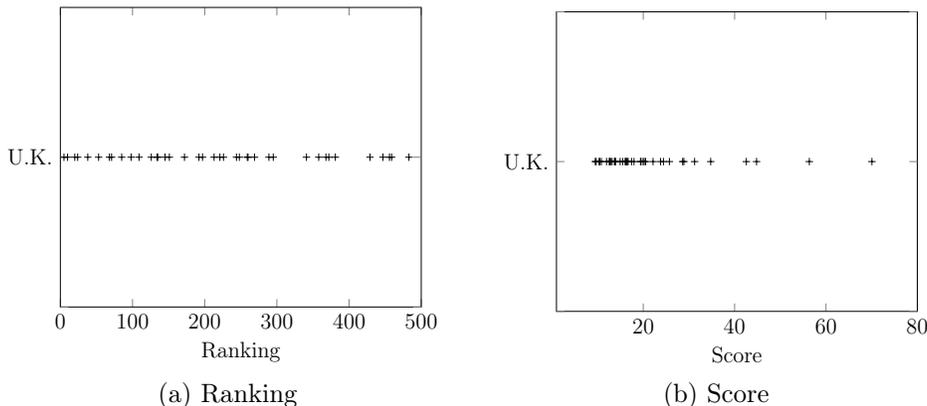


Figure 7: Indicators of University Quality

Figure 7 plots the two indicators of quality. Panel (a) provides the ranking indicator while Panel (b) does the same for the score indicator. The figures suggest that, at least from an empirical point of view, it is important to use both indicators to account for the potential difference in the way they reflect quality.

### 3.2.5 Host Capacity

The specificity of our RUM model takes into account the capacity constraints of the universities. The constraints in terms of host capacity of foreign students ($EC_{u^d}$ in equation (30)) is captured by the total number of students enrolled at the university of destination during the academic year considered. The U.K. has smaller universities (with an average of 14,575 students enrolled) and a relatively smaller standard deviation (see Table 8), however the distributions (see Figure 8) highlight significant differences between U.K. universities.

---

[16]For instance, while the first university (Harvard) has a global score of 100, universities ranked between position 2 and 5 have scores between 72.6 and 70.0. Universities ranked in positions 51 to 100 have scores between 31.7 and 24.2, suggesting that the distribution is significantly skewed to the right.
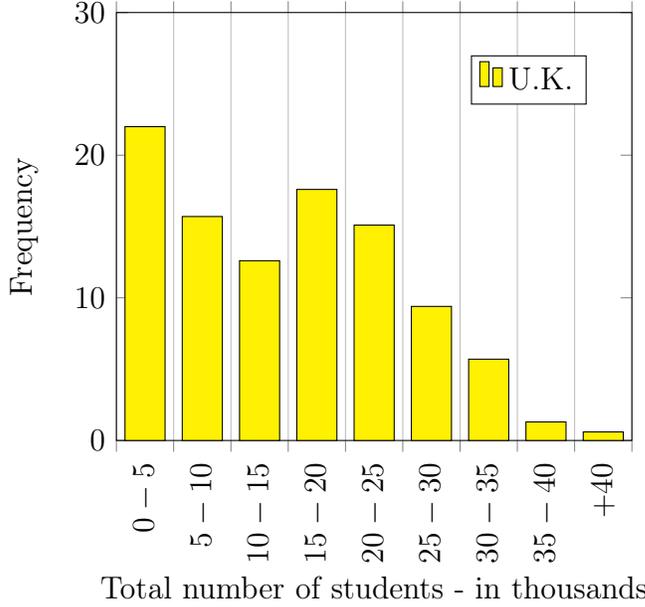
Figure 8: Host Capacity in U.K. universities

| Mean | 14575 |
|---|---|
| Median | 14860 |
| Standard deviation | 5619 |
| Min | 290 |
| 1st Quintile | 3252 |
| 2nd Quintile | 10698 |
| 3rd Quintile | 17400 |
| 4th Quintile | 23480 |
| Max | 40680 |

