Working Paper No. 6

International Student Migration to Germany

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UNIVERSITÄT BERN

Leading House Working Paper No. 6

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September 2007

Published as: "International student migration to Germany." *Empirical Economics*, 42(2012)1: 345-361. By Donata Bessey.
Available at: http://dx.doi.org/10.1007/s00181-010-0417-0

Deutsche Zusammenfassung

Die Bundesrepublik Deutschland ist nach den Vereinigten Staaten und Großbritannien das wichtigste Zielland für internationale Studierende weltweit. Dieses Working Paper analysiert die Determinanten der Migration internationaler Studierender nach Deutschland in den Jahren zwischen 1997 und 2002.

Als theoretische Grundlage dient eine „*augmented gravity equation*", die in der empirischen Analyse sowohl in log-linearisierter als auch in multiplikativer Form geschätzt wird.

Der Bestand von Studenten der gleichen Nationalität in Deutschland hat stets einen signifikant positiven Einfluss auf die Zuströme von Bildungsmigranten. Dieses Ergebnis deutet auf die große Bedeutung von Netzwerken als eine Form von Sozialkapital für Migranten hin. Die Kosten einer Migrationsentscheidung sind geringer, wenn nachfolgende Migranten vom Wissen der bereits im Land befindlichen profitieren können.

Aus Herkunftsländern mit politisch repressiven Regimes kommen signifikant weniger Studenten nach Deutschland – es scheint also keine Evidenz für Flüchtlingsmigration unter den Studenten zu geben. Anders als in der internationalen Migration scheint das verfügbare Einkommen im Herkunftsland keine signifikante Rolle für Migrationsentscheidungen von Studierenden zu spielen, was sich durch die Existenz von Stipendienprogrammen erklären lässt. Allerdings kommen weniger Studenten aus weiter entfernten Herkunftsländern nach Deutschland, was sich neben den größeren monetären Kosten auch durch stärkere kulturelle Unterschiede und damit verbundene höhere psychische Kosten einer Migrationsentscheidung erklären lässt.

International Student Migration to Germany

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Abstract

This paper presents first empirical evidence on international student migration to Germany. I use a novel approach that analyzes student mobility using an augmented gravity equation and find evidence of strong network effects and of the importance of distance - results familiar from the empirical migration literature. However, the importance of disposable income in the home country does not seem to be too big for students, while the fact of being a politically unfree country decreases migration flows significantly. I also provide extensive sensitivity checks and estimates using both the usual log-linearized and a multiplicative specification. The results are quite stable.
JEL classification: F 22, I 23
Keywords: Globalization of higher education, international migration, gravity equation

My thanks go to Claudia Buch, Jörn Kleinert, Katja Neugebauer and Farid Toubal for advice and help, as well as to Yu-Hwai Hwang, Xenia Kirgis, Melanie Korst, Ines Pelger, Johanna von Borstel and Mi-Kyong Yoon for their comments on earlier versions and for many discussions. Franziska Schoch has provided excellent research assistance. All remaining errors and inaccuracies are solely in my own responsibility.

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Higher education is becoming a global business. International student mobility has been on the rise for the last 25 years. According to the International Finance Corporation, 2% of the world's 100 million students were enrolled in a program abroad in 2003 (The Economist, 26th February, 2005). In addition, many universities start to offer their services abroad by opening offshore campuses or by introducing distance-learning courses. Education is becoming a tradable service, with consequences for universities and students all over the world. The opportunities for universities are growing as well as market pressure resulting from a higher level of competition.

Globalization and a higher degree of mobility increase the set of opportunities available to a prospective student who decides on his or her future career. Mobility schemes like ERASMUS, the European Region Action Scheme for the Mobility of University Students, encourage students to spend time at a partner university abroad. At the same time, more and more students decide even to spend their entire course of studies at a foreign university. Harmonized degrees that are approved across Europe following the Bologna reform enable students to choose their preferred university, no matter where it is located.

The OECD education database shows that the United States were the most important destination country in 1999 (with 31% of all students enrolled in a foreign country worldwide), followed by the United Kingdom (16%), Germany (12%), France (9%), and Australia (8%) (Larsen, Martin and Morris 2002).[1] Germany is one of the major destination countries for students from Asia and the Pacific region and from the rest of Europe (Tremblay 2004). At first sight, this is surprising because most degree programs are still offered in German, but a growing number of higher education institutions are already providing courses or entire degree programs in English. Additionally, German public universities did not charge any tuition fees in the time period

[1] It is worth mentioning that the member countries included in the database use in most cases the concept of citizenship, and not of "educational citizenship" (Tremblay 2002). Depending on citizenship laws in the countries, this can bias the resulting numbers substantially.

covered by my analysis and have a good overall quality. The "Academic Ranking of World Universities" of the Shanghai University 2004[2] ranked the performance of more than 500 universities worldwide. Germany's universities occupied the fourth place with respect to the number of universities among the top 500, even if there seem to be no top institutions. The recruiting of foreign students is also becoming an important topic, leading to specialized information websites for prospective students in order to compete more effectively in the global race for talents. Understanding the determinants of international student migration to Germany could provide valuable information on this policy-relevant topic.

In spite of the growing importance of internationalization in higher education, the amount of reasearch that has been dedicated to the topic up to now is quite small. The analysis by Kim (1998) provides an empirical investigation of the number of students abroad in 1969 and 1985 for 101 countries, but the focus of his work is on growth effects of sending students abroad. Dreher and Poutvaara (2005) analyze the impact of student migrant flows on international migration on the whole. Dia (2005) provides descriptive statistics on the topic. The remainder of the existing research focuses on student mobility as a form of trade in educational services and uses descriptive statistics.[3] However, an analysis from this point of view is difficult because trade in educational services is nearly impossible to disentangle from international trade in services statistics (Larsen, Martin and Morris 2002). In this paper, I am going to take a different point of view: students are treated like international migrants, and their migration is analyzed empirically using a gravity equation approach. Unlike the difficult situation for trade statistics, there are detailed data on incoming students to Germany without a German "Abitur" (university entrance diploma) available. They can be used for an empirical investigation of student mobility, including temporary as well as permanent migration.[4]

While there is only limited empirical evidence on international student mi-

[2]Source: ed.sjtu.edu.cn/ranking.htm

[3]See, for instance, Tremblay 2002.