Total number of students

Table 8: Host Capacity in U.K. universities

# 4 Econometric approach and results

## 4.1 From Theory to Econometric Specification

Our econometric specification is based on equation (30) that provides the determinants of choosing a specific university, conditionally upon studying abroad in the U.K. The benchmark estimated equation takes the following form:

$$
\begin{aligned}
\ln(\tilde{M}_{o,d,u^d}) = \ & \alpha + \alpha_d + \beta_1 ln\left(expreturn_{u^d}\right) + \beta_2 ln\left(quality_{u^d}\right) + \beta_3 \ln(fees_{u^d}) + \\
& \beta_4 \ln(livingcost_{u^d}) + \beta_5 \ln(hostcapacity_{u^d}) + \epsilon_{d,u^d}
\end{aligned}
\tag{31}
$$

.

where $\tilde{M}_{o,d,u^d}$ denotes the observed number of students coming from country $o$ and studying in university $u^d$ in country $d$ (here U.K.). As noted above, this is applied to one specific academic year, 2011-2012. The data are therefore dyadic and time-invariant in nature. $fees_{u^d}$, $livingcost_{u^d}$, $quality_{u^d}$, $hostcapacity_{u^d}$ and $expreturn_{u^d}$ stand respectively for $CS_{u^d}$, $CS_{u^d}$, $Q_{u^d}$, $EC_{u^d}$ and $w_{u^d}$ in equation (30). $\alpha_d$ is a set of fixed effects controlling for all factors specific to the country of origin of the foreign students. It includes $\ln(\hat{M}_d^o)$ in equation (30). Given that we focus on a specific destination country, $\alpha_d$ also controls for bilateral factors between the origin country and the university. $\alpha$ is a constant term that includes the theoretical term $\ln(\sum_{u=1}^{n_u^d} \exp(VS_u(X_u)))$ from equation (30) that does not vary across institutions. $\epsilon_{d,u^d}$ is an error term that is assumed to be independently and identically distributed.

Before we proceed to the estimation, a couple of comments are in order. First, we make clear that equation (31) corresponds to the last stage of the migration process of foreign students. Previous stages concern (i) the decision to study abroad or domestically, and (ii) the choice of the country of destination. This paper focuses only on the last stage. Another possibility would have been to integrate several destination countries in the same analysis, that is, to pool universities of different countries. Beyond the limitations in data availability, this is not desirable for several reasons. The main objection is that pooling universities of different countries would lead to a clear rejection of the IIA hypothesis implicit in the estimation of (31). The rejection of the IIA hypothesis would occur because the choice structure involves two countries that might be considered as nests in the decision process. Given that it is very likely that the degree of substitution between two universities varies with respect to the country of destination, we prefer in the end to estimate the model separately for each country of destination. This issue is also related to the well-known problem of multilateral resistance of migration (Bertoli and Fernández-Huertas Moraga (2013); Beine et al. (2015)). In other words, pooling several countries and integrating the choice of the destination country would entail the estimation of a nested logit model with several potential nests. This is obviously beyond the scope of this paper and is left for future investigation.

Second, equation (31) omits the term $\ln(M_{d,u^d})$ in equation (30) which is unobservable. This term indeed captures the total demand to university $u^d$ coming from all origin countries before the impact of the constraints associated with the educational capacities. While in theory this is observable for each university, it is not available to the econometrician and will be included in the error term. This in turn might lead to estimation biases that we will discuss in the identification strategy. See section 4.3.