[4]The available data for Germany do not allow for a distinction between these two types of migration.

gration, this paper is also related to two other strands of empirical migration literature. The first one is interstate student migration within the United States, the second one international migration on the whole.[5] The studies for student migration seem to suggest that this migration follows a similar path as international migration.[6] Migration flows seem to decrease with the costs of a migratory decision, measured as geographical distance (Kyung 1996), higher tuition fees in the receiving state (Mak and Moncur 2001, McHugh and Morgan 1984) or merit-based scholarship programs in the sending states (Mak and Moncur 2001): as these programs are only available to native students from a given state, they increase the opportunity costs of education abroad. Just as in the empirical international migration literature, outmigration from a state seems to increase with the disposable income (Kyung 1996, McHugh and Morgan 1984). Wealthier students have a larger set of opportunities for their educational choices because they are not dependent on scholarships or grants, hence they are more mobile with respect to their education.

On the benefit side, different measures of higher college quality, resulting in higher benefits associated with the degree, seem to attract more students from abroad or to make more students stay. The benefits of college education are likely to increase with the quality of the chosen school. See, for example, Black, Jeffrey and Smith 2005. The number of colleges in a sending state (hence, the set of educational opportunities) decreases outmigration (Hsing and Mixon 1996, Mak and Moncur 2001), as well as expenditure per student (Hsing and Mixon 1996) that possibly raises college quality.

Academically more gifted students seem to have a higher propensity to migrate within the United States. Kyung (1996) finds a significantly positive influence of the average Scholastic Aptitude Test (SAT) score in the sending states, and Baryla and Dotterweich (2001) find a higher enrolment rate of nonresident students at more selective colleges. These results go well in line

[5]See, for example, Massey et al. (1993) or Ghatak, Levine and Price (1996) for more comprehensive surveys of the empirical and theoretical migration literature.

[6]See, for example, Rotte and Vogler (1998) or Karras and Chiswick (1999) for migration to Germany, Hatton and Williamson (2002) and Karemera et al. (2000) for the United States or Pedersen, Pytlikova and Smith (2004) for 27 OECD member states.

with the importance of reputation in college education: Highly qualified students are willing to migrate in order to receive the best education.
In an international context, I expect to find similar driving forces for student migration. However, the data availability is worse than within the United States, because there are no international data available on possible impact factors like student performance (except the Programme for International Student Assessment (PISA) for OECD countries), the number of universities or university selectivity. An analysis of international student migration will therefore be restricted to more general driving forces, such as the economic, geographical and demographic characteristics of the sending countries. I use an augmented gravity equation in order to analyze the determinants of student migrant flows, a workhorse in the analysis of international flows of goods, services, and people. In addition, I also provide extensive sensitivity checks by estimating the gravity equation both as a log-linearized and a multiplicative version, using pseudo-maximum likelihood methods with robust standard errors for cross-sectional and panel data.
Several questions shall be adressed in this first empirical analysis of international student migration to Germany. First, which are the driving forces of international student migration? Does this special type of migration follow a similar path as migration on the whole? And how robust are the results with respect to different specifications of the estimation equation?
The remainder of this paper is organized as follows: Part 2 presents the data sources for the empirical analysis. The gravity equation approach as theoretical foundation is introduced in Part 3, and Part 4 describes the selection and construction of variables for the empirical analysis. Part 5 describes the data set and descriptive findings. Part 6 provides the estimation results, a discussion of these results and an extensive sensitivity analysis, while Part 7 draws a short conclusion.

2 Data Sources

The data for the empirical analyses were gathered from various sources and cover the time period between 1997 and 2002. The sample composition is

provided in Appendix A.
Data on the stocks and inflows of students to Germany from a given sending country were obtained from "Wissenschaft Weltoffen" ("Cosmopolitan Science"), a joint venture of the German Academic Exchange Service (DAAD) and the Higher Education Information System (HIS). They collect numbers on all students without a German university entrance diploma (Abitur), the so-called educational foreigners (Bildungsausländer). The numbers include students at all institutions of higher education: universities, universities of applied sciences (Fachhochschulen), art colleges (Kunsthochschulen) etc. The data quality is high, but there are some critical points worth mentioning. First of all, they include all students without a German "Abitur" who start to study at German universities, also exchange students who stay for one or two semesters in Germany and not for an entire degree program. Students with German citizenship who gained their university admission examination abroad are also treated as educational foreigners. The data sources do not contain any information on the former educational career of students, which means that it is not possible to say if the incoming students are first-time students, if they come to Germany in order to gain a second university degree, or just for an exchange stay. However, the numbers are highly valid as a measure for overall student mobility.
The other regressors for the empirical analysis were taken from different sources. Geographical information was taken from the online database of the Centre d'Études Prospectives et d'Informations Internationales (CEPII)[7]. Data on gross domestic product per capita and population in sending states were obtained from the World Bank's "World Development Indicators" online database, with the exception of Taiwan, where information on population and GDP was only available from the CIA World Factbook.[8] In addition, I included information from the Freedom House Index. This index offers a measure of political rights and civil liberties for nearly all the countries that are part of the sample on a scale from one ("free") to seven ("not free"). I included a dummy variable with the value of 1 for countries that were judged

[7]Source: www.cepii.fr
[8]Sources: www.worldbank.org/devdata, www.cia.gov/cia/publications/factbook

"partly free" and "not free".

3 Theoretical Considerations

Tinbergen (1962) was the first one to use the law of gravitation in order to describe international trade flows. Today, the gravity equation approach has become a workhorse in the empirical analysis of international flows of goods and people, including applications to foreign direct investment, migration or tourism. Karemera et al. (2000) sketch a derivation of the reduced form gravity equation for international migration from supply and demand forces. In its deterministic form, the resulting baseline migration flow equation between two countries i and j can be written as

$$F_{ij} = \frac{\alpha_0 S_i^{\alpha 1} D_j^{\alpha 2}}{R_{ij}^{\alpha 3}} \tag{1}$$

where supply S_i is a function of income in the country of origin, population size, and factor endowments. Similarly, demand D_j is a function of income and population in the country of destination. Supply and demand can of course be seen as push and pull factors of international migration flows. R_{ij} represents different factors that promote or deter migration between the two countries, such as distance, visa regulations, or the political situation in the country of origin. In Newton's original formulation, S_i and D_j represent the mass of the objects under consideration, while R_{ij} denotes the distance between them. α_0 is the equivalent to the gravitational constant in Newton's original equation. While Karemera et al. (2000) do not provide a further explanation for the existence of this parameter, Buch et al. (2004) note that the constant in an empirical application (using OLS regression and a log-log specification) of the gravity equation also captures distance costs.

In an empirical application, the unknown parameters α_1, α_2 and α_3 can be obtained using different regression techniques for a stochastic version of equation (1). The standard approach in the literature was to take logs of equation (1) and estimate the log-linearized version using OLS. I also estimate a multiplicative version using a Poisson pseudo-maximum likelihood specification,

following recent work by Santos Silva and Tenreyro (2006).
In empirical applications of the gravity equations, researchers typically "augment" the equation using variables that should intuitively affect the flows, but with less theoretical justification. I follow this approach and augment the equation by several variables that I introduce and discuss in the next section.

4 Selection and construction of variables for the empirical estimations

Several factors should influence the variable R_{ij} in equation (1), hence, the factors that increase or deter migration between two countries. The costs of a foreign degree are most probably higher than those of a domestic one. Students have to travel more frequently, they can have difficulties with a new language or social and psychic costs due to the necessary adaptation to a new culture and a different environment. However, these costs can be lowered if there exists a positive externality of a student network, and the student can use the social capital of this network (the "friends and relatives effect"). Several results from the empirical migration literature stress the importance of networks. Gross and Schmitt (2003) observe a clustering of migrants in ethnically homogenous groups and attribute this fact to lowered informational asymmetries within a migrant network, and more attractive wages for migrants within their cultural community below a certain threshold size of the community. For student migrants, informational asymmetries about the university they choose should also play an important role. Subsequent migrants can benefit from the social capital of their compatriots, and this lowers the costs of educational migration to the destination country. Hence, I expect a high importance of the stock of students of one citizenship already living in Germany and a positive coefficient sign in the empirical estimations.
A higher distance increases the costs of educational migration, because students have to travel to their chosen university, and voyages home become more expensive with an increasing distance. Additionally, the distance be-

tween two countries can be seen as a very rough measure of cultural similarity, because countries in geographical proximity tend to have similar cultures, values and languages. I included information on the geodesic distance (using latitudes and longitudes of the considered countries) between the most important agglomerations in the country of origin and Germany (Clair et al. 2004). A greater distance should lower the inflows of students to Germany and enter the estimations with a negative sign.

Additionally, I entered dummy variables for further geographical characteristics of the sending country, e.g., for the continents of origin, for the fact of being landlocked, and for the fact of sharing a common border with Germany. These geographical variables can also reflect costs of a migratory decision. For the continents, Europe and the former Soviet Union's member states are the baseline category. Student migration to Germany is probably highest within this group of countries, especially due to the higher degree of temporary migration within mobility schemes. The expected coefficient signs on the dummies for continents of origin are therefore negative. The fact of being landlocked is found to decrease trade flows extremely (Overman, Redding and Venables 2001), while the results for migration are less clear. I expect the importance of being landlocked to be negligible for student migrants in times of international air connections and therefore an insignificant coefficient sign, but higher student inflows from Germany's neighboring countries. The contiguity dummy should therefore enter the estimation results with a positive sign.

The Freedom House Index index offers a measure of political rights and civil liberties for nearly all the countries that are part of the sample on a scale from one ("free") to seven ("not free"). I included a dummy variable with the value of 1 for countries which were judged "partly free" and "not free". In general, living in a free country should increase the quality of education, the choice of educational opportunities and the benefits associated with a university degree, hence less migrants from free countries. However, the difficulties of leaving an unfree country should also be kept in mind, and living in an unfree country should increase the costs of a migratory decision. Repressive regimes can try to decrease the set of educational opportunities for their citizens by imposing different kinds of mobility restrictions for leaving the country. On the other hand, it is possible that students (as well as other citizens) leave unfree countries because of political repression or terror, and this refugee migration could increase the inflows from such a country to Germany substantially. The expected coefficient sign for this variable is therefore not clear.

The population of the sending country was included to control for the fact that larger countries tend of course to send more students abroad. This regressor is clearly positively correlated with the dependent variable, the inflow of students to Germany in a given year. The correlation coefficients varied between 0.21 and 0.62, providing descriptive evidence for the importance of "mass" in the gravity equation.

The empirical results for college student migration within the United States and for international migration on the whole suggest that outmigration increases with the disposable personal income in the sending states. This should also be the case for international student migrants. Students from wealthier countries have probably better options to go abroad for an exchange year or their entire degree program. Hence, I included information on GDP per capita of the sending country for a given year, measured in purchasing parity power adjusted constant 1995 international US dollars. The expected coefficient sign on this regressor is, again, positive.

5 Descriptive Statistics

The annual inflows of foreign students to Germany have witnessed a rather impressive growth during the last years. The total number of incoming foreign students without a German "Abitur" has nearly doubled during the years from 1997 to 2002. However, the regional composition of students has changed substantially. The share of students from Europe and the former Soviet Union has dropped by nearly 10%, and this loss has been outweighed by an increase of incoming students from Asia (including Australia and New Zealand). The largest part of Asian students comes from the People's Republic of China. The share of African students has remained quite stable (about

7%), while the percentage of students from the Americas has declined slightly (from 10% to 8%). The main results with respect to the regional composition of annual inflows are summarized in the following table.

Table 1 about here

A look at the growth rates of the inflows to shows that they are highest for students from Asia. The highest growth rate was the one for students from Asia in 2000/2001. At the same time, more and more students from non-OECD member countries decide to study in Germany: since 2000, the majority of incoming students in Germany are citizens of non-OECD member states.

Table 2 about here

The growing degree of internationalization in the composition of Germany's student body can be highlighted further by a look at the percentage of educational foreigners among freshmen at German universities that has nearly doubled between 1997 and 2002.

Table 3 about here

The changing composition of the foreign student body in Germany can also be underlined by a look at the most important countries of origin. China's share increased steadily, as well as student migration from the central and eastern European transition economies, and the importance of West European countries and the United States decreased during this time period. The number of incoming students from European countries has increased slightly, probably because of the very stable form of student migrant flows within ERASMUS and other mobility programs. But the growth rates of inflows from European states are clearly not high enough to keep the share of the incoming European students constant.

Table 4 about here

It is also interesting to see that the 25 most important countries of origin account for 75% of all incoming students between 1997 and 2002. There is a

high degree of concentration towards several major countries of origin. The institutionalization of sending students abroad (e.g., in the case of China) favors the further growth of student inflows from these countries.
The regional shares of stocks of foreign students without a German Abitur in Germany have remained quite stable during the time period in consideration. An interesting point is the change between OECD member states and non-OECD members.