## 4.2 Econometric Method

Another issue is the prevalence of a high percentage of zero values for the bilateral migration flows. In our sample, for the year 2011 under investigation, we have 61.6 per cent zero values for the bilateral flow of first-degree foreign students for the U.K. The presence of a high proportion of zero values is well-known to generate biases in the key estimates using traditional panel fixed-effect estimates (Silva and Tenreyro (2006). The use of $log\left(1 + \tilde{M}_{o,d,u^d}\right)$ as the dependent (so-called scaled OLS) allows us to solve the selection problem due to the drop of the zero observations. Nevertheless, the scaled OLS estimation technique would give inconsistent estimates in the presence of heteroskedasticity. Silva and Tenreyro (2006) show that Poisson regressions are robust to different patterns of heteroskedasticity. We follow this route in the subsequent estimation and use the Poisson estimates as the benchmark. However, our tables will report the scaled OLS estimates of equation (31) for robustness checks.

## 4.3 Dealing With Endogeneity Concerns

In the model of Section 2, tuition fees are exogenous and decided by university authorities independent of numbers of students or other characteristics. In reality, the exogenous nature of fees in specification (31) is questionable on several grounds. First, fees might depend on the attractiveness of the university: successful universities attracting a large number of (foreign) students can easily raise the tuition fees compared with other universities. This leads to a reverse causality issue between student flows and fees. While the bilateral nature of $\tilde{M}_{o,d,u^d}$ mitigates this aspect, it is important to deal with the potential endogeneity of fees.[17]

On top of that, fees might be correlated with some unobserved characteristics of the university such as the quality of amenities on campus or in the hosting city. Another possibility is that universities set quotas for foreign students that are unknown to the econometrician. In the case of the U.K., this is an important feature, as emphasized by Machin and Richard (2017). This can in turn lead to a quantity-price trade-off and induce a positive correlation between fees and quotas. The source endogeneity of tuition fees also calls for a specific treatment. The use of IV estimation is cumbersome in the U.K.[18] Therefore, we propose another simple solution to tackles the endogeneity of fees by using a sample of students for which the fees are no longer endogenous.

Therefore, instead of a traditional IV, we propose another simple solution to tackles the endogeneity of fees by using a sample of students for which the fees are no longer endogenous. We take advantage of the fact that during the academic year 2011-2012, U.K. universities were subject to caps on the amount of fees they could charge to native and European first-cycle students. Those caps did not apply to students originating from outside the EU. On top of that, there is some regional variation in the tuition caps applied to universities. Scottish universities were subject to lower caps compared with those applied to other institutions in the U.K. Moreover, the cap set by the Scottish government applied only to non-Scottish U.K. students. The Scottish government covered first-degree tuition fees for both natives and European students, thus allowing them to get first-cycle education in Scottish universities for free (European Commission (2012)). In contrast, the other U.K. universities set tuition fees for EU students that are equal to the £3,375 cap. It follows that, in restricting the sample to European countries as origin countries, we can estimate equation (31) in a context in which fees are clearly exogenous.

In practice, we run regressions based on model (31) for various sub-samples in terms of origin countries. We first restrict the analysis to first-cycle students, that is, those who are subject to caps on fees. In contrast, if we use all countries or the non-EU origin countries, this should lead to results subject to the endogeneity bias. A comparison between the

---

[17]Another way of looking at this endogeneity problem is contained in equation (30). In fact, the fee level ($CS_{u^d}$) in each university is likely to be positively correlated with the *ex-ante* total foreign demand $M_{d,u^d}$, which is omitted from equation (31).

[18]Beine et al. (2017a) use the status of the university as an instrument to estimate a similar equation for Italian universities. This is not possible in the case of the U.K. as the information about the status is not clear-cut. Some alternative instruments such as the share of the budget subsidized by the central government turned out to be weak instruments and generated inconsistent results.

results based on different samples allows us to shed some light on the magnitude of the bias associated with the endogeneity of tuition fees. Based on this strategy, Tables 9 and 10 present the results of the estimation of model (31) for the three sub-samples of origin countries and for the two estimation techniques. Table 9 presents the results with the indicator of quality based on the ranking, while Table 10 reports the findings obtained with the score indicator.