Table 5 about here

Unfortunately, there are no data on student outflows from Germany available. The calculation of net inflows (as differences in the student stocks between two years) shows that the fluctuations among students have to be of different sizes. The outflows can be due to different reasons, e.g. because students graduate or exchange students leave the country after one year. But if the difference in stocks is small compared to the yearly gross inflow, there has to be a higher degree of fluctuation. Hence, the quotient net inflows/gross inflows can be interpreted as a rough measure of fluctuation: the lower this percentage, the higher is the fluctuation (and probably the number of exchange students among the student inflows). The following table presents these percentages.

Table 6 about here

Empty fields mean that the stock of students during the year has decreased, and the percentage could not be calculated. As expected, the fluctuation seems to be quite high among the European students and also among the Americans, where there are most exchange programs. Students from Africa and Asia seem to be more likely to stay for an entire degree program: the fluctuation seems to be lower for these students, and the development of this percentage for students from Asia is striking. The relatively stable shares of student stocks can also be explained by the fact that differences in stocks (or net inflows) are quite small, compared to the yearly gross inflows.
Descriptive statistics for the other regressors can be found in Appendix B. In the following section, I am going to present the estimation approach and a discussion of the empirical results.

6 Estimations and Discussion of the Results

6.1 Estimation Strategy

Taking logs of equation (1) yields an estimable equation. Augmenting it by various other variables yields the following equation that describes the inflows of foreign students to Germany in a given year.

$$students_{it} = \beta_0 + \beta_1 dist_i + \beta_2 studentstock_{it} + \beta_3 gdpabs_{it}$$
$$+\beta_4 popul_{it} + \delta_0 freedom_{it} + \delta_1 other_i + u_i \qquad (2)$$

The index i denotes cross-sectional units (i.e.countries) and the index t denotes years in the panel data estimations.
While estimating a log-linearized version of the gravity equation has been the standard approach in the literature for many years, recent work by Santos Silva and Tenreyro (2006) points out that this can lead to inconsistent estimates. The most obvious reason is that the dependent variable, $students_{it}$, may be zero for some countries of origin. A second reason is that the error term in the log-linearized estimation equation will be independent of the covariates only under very restrictive conditions.[9] However, the authors show that estimation of a Poisson pseudo-maximum likelihood (PPML) model is a simple method to overcome these drawbacks because the only condition for consistency of this estimator is that the conditional expectation of the mean be correctly specified, i.e. $E[y_i|x] = exp(x_i\beta)$.[10] In addition, their Monte Carlo simulations show that this estimator is robust to different patterns of heteroskedasticity. Hence, I also estimate a multiplicative version of the gravity equation and compare the results to the OLS estimates. I also provide panel data estimates for both approaches.

[9]In fact, it is necessary that u_i can be written as $u_i = exp(x_i\beta)v_i)$, where v_i is a random variable that is statistically independent of x_i.

[10]This result goes back to Gourieroux et al. (1984): the data do not have to follow a Poisson distribution at all.

6.2 Cross-Section Regressions

The following tables present results for cross-sectional analyses for the entire sample and each of the six years. In the tables, results from four different estimation approaches are shown. The log-linearized version that allows to interpret estimated coefficients as elasticities uses as dependent variables the natural logarithm of student inflows and of student inflows +1 (as a common way to deal with zero values of the dependent variables). For the PPML estimations, I also show results from two different versions, namely the standard one and a restricted sample with positive values of student inflows only for the sake of comparability to the OLS estimates. The interpretation of the coefficients is slightly different from the ordinary least squares model. The conditional mean of the Poisson regression model is given by $\mu = E(y|x) = exp(\mathbf{x}\beta)$, and partial differentiation with respect to x_j shows that the marginal effect of a change is $\frac{\partial E(y|x)}{\partial x_j} = \frac{\partial exp(x\beta)}{\partial x\beta} \cdot \frac{\partial x\beta}{\partial x_j} = \exp(x\beta)\beta_j = E(y|x)\beta_j$, and $\beta_j = \frac{\partial E(y|x)}{\partial x_j} \cdot \frac{1}{E(y|x)} = \frac{\partial \log[E(y|x)]}{\partial x_j}$.

Tables 7 - 12 about here

The stock of students of the same citizenship in Germany is always found to have a positive and significant impact on the inflows to Germany. The positive externalities of student networks could provide an explanation for this very stable result. A 1% increase in the student stock of the same nationality already living in Germany increases the inflows between 0.77% and 0.87% using OLS. For the exchange students, the existence of exchange programs between partner universities abroad and in Germany can also help to explain this clustering of students of the same citizenship in Germany. These channels for international student migration make it more likely that an initial stream of exchange students to Germany remains stable or even increases in the subsequent years, because information costs are lowered substantially for the later students. They can use the informations that their predecessors provide, e.g., by an ERASMUS field report.[11] Knowing older students who

[11] All ERASMUS exchange students are required to write such a report after their stay abroad. Subsequent students who are interested in going to the same university can use these reports as a decision aid.

have already studied at a certain partner university also increases the probability of choosing the same institution for subsequent exchange students, and student mobility flows are thus probably very stable between partner universities in different European countries.

Political freedom and civil liberties are related closely to the mobility of a country's citizens, hence also its students. The regression results show that being a partially free or unfree country lowers the student inflows from this country to Germany significantly. Authoritarian regimes seem to be successful in their attempts to decrease the educational opportunities for their students by restricting their mobility, and being an unfree or partially free country lowers the inflows of its students to Germany between 28.36% and 42.12% in the six analyzed years using OLS.

Quite surprisingly, a higher GDP per capita does not seem to increase student inflows to Germany. This fact can probably be explained by the existence of grants or scholarship programs that make students independent of their families' financial support.

At first sight, one of the most interesting results is the fact that distance is less important to student migrants than to other migrants. However, the continent dummies for Asia, Africa and the Americas show always significantly negative signs (with one exception for Asia), and this fact suggests that distance effects are probably captured by these control variables. Additionally, student mobility is higher in Europe (and the former Soviet Union) thanks to exchange programs. As Europe is the baseline category for the continent dummies, the negative signs for the other continents are not very surprising. For Asia and the Americas, it is interesting to see that the size of the coefficient shows a decreasing size over time. This does not seem to be the case for Africa.

Additional estimations without the control dummies for the continents showed the expected significantly negative signs of the distance coefficient, and it is interesting that the size of the coefficient decreased over time (see tables 21 -26 in Appendix C). A one percent increase in distance lowered student inflows to Germany between 0.34% in 1997 and 0.19% in 2002 using OLS. It seems that the degree of international student mobility increased significantly

over the analyzed time period, and the impact of distance to Germany on migratory decisions of students seemed to decline.
The need to control for population size is confirmed by the cross sectional estimation results. Population size and the inflows of students to Germany are clearly correlated, and the positive impact of "mass" (i.e., population size) that one expects from the gravity equation is clearly confirmed by the regression results for student migrants. A 1% increase in population increases student inflows to Germany between 0.15% and 0.22%.
The fact of being landlocked does not seem to matter for student migration to Germany.
The goodness of fit of this model specification is high, especially for a cross-sectional analysis. The R^2 varies between 0.90 and 0.94, meaning that a large part of the variance in student inflows to Germany can be explained by characteristics of the sending countries only. It is quite surprising to see that individual-level decisions about studying abroad can be explained nearly exclusively by macroeconomic, political and geographical determinants. The estimated coefficients seem to be quite stable over time, meaning that the determinants of international student migration do not seem to change for different years worldwide. A candidate explanation for this finding is the probably high degree of institutionalization of international student migration. University networks seem to be very important for student migration.
In general, results from the PPML estimates look quite similar to OLS estimates with robust standard errors.
However, estimated coefficients for being an unfree country are larger under the PPML specification of the estimation equation. Population size of the sending country also shows larger estimated coefficients. In addition, the migration-deterring distance effects seem to be captured to a larger extent by the distance than by the continent dummies. The differing significance levels could be due to the fact that robust (Huber-White) standard errors in the log-linearized version of the estimation equation are only asymptotically robust to heteroskedasticty of unknown form and the sample sizes are not too big.
In the regression without the continent dummies, the estimated coefficients

for distance are always quite close to the results from the OLS specification. The findings of a larger impact of population size and the dummy for being an unfree country are confirmed by these estimations. Interestingly, the contiguity dummy shows always a significantly negative estimation coefficient in the PPML specifications. This could be due to the fact that students from the German-speaking neighboring countries do not gain much from an exchange stay in Germany because they do not learn a new language.

6.3 Panel Data Estimations

An important point of panel data analysis is the possibility to control for unobserved heterogeneity in the cross-sectional and temporal dimension of the data set, e.g., country-invariant unobserved variables that influence student inflows to Germany. However, the cross-sectional analysis has already explained a large part of the variance of student inflows, and the panel data estimations should therefore be regarded rather as an additional sensitivity analysis.
I also estimate a fixed-effects Poisson pseudo-maximum likelihood regression with robust standard errors following Wooldrige (1999) with the panel data set. To my knowledge, this is the first multiplicative-form estimation of a gravity equation for panel data.
Fixed effects estimation is always consistent and assumes that the unobserved effect can be correlated with the regressors- hence, it is the appropriate estimation method when the unobserved effect is non-random, as it should be the case for countries in the case of international student migration. The random effects model, on the other hand, assumes that the unobserved effect is uncorrelated with the regressors, and is more efficient but (possibly) not consistent. The Hausman test (Hausman 1978) suggested the appropiateness of a fixed effects model for the estimation, but the disadvantage of this model is of course the loss of time-invariant information. The following table presents the estimation results for pooled cross section and panel data estimations.

Table 13 about here

The panel data estimations show results familiar from the previous sections. However, it is interesting to see that just one coefficient stays statistically significant: the positive influence of the stock of students already living in Germany.[12] The negative influence of being an unfree country on student inflows to Germany disappears for the cross-section fixed effects estimation, which can be due to the fact that the political situation is not very likely to change in such a short time period, and time-invariant factors are cancelled out due to the fixed effects estimation method. The same holds probably true for the other regressors.
Finally, results from the PPML approach for panel data show again the same picture: the estimated coefficient on the stock of students of the same citizenship already living in Germany shows the highest impact on student inflows to Germany and is highly significant. This effect is very large compared to the significantly negative impact of being an unfree country.

7 Conclusion

The present article provided a gravity equation analysis of international student migration. I provided estimation results from a log-linearized version as well as from a multiplicative specification using a Poisson pseudo-maximum likelihood estimator, applied to both cross-sectional and panel data.
The empirical results provide evidence for the predictions of the gravity equation. Distance as captured by the geodesic distance or a dummy variable for a continent of origin other than Europe shows in most cases significantly negative coefficient signs, but with a decreasing importance over time for the cross-sectional results and both specifications. The descriptive finding of an increase in worldwide student mobility during the time period covered by my data set is confirmed by the estimation results.
Unfree countries send less students to Germany- they seem to decrease the educational opportunities for their citizens successfully, resulting in higher costs of a migratory decision. Refugee migration does not seem to be an

[12]This holds also true for estimations of subsamples according to income groups or continents of origin. Estimation results are available from the author.

important reason for student migrants to Germany.
Unlike the cases of international migration on the whole and interstate student migration in the U.S., disposable income in the sending state, measured as gross domestic product per capita, does not always show the expected positive sign. Grants or scholarships can provide an explanation for this result, especially for students from poorer countries.
These estimation results also suggest that the driving forces of student migration differ in some features from international migration on the whole, especially with respect to personal income in the sending states. Additionally, the empirical patterns of student migration show that there is a high degree of concentration among the sending countries. The importance of partner universities that send their exchange students to a certain country is probably high, leading to stable streams of student migrants over time. I suppose that the "friends and relatives effect" is more important for permanent migrants, while the importance of partner universities should be higher for exchange students. However, the available data on student inflows to Germany make the confirmation of this conjecture impossible because they do not distinguish between temporary and permanent migration. Nevertheless, it is possible to interpret the stable impact of the stock of students of the same citizenship in Germany as a confirmation of the positive externality of a student network. It also makes clear that student migration is a highly insitutionalized form of international migration: the channels for student migration are extremely stable.
The empirical results could also be interesting from a policy-oriented perspective. Germany faces skill shortages in several sectors and plans to facilitate the recruitment of skilled labor for firms, inter alia via a three-year right of residence for foreign graduates of German universities. It should be easier to recruit graduates from countries with a larger migrant community and therefore it could be sensible to concentrate efforts on graduates from these countries.
The globalization process in higher education has just started, and it will be highly interesting to follow its evolution in the next years. I hope that the present work was a small step in its analysis.