The estimation results of Tables 9 and 10 yield basically two lessons. First, using only EU countries as origin countries and a sample of first-cycle foreign students, we find some support in favor of a negative impact of tuition fees. The estimated elasticity is close to -0.1%, suggesting a moderate impact of tuition fees. Nevertheless, we should not forget that this concerns only first -cycle students that are in general less mobile compared to master or Phd students (see Bertrand-Cloodt et al. (2017)). Furthermore, to the extent that there is also a positive selection in the migration of foreign students, the sample includes only European students who come in general from wealthy families in Europe. Mixing up EU and non EU students yields also a negative elasticity, but this estimate is once again likely to be positively biased due to the fact that fees for non EU student are clearly endogenous.

Table 9: Determinants of Student Migration, First-Cycle Students From EU Countries.

| Variables | Scaled OLS | | | Poisson | | |
|---|---|---|---|---|---|---|
| | All | EU | No EU | All | EU | No EU |
| Fees | -0.064*** | -0.086*** | 0.114*** | -0.078*** | -0.084*** | 0.432* |
| | (0.01) | (0.01) | (0.03) | (0.01) | (0.01) | (0.21) |
| Cost of living | 0.560*** | 1.956*** | 0.339*** | 0.993*** | 1.220*** | 0.809** |
| | (0.04) | (0.19) | (0.04) | (0.20) | (0.32) | (0.25) |
| Quality (ranking) | 0.037*** | 0.077*** | 0.024*** | 0.073*** | 0.032* | 0.070*** |
| | (0.00) | (0.01) | (0.00) | (0.01) | (0.01) | (0.02) |
| Host capacity | 0.290*** | 0.742*** | 0.233*** | 0.892 *** | 0.862*** | 0.933*** |
| | (0.01) | (0.03) | (0.01) | (0.05) | (0.06) | (0.07) |
| Income | 0.104*** | -0.057 | 0.102*** | -0.015 | 0.027 | -0.096 |
| | (0.02) | (0.10) | (0.02) | (0.12) | (0.15) | (0.16) |
| Origin FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.661 | 0.581 | 0.621 | - | - | - |
| Pseudo $R^2$ - | - | - | - | 0.706 | 0.464 | 0.737 |
| Nber Obs | 24360 | 2900 | 21460 | 21228 | 2900 | 18328 |

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

Second, the results for the sample of non-EU regions suggest that the failure to deal with the endogeneity of tuition fees leads to significant biases in the estimation of their impact. Once again, failure to deal with the endogenous nature of fees leads to overestimating their impact, which in turn is consistent with reverse causality and positive correlation between fees and unobserved amenities for instance. Focusing on the Poisson regressions, the results

obtained with the non-EU countries exhibit a positive and a barely significant effect of tuition fees. While fees can in practice have additional dimensions that the pure cost component outlined in Section 2 (such as a signal of quality or a mitigation of the cost through coverage by education grants), such a strong and positive impact would nevertheless be difficult to rationalize. While we do not account for the existence of education grants, our estimations account for the variation in the quality of universities, which rules out the signaling effect of fees. Our results for the different samples instead suggest that the positive impact obtained in previous work is in great part driven by endogeneity issues.

Table 10: Determinants of Student Migration, First-Cycle Students From EU Countries (Score Indicator of Quality).

| Variables | SCALED OLS | | | Poisson | | |
|---|---|---|---|---|---|---|
| | All | EU | No EU | All | EU | No EU |
| Fees | -0.064*** | -0.087*** | 0.110*** | -0.079 *** | -0.084*** | 0.395 |
| | (0.01) | (0.01) | (0.03) | (0.01) | (0.01) | (0.22) |
| Cost of living | 0.555*** | 1.947*** | 0.336*** | 0.974*** | 1.219*** | 0.787*** |
| | (0.04) | (0.19) | (0.04) | (0.20) | (0.32) | (0.25) |
| Quality (score) | 0.059*** | 0.127*** | 0.038*** | 0.116*** | 0.056** | 0.111*** |
| | (0.00) | (0.01) | (0.00) | (0.02) | (0.02) | (0.02) |
| Host capacity | 0.289*** | 0.739*** | 0.233*** | 0.888 *** | 0.857*** | 0.930*** |
| | (0.01) | (0.03) | (0.01) | (0.05) | (0.06) | (0.07) |
| Income | 0.103*** | -0.061 | 0.102*** | -0.017 | 0.021 | -0.089 |
| | (0.02) | (0.10) | (0.02) | (0.12) | (0.15) | (0.16) |
| Origin FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.661 | 0.581 | 0.621 | - | - | - |
| Pseudo $R^2$ - | - | - | - | 0.722 | 0.465 | 0.736 |
| Nber Obs | 24360 | 2900 | 21460 | 24360 | 2900 | 18328 |

* $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$

Tables 9 and 10 also exhibit counter intuitive results for both the cost of living and income. The fact that the income coefficient is not significant could be due to the fact that our baseline sample contains only first-cycle students. The prospects of finding a good job are much more better for masters students than for bachelor-level students. First cycle in higher education primarily aims also at providing a good training to facilitate access to graduate studies rather on top of providing a degree that is "usable" right away on the job market.

The low level of the estimated impact of tuition fees calls for further investigation. It might also be the case that first-cycle students react less to quality of the university as bachelor studies are quite similar across universities in terms of programs and quality . To check this conjecture, we run similar regressions using masters students' flows instead

of first-cycle students.[19] Tables 12 and 13 in the Appendix[20] report the results obtained. Once we use only masters student flows, the coefficient on income becomes both positive and highly significant. Interestingly, the quality coefficients also become both positive and highly significant for both estimation techniques. Consequently, the failure of the regressions reported in tables 9 and 10 to find such evidence could be driven by the fact that first-degree students are less likely to change location, for example, to benefit from job opportunities.

# 5  Conclusions

This paper contributes to the identification of the determinants of student migration. We first propose an extended model of the choice of location for foreign students that integrates prominent feature of that process. This includes the existence of enrollment capacity constraints at the university level. We build on the traditional RUM approach to which we add capacity constraints at the university level. We derive, under mild conditions, an equilibrium equation that can predict the bilateral flow of students for each origin to each university from the identified determinants. We uncover an expected role for fees, quality of the university, capacity constraints and expected income after graduation.

In the empirical part, we stress the importance of using data at the university level. This is confirmed by the significant variation of the main features of student migration across the universities. We test the predicting power of the model by using data on student flows from each country of the world to each university in the U.K. We estimate the theory-based gravity equation using covariates collected at the university level, using appropriate estimation techniques suited for this type of data. This includes Poisson pseudo-Maximum Likelihood estimates that account for a large proportion of zeroes in the bilateral flows of foreign students. Furthermore, our theoretical specification makes clear that endogeneity of tuition fees is likely to be an important issue in the econometric estimation of the gravity equation. We propose an easy statistical solution to solve that endogeneity issue suitable in the case of the U.K. We rely on specific samples of foreign students (first cycle students coming from EU countries) subject to fee caps.

Our analysis generates interesting and new findings. First, we find evidence of the negative role of a university's tuition fees on the flow of students choosing to study in that university. Surprisingly, this negative and significant role is new in the literature. We stress the importance of dealing with the endogeneity of tuition fees. Failure to account for endogeneity results in a positive and significant result. This is confirmed by auxiliary regressions involving a sample of foreign students for which tuition fees are clearly endogenous. While tuition fees are found to have some influence on the location of foreign students, our analysis also emphasizes and confirms the role of other important factors. We find support in favor of the role of the university's quality. Also, the expected return to education after graduation

---

[19]Fees for masters students are unregulated in U.K.; the reader should therefore not rely on the coefficients on fees there obtained.

[20]Table 14 in the Appendix B reports the estimation results using the whole flows of international students to U.K. (both first-degree and masters students).

is found to be important. This last result is in line with the implications of the migration model of foreign education.