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Table 1: Regional Shares of Incoming Students

	1997	1998	1999	2000	2001	2002
Europe+F.S.U.	70.42%	69.20%	67.17%	66.19%	63.60%	61.57%
Africa	7.26%	7.80%	8.03%	7.58%	6.60%	7.02%
Asia	11.99%	13.35%	15.34%	17.57%	21.75%	23.46%
Americas	10.33%	9.65%	9.46%	8.66%	8.05%	7.94%
OECD	65.12%	61.95%	57.11%	53.37%	48.76%	46.08%
Non-OECD	34.88%	38.05%	42.89%	46.63%	51.24%	53.92%
Total number	30,931	34,619	39,772	45,027	53,053	58,338

Table 2: Growth Rates of Inflows

	1997/98	1998/99	1999/00	2000/01	2001/02
World	11.92%	14.88%	13.21%	17.82%	9.96%
Europe+F.S.U.	9.98%	11.52%	11.57%	13.22%	6.45%
Africa	20.25%	18.17%	6.89%	2.55%	17.09%
Asia	24.65%	32.02%	29.65%	45.86%	18.63%
Americas	4.57%	12.66%	3.59%	9.54%	8.43%
OECD	6.47%	5.91%	5.80%	7.65%	3.93%
Non-OECD	22.09%	29.50%	23.08%	29.46%	15.70%

Table 3: Percentage of Educational Foreigners among German Freshmen

	1997	1998	1999	2000	2001	2002
Percentage	8.50%	9.30%	9.90%	10.40%	11.40%	16.30%
Total number	267,445	272,473	291,447	314,956	344,830	358,792

Table 4: Top 5 Countries of Origin

Rank	1997	1998	1999	2000	2001	2002
1	France	France	France	China	China	China
2	USA	USA	Poland	France	France	Poland
3	Italy	Spain	USA	Poland	Poland	Bulgaria
4	Spain	Italy	Spain	Spain	Bulgaria	France
5	UK	Poland	China	USA	Spain	Russia

Table 5: Regional Shares of Student Stocks

	1997	1998	1999	2000	2001	2002
Europe+F.S.U.	54.48%	55.77%	56.77%	57.10%	57.41%	57.19%
Africa	12.70%	13.07%	13.41%	13.57%	13.24%	12.47%
Asia	25.24%	23.76%	22.81%	22.48%	22.92%	24.38%
Americas	7.59%	7.40%	7.01%	6.85%	6.43%	5.95%
OECD	49.22%	48.47%	47.25%	45.04%	42.51%	39.33%
Non-OECD	50.78%	51.53%	52.75%	54.96%	57.49%	60.67%
Total	98,852	102,583	107,732	111,976	124,834	141,909

Table 6: Fluctuation Measure

	1997/98	1998/99	1999/00	2000/01	2001/02
World	12.06%	14.87%	10.67%	28.56%	32.18%
Europe+F.S.U.	15.41%	16.51%	10.37%	25.95%	28.14%
Africa	37.96%	38.53%	23.46%	39.06%	33.51%
Asia		4.20%	9.85%	43.47%	51.95%
Americas	2.88%		3.30%	9.00%	9.67%
OECD	5.29%	5.53%		10.94%	10.59%
Non-OECD	24.71%	30.08%	27.60%	48.72%	52.73%

Table 7: Comparison OLS vs. Poisson, 1997

Dep. variable	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.826***	0.765***	0.688***	0.687***
	(0.048)	(0.043)	(0.057)	(0.057)
log of geodesic dist.	0.053	-0.01	-0.233***	-0.233***
	(0.115)	(0.095)	(0.075)	(0.075)
log of population	0.145***	0.145***	0.266***	0.266***
	(0.049)	(0.047)	(0.045)	(0.045)
log of GDP per capita	0.009	-0.014	-0.022	-0.022
	(0.046)	(0.040)	(0.067)	(0.067)
1 = Africa	-0.915***	-0.824***	-0.442**	-0.443**
	(0.164)	(0.151)	(0.224)	(0.224)
1 = Asia	-1.191***	-1.051***	-0.745***	-0.745***
	(0.218)	(0.182)	(0.200)	(0.199)
1 = Americas	-0.857***	-0.749***	-0.052	-0.052
	(0.238)	(0.211)	(0.233)	(0.233)
1 = unfree country	-0.369***	-0.368***	-0.648***	-0.647***
	(0.109)	(0.103)	(0.138)	(0.137)
1 = contiguity	0.118	0.098	-0.208**	-0.207**
	(0.175)	(0.156)	(0.095)	(0.095)
1 = landlocked	0.104	0.102	0.124	0.125
	(0.092)	(0.086)	(0.097)	(0.097)
Constant	-2.412**	-1.425**	-1.122	-1.11
	(0.954)	(0.708)	(0.763)	(0.764)
Observations	146	150	150	146
R-squared	0.93	0.94		
Log pseudolikelihood			-2142.6519	-9867.8887

Robust standard errors are given in parentheses, ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 8: Comparison OLS vs. Poisson, 1998

Dep. variable	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.768***	0.727***	0.716***	0.714***
	(0.055)	(0.053)	(0.064)	(0.064)
log of geodesic dist.	-0.026	-0.027	-0.193**	-0.193**
	(0.120)	(0.119)	(0.084)	(0.083)
log of population	0.192***	0.210***	0.284***	0.283***
	(0.056)	(0.058)	(0.047)	(0.047)
log of GDP per capita	-0.073	-0.087**	-0.03	-0.029
	(0.047)	(0.043)	(0.033)	(0.033)
1 = Africa	-0.897***	-0.947***	-0.37	-0.368
	(0.169)	(0.173)	(0.292)	(0.291)
1 = Asia	-0.924***	-0.962***	-0.766***	-0.765***
	(0.225)	(0.219)	(0.235)	(0.234)
1 = Americas	-0.937***	-0.955***	-0.226	-0.224
	(0.250)	(0.230)	(0.237)	(0.237)
1 = unfree country	-0.414***	-0.369***	-0.656***	-0.658***
	(0.113)	(0.118)	(0.141)	(0.141)
1 = contiguity	0.104	0.154	-0.176*	-0.174*
	(0.190)	(0.188)	(0.090)	(0.090)
1 = landlocked	-0.504*	-0.426**	-0.013	-0.011
	(0.258)	(0.195)	(0.130)	(0.131)
Constant	-1.664*	-1.618*	-1.745***	-1.721***
	(0.913)	(0.895)	(0.631)	(0.631)
Observations	143	151	151	143
R-squared	0.9	0.9		
Log pseudolikelihood			-2673.5498	-10401.586

Robust standard errors are given in parentheses, ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 9: Comparison OLS vs. Poisson, 1999