# References

Abbott, A. and Silles, M. (2015). Determinants of international student migration. *World Economy*, 39(5):621–635.

Agasisti, T. and Dal Bianco, A. (2007). Determinants of college student migration in italy: Empirical evidence from a gravity approach. Technical report, Paper presented at the Congress of the European Regional Science Association. Paris, September. Available at SSRN 1063481.

Alecke, B., C. B. and Mitze, T. (2013). The effect of tuition fees on student enrollment and location choice interregional migration, border effects and gender differences. Technical report, Ruhr Economic Papers 404.

Baskerville, S. (2013). A guide to UK higher education and partneships for overseas universities. Technical report, UK Higher Education International Unit: Research Series 11.

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education.* University of Chicago Press.

Beine, M., Bertoli, S., and Fernández-Huertas Moraga, J. (2015). A practioners guide to gravity models of international migration. *World Economy*, 39(4):496–512.

Beine, M., Docquier, F., and Özden, Ç. (2011). Diasporas. *Journal of Development Economics*, 95(1):30–41.

Beine, M., Marco, D., and Ragot, L. (2016). The role of fees in foreign education: Evidence from Italy and the U.K. *CREA discussion paper, 2016-06*.

Beine, M., Marco, D., and Ragot, L. (2017a). The role of fees in foreign education: Evidence from Italy. *CREA discussion paper, 2017-09*.

Beine, M., Noël, R., and Ragot, L. (2014). Determinants of the international mobility of students. *Economics of Education Review*, 41(C):40–54.

Beine, M., Pauline, B., and Bricongne, J.-C. (2017b). Aggregate fluctuations and international migration. *Scandinavian Journal of economics*. Forthcoming.

Bertoli, S. and Fernández-Huertas Moraga, J. (2013). Multilateral resistance to migration. *Journal of Development Economics*, 102(C):79–100.

Bertrand-Cloodt, D., Cörvers, F., and Heijke, H. (2017). Ability, academic climate, and going abroad for work or pursuing a phd. *CESifo Econ Studies*, 63(1):119–140.

Bessey, D. (2012). International student migration to Germany. *Empirical Economics*, 42(1):345–361.

Bruckmeier, K., Fischer, G.-B., and Wigger, B. U. (2013). Does distance matter? Tuition fees and enrollment of first-year students at German public universities. Technical report, CES IFO Working paper 4258.

Bruckmeier, K. G.-B. F. and Wigger, B. U. (2015). Tuition fees and the time to graduation: evidence from a natural experiment. *Journal of Higher Education Policy and Management*, 37:459–71.

Card, D. and Krueger, A. B. (1992). Does school quality matter? returns to education and the characteristics of public schools in the united states. *The Journal of Political Economy*, 100(1):1–40.

Carlson, S. M. (1992). Trends in race/sex occupational inequality: conceptual and measurement issues. *Social Problems*, (39):269–290.

De Palma, A., Picard, N., and Waddell, P. (2007). Discrete choice models with capacity constraints: an empirical analysis of the housing market of the greater paris region. *Journal of Urban Economics*, 62(2):204–230.

Dreher, A. and Poutvaara, P. (2008). Student flows and migration: an empirical analysis. *World Development*, 39(8):1294–1307.

European Commission (2012). *National Student Fee and Support Systems 2011/2012*. European Commission.

González, C. R., Mesanza, R. B., and Mariel, P. (2011). The determinants of international student mobility flows: an empirical study on the Erasmus programme. *Higher Education*, 62(4):413–430.

Grogger, J. and Hanson, G. H. (2011). Income maximization and the selection and sorting of international migrants. *Journal of Development Economics*, 95(1):42–57.

Hunt, G. L. (2000). Alternative Nested Logit Model structures and the special case of partial degeneracy. *Journal of Regional Science*, 40(1):89–113.

Jena, F. and Reilly, B. (2013). The determinants of United Kingdom student visa demand from developing countries. *IZA Journal of Labor & Development*, 2(1):1–22.