Dep. variable	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.830***	0.749***	0.770***	0.768***
	(0.051)	(0.048)	(0.064)	(0.064)
log of geodesic dist.	-0.103	-0.147	-0.108	-0.107
	(0.101)	(0.094)	(0.088)	(0.088)
log of population	0.148***	0.167***	0.268***	0.268***
	(0.053)	(0.053)	(0.051)	(0.051)
log of GDP per capita	-0.088**	-0.094**	-0.02	-0.02
	(0.044)	(0.042)	(0.038)	(0.038)
1 = Africa	-0.656***	-0.669***	-0.396	-0.394
	(0.157)	(0.164)	(0.273)	(0.273)
1 = Asia	-0.531***	-0.486**	-0.727***	-0.727***
	(0.197)	(0.186)	(0.269)	(0.268)
1 = Americas	-0.423*	-0.359*	-0.273	-0.274
	(0.238)	(0.214)	(0.224)	(0.223)
1 = unfree country	-0.418***	-0.382***	-0.604***	-0.605***
	(0.118)	(0.112)	(0.159)	(0.159)
1 = contiguity	-0.016	0.019	-0.153	-0.152
	(0.166)	(0.160)	(0.093)	(0.093)
1 = landlocked	-0.098	-0.098	-0.222	-0.221
	(0.150)	(0.136)	(0.252)	(0.253)
Constant	-0.726	-0.167	-2.470***	-2.463***
	(0.823)	(0.784)	(0.828)	(0.829)
Observations	148	155	155	148
R-squared	0.92	0.93		
Log pseudolikelihood			-2867.535	-12546.443

Robust standard errors are given in parentheses, ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 10: Comparison OLS vs. Poisson, 2000

Dep. variable	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.814***	0.736***	0.833***	0.831***
	(0.063)	(0.054)	(0.057)	(0.057)
log of geodesic dist.	-0.083	-0.096	-0.138	-0.138
	(0.118)	(0.109)	(0.092)	(0.092)
log of population	0.151***	0.196***	0.251***	0.251***
	(0.055)	(0.056)	(0.054)	(0.054)
log of GDP per capita	-0.054	-0.06	-0.042	-0.042
	(0.056)	(0.055)	(0.053)	(0.053)
1 = Africa	-0.809***	-0.793***	-0.480***	-0.480***
	(0.152)	(0.160)	(0.185)	(0.185)
1 = Asia	-0.523**	-0.636***	-0.509**	-0.509**
	(0.216)	(0.197)	(0.258)	(0.258)
1 = Americas	-0.513**	-0.505**	-0.182	-0.183
	(0.237)	(0.226)	(0.222)	(0.222)
1 = unfree country	-0.324***	-0.327***	-0.471***	-0.470***
	(0.111)	(0.108)	(0.135)	(0.135)
1 = contiguity	0.053	0.117	-0.195	-0.194
	(0.177)	(0.175)	(0.126)	(0.126)
1 = landlocked	-0.082	-0.078	0.075	0.074
	(0.117)	(0.111)	(0.088)	(0.087)
Constant	-0.986	-1.064	-2.317***	-2.305***
	(0.980)	(0.901)	(0.830)	(0.831)
Observations	146	155	155	146
R-squared	0.92	0.92		
Log pseudolikelihood			-3011.4112	-14503.548

Robust standard errors are given in parentheses, ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 11: Comparison OLS vs. Poisson, 2001

Dep. variable	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.791***	0.748***	0.876***	0.874***
	(0.054)	(0.046)	(0.058)	(0.058)
log of geodesic dist.	-0.117	-0.017	-0.093	-0.093
	(0.104)	(0.102)	(0.094)	(0.094)
log of population	0.215***	0.201***	0.240***	0.240***
	(0.041)	(0.041)	(0.052)	(0.052)
log of GDP per capita	-0.06	-0.084**	-0.075	-0.074
	(0.041)	(0.040)	(0.051)	(0.051)
1 = Africa	-0.893***	-0.956***	-0.551***	-0.550***
	(0.159)	(0.168)	(0.159)	(0.159)
1 = Asia	-0.243	-0.422**	-0.289	-0.29
	(0.202)	(0.203)	(0.272)	(0.272)
1 = Americas	-0.533**	-0.596***	-0.143	-0.146
	(0.212)	(0.205)	(0.236)	(0.236)
1 = unfree country	-0.419***	-0.424***	-0.418***	-0.418***
	(0.100)	(0.101)	(0.134)	(0.134)
1 = contiguity	0.006	0.193	-0.104	-0.103
	(0.162)	(0.153)	(0.132)	(0.132)
1 = landlocked	-0.149	-0.223	-0.556***	-0.554***
	(0.170)	(0.174)	(0.190)	(0.191)
Constant	-1.505	-1.611*	-2.572***	-2.568***
	(0.977)	(0.860)	(0.873)	(0.873)
Observations	144	154	154	144
R-squared	0.94	0.94		
Log pseudolikelihood			-3297.9304	-17334.432

Robust standard errors are given in parentheses, ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 12: Comparison OLS vs. Poisson, 2002

Dep. variable	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.865***	0.808***	0.866***	0.865***
	(0.049)	(0.042)	(0.047)	(0.047)
log of geodesic dist.	-0.085	-0.086	-0.152*	-0.151*
	(0.099)	(0.097)	(0.082)	(0.082)
log of population	0.173***	0.164***	0.229***	0.229***
	(0.045)	(0.044)	(0.037)	(0.037)
log of GDP per capita	-0.029	-0.055	-0.042	-0.041
	(0.053)	(0.051)	(0.055)	(0.055)
1 = Africa	-0.706***	-0.708***	-0.425**	-0.425**
	(0.190)	(0.183)	(0.181)	(0.181)
1 = Asia	-0.306	-0.355*	-0.272	-0.272
	(0.188)	(0.194)	(0.215)	(0.215)
1 = Americas	-0.416	-0.373	-0.046	-0.048
	(0.257)	(0.244)	(0.221)	(0.221)
1 = unfree country	-0.282**	-0.288***	-0.388***	-0.388***
	(0.118)	(0.110)	(0.103)	(0.103)
1 = contiguity	0.033	0.071	-0.119	-0.118
	(0.160)	(0.156)	(0.110)	(0.110)
1 = landlocked	0.004	0.009	-0.096	-0.096
	(0.118)	(0.113)	(0.091)	(0.091)
Constant	-1.847**	-1.14	-2.100***	-2.098***
	(0.874)	(0.842)	(0.642)	(0.642)
Observations	144	152	152	144
R-squared	0.93	0.93		
Log pseudolikelihood			-2764.466	-17401.155