Kahanec, M. and Králiková, R. (2011). Pulls of International Student Mobility. IZA Discussion Papers 6233, Institute for the Study of Labor (IZA).

Machin, S. and Richard, M. (2017). Paying out and crowding out? the globalization of higher education. *Journal of Economic Geography*, page Forthcoming.

McFadden, D. L. (1984). Econometric analysis of qualitative response models. *Handbook of Econometrics*, 2:1395–1457.

OECD (2015). *Education at a Glance 2015: OECD Indicators*. OECD Publishing, Paris.

Perkins, R. and Neumayer, E. (2014). Geographies of educational mobilities: exploring the uneven flows of international students. *The Geographical Journal*, 180(3):246–259.

Reardon, S. and Firebaugh, G. (2002). Measures of multigroup segregation. *Sociological Methodology*, (32):33–67.

Reardon, S. F. (1998). Measures of racial diversity and segregation in multigroup and hierarchically structured populations. In *Annual meeting of the Eastern Sociological Society, Philadelphia*.

Rosenzweig, M. (2008). Higher education and international migration in Asia: Brain circulation. In *Annual World Bank Conference on Development Economics*, pages 59–100.

Rosenzweig, M. R. (2006). Global wage differences and international student flows. In Rosenzweig, M. R., Irwin, D. A., and Williamson, J. G., editors, *Global labor Market? (Brookings trade forum)*, pages 57–96. Washington DC: Brookings Institute Press.

Sakoda, J. (1981). A generalized index of dissimilarity. *Demography*, (18):245–250.

Silva, J. S. and Tenreyro, S. (2006). The log of gravity. *The Review of Economics and statistics*, 88(4):641–658.

Theil, H. (1972). *Statistical Decomposition Analysis*. North-Holland, Amsterdam.

Train, L. (2003). *Discrete Choice Methods with simulation*. Cambridge University Press.

Van Bouwel, L. and Veugelers, R. (2013). The determinants of student mobility in Europe: the quality dimension. *European Journal of Higher Education*, 3(2):172–190.

# A Summary Data

Table 11: Summary Table of Main Data

| Variable | Term in (30) | Definition | Source |
|----------|--------------|------------|--------|
| **International Students** | $\tilde{M}_{o,d,u^d}$ | Number of foreign students coming from country $i$ and enrolled in university $u$ | HESA. |
| **Fees** | $CS_{u^d}$ | Average fees charged by university $u$ | U.K.: Tuition Reddin Survey. |
| **Quality** | $Q_{u^d}$ (ranking) | Quality of university $u$ based on Top 500 ranking | Top 500 Shanghai Ranking ARWU. |
| **Host Capacity** | $EC_{u^d}$ | Total number of students enrolled at university $u$ | HESA. |
| **Cost of living** | $CL_{u^d}$ | Cost of Living in city/district $j$, where institution $u$ is located | Numbeoo dataset. |
| **Expected return** | $w_{u^d}$ | GDP per capita in the district where university $u$ is located | GDP at NUTS 3 level, Eurostat. |

# B    Additional Estimation results

Table 12: Master Students (Quality=ranking)

|  | SCALED OLS | | | Poisson | | |
|---|---|---|---|---|---|---|
| Variables | all | EU | No EU | all | EU | No EU |
| Fees | -0.022*** | -0.025*** | 0.068* | -0.028 | -0.003 | 0.131 |
|  | (0.01) | (0.01) | (0.03) | (0.02) | (0.02) | (0.24) |
| Cost of living | 0.535*** | 1.526*** | 0.379*** | 1.246*** | 1.220* | 1.171*** |
|  | (0.04) | (0.15) | (0.04) | (0.28) | (0.51) | (0.33) |
| Quality | 0.051*** | 0.111*** | 0.039*** | 0.116*** | 0.123*** | 0.108*** |
| **Ranking** | (0.00) | (0.01) | (0.00) | (0.01) | (0.02) | (0.02) |
| Host capacity | 0.276*** | 0.557*** | 0.239*** | 0.958 *** | 0.829*** | 0.987*** |
|  | (0.01) | (0.02) | (0.01) | (0.06) | (0.08) | (0.07) |
| Income | 0.175*** | 0.418*** | 0.134*** | 0.114 | 0.958*** | -0.046 |
|  | (0.02) | (0.08) | (0.02) | (0.15) | (0.23) | (0.17) |
| Origin FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.619 | 0.590 | 0.616 | - | - | - |
| Pseudo $R^2$ - | - | - | - | 0.748 | 0.564 | 0.769 |
| Nber Obs | 24360 | 2900 | 21460 | 24360 | 2900 | 18328 |

* $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$

Table 13: Master Students (Quality = score)

|  | SCALED OLS | | | Poisson | | |
|---|---|---|---|---|---|---|
| Variables | all | EU | No EU | all | EU | No EU |
| Fees | -0.023*** | -0.026*** | 0.063* | -0.030 | -0.005 | 0.128 |
|  | (0.01) | (0.01) | (0.03) | (0.02) | (0.02) | (0.25) |
| Cost of living | 0.528*** | 1.513*** | 0.374*** | 1.190*** | 1.179* | 1.114*** |
|  | (0.04) | (0.15) | (0.04) | (0.28) | (0.51) | (0.33) |
| Quality | 0.081*** | 0.179*** | 0.061*** | 0.174*** | 0.190*** | 0.159*** |
| **Score** | (0.00) | (0.01) | (0.00) | (0.02) | (0.03) | (0.03) |
| Host capacity | 0.275*** | 0.554*** | 0.239*** | 0.957 *** | 0.822*** | 0.989*** |
|  | (0.01) | (0.02) | (0.01) | (0.06) | (0.08) | (0.07) |
| Income | 0.175*** | 0.413*** | 0.134*** | 0.127 | 0.962*** | -0.031 |
|  | (0.02) | (0.08) | (0.02) | (0.15) | (0.23) | (0.17) |
| Origin FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.619 | 0.591 | 0.616 | - | - | - |
| Pseudo $R^2$ - | - | - | - | 0.746 | 0.564 | 0.767 |
| Nber Obs | 24360 | 2900 | 21460 | 24360 | 2900 | 18328 |

* $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$

Table 14: All students (first and master degree, Quality=ranking)

| Variables | SCALED OLS | | | Poisson | | |
|---|---|---|---|---|---|---|
| | all | EU | No EU | all | EU | No EU |
| Fees | -0.059*** | -0.080*** | 0.134*** | -0.063*** | -0.063*** | 0.284 |
| | (0.01) | (0.01) | (0.04) | (0.01) | (0.01) | (0.20) |
| Cost of living | 0.726*** | 2.199*** | 0.489*** | 1.108*** | 1.270*** | 0.988*** |
| | (0.05) | (0.18) | (0.05) | (0.20) | (0.36) | (0.25) |
| Quality | 0.056*** | 0.107*** | 0.041*** | 0.093*** | 0.060*** | 0.089*** |
| **Ranking** | (0.00) | (0.01) | (0.00) | (0.01) | (0.01) | (0.01) |
| Host capacity | 0.382*** | 0.826*** | 0.326*** | 0.919 *** | 0.847*** | 0.959*** |
| | (0.01) | (0.03) | (0.01) | (0.05) | (0.05) | (0.06) |
| Income | 0.171*** | 0.093 | 0.157*** | 0.044 | 0.269 | -0.070 |
| | (0.02) | (0.10) | (0.03) | (0.11) | (0.16) | (0.14) |
| Origin FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.694 | 0.629 | 0.667 | - | - | - |
| Pseudo $R^2$ | - | - | - | 0.757 | 0.521 | 0.784 |
| Nber Obs | 24360 | 2900 | 21460 | 21228 | 2900 | 18328 |

* $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$