Robust standard errors are given in parentheses, ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 13: Panel Data Estimations

	Pooled OLS	Fixed Effects	Random Effects	PPML
log of student stock	0.818***	0.561***	0.753***	1.055***
	(0.018)	(0.053)	(0.028)	(0.103)
log of geodesic dist.	-0.058		-0.109	
	(0.049)		(0.095)	
log of population	0.167***	0.078	0.173***	0.114
	(0.019)	(0.064)	(0.031)	(0.103)
log of GDP per capita	-0.044**	0.036	0.006	0.044
	(0.021)	(0.035)	(0.028)	(0.043)
1 = Asia	-0.616***		-0.637***	
	(0.090)		(0.180)	
1= Americas	-0.618***		-0.630***	
	(0.099)		(0.198)	
1= Africa	-0.813***		-0.908***	
	(0.079)		(0.159)	
1 = unfree country	-0.381***	-0.08	-0.220***	-0.263**
	(0.049)	(0.092)	(0.069)	(0.129)
1 = contiguity	0.051		0.126	
	(0.114)		(0.230)	
1 = landlocked	-0.057		-0.042	
	(0.051)		(0.038)	
Constant	-1.501***	-0.345	-1.197	
	(0.404)	(1.075)	(0.763)	
Observations	871	871	871	917
R-squared	0.92	0.8811	0.915	
Hausman Test:				
Value of χ^2			34.55	
Prob.			0.00	
Breusch-Pagan Test:				
Value of χ^2			452.23	
Prob.			0.00	

A Sample Composition

Table 14: Entire Sample

Afghanistan	Dominican Republic	Lebanon	Romania
Angola	Algeria	Liberia	Russia
Albania	Ecuador	Libya	Rwanda
United Arab Emirates	Egypt	St. Lucia	Saudi Arabia
Argentina	Eritrea	Liechtenstein	Sudan
Armenia	Spain	Sri Lanka	Senegal
Australia	Estonia	Lesotho	Singapore
Austria	Ethiopia	Lithuania	Sierra Leone
Azerbaijan	Finland	Luxembourg	El Salvador
Burundi	France	Latvia	San Marino
Belgium	Gabon	Morocco	Somalia
Benin	United Kingdom	Monaco	Sao Tome and Principe
Burkina Faso	Georgia	Moldova	Suriname
Bangladesh	Ghana	Madagascar	Slovakia
Bulgaria	Guinea	Mexico	Slovenia
Bahrain	Gambia, The	Macedonia	Sweden
Bahamas	Guinea-Bissau	Mali	Swaziland
Bosnia-Herzegovina	Greece	Malta	Seychelles
Belarus	Grenada	Burma	Syria
Belize	Guatemala	Mongolia	Chad
Bolivia	Guyana	Mozambique	Togo
Brazil	Honduras	Mauritania	Thailand
Barbados	Croatia	Mauritius	Tajikistan
Bhutan	Haiti	Malawi	Turkmenistan
Botswana	Hungary	Malaysia	Trinidad and Tobago
Central African Republic	Indonesia	Namibia	Tunisia
Canada	India	Niger	Turkey
Switzerland	Ireland	Nigeria	Taiwan
Chile	Iran	Nicaragua	Tanzania
China	Iraq	Netherlands	Uganda
Cote d'Ivoire	Iceland	Norway	Ukraine
Cameroon	Israel	Nepal	Uruguay
Congo (Brazzaville)	Italy	New Zealand	United States
Colombia	Jamaica	Oman	Uzbekistan
Comoros	Jordan	Pakistan	The Holy See (Vatican)
Cape Verde	Japan	Panama	Venezuela
Costa Rica	Kazakhstan	Peru	Vietnam
Cuba	Kenya	Philippines	Yemen
Cyprus (Greek)	Kyrgyzstan	Poland	Serbia and Montenegro
Czech Republic	Cambodia	North Korea	South Africa
Djibouti	South Korea	Portugal	Congo (Kinshasa)
Dominica	Kuwait	Paraguay	Zambia
Denmark	Laos	Qatar	Zimbabwe

B Descriptive Statistics

B.1 Student Inflows, 1997 - 2002

Table 15: Entire Sample: Student Inflows

World	1997	1998	1999	2000	2001	2002
Mean	179.83	201.27	231.23	261.78	308.45	339.17
Min	0	0	0	0	0	0
Max	2997	3006	3124	3451	6180	6985
S.D.	403.49	437.06	497.32	570.87	732.29	802.17

B.2 Student Stocks, 1997 - 2002

Table 16: Entire Sample: Student Stocks

World	1997	1998	1999	2000	2001	2002
Mean	584.92	607.00	626.35	651.02	725.78	825.05
Min	0	0	1	1	0	0
Max	6434	6414	6306	6642	8745	13523
S.D.	1142.99	1165.46	1195.53	1232.46	1418.61	1738.42

B.3 Gross Domestic Product per capita, 1997 - 2002

Table 17: Entire Sample: GDP per capita

World	1997	1998	1999	2000	2001	2002
Mean	7265.49	7418.49	7534.39	7838.19	7922.29	7978.24
Min	453.39	459.18	418.63	426.66	440.37	463.62
Max	37346.68	40399.29	44715.63	51636.82	52662.77	54200.81
S.D.	7677.04	7914.62	8200.47	8668.65	8764.35	8929.17

B.4 Population, 1997 - 2002

Table 18: Entire Sample: Population

World	1997	1998	1999	2000	2001	2002
Mean	34145766.27	33793605.63	34245641.26	34681291.74	35119235.84	35530683.91
Min	26000	26000	26000	26900	27300	27700
Max	1230000000	1241935000	1253735000	1262645000	1271850000	1280400000
S.D.	123744013.61	124622940.97	126171165.13	127559962.50	128949218.17	130289181.45

B.5 Political Freedom and Average Distances

Table 19: Percentage of unfree/partially free countries

	1997	1998	1999	2000	2001	2002
World	59.88%	56.98%	58.72%	56.98%	55.23%	55.23%
OECD	10.34%	6.90%	6.90%	3.45%	3.45%	3.45%
Non-OECD	69.93%	67.13%	69.23%	67.83%	65.73%	65.73%
Europe	37.25%	35.29%	35.29%	33.33%	31.37%	31.37%
Asia	78.38%	72.97%	72.97%	72.97%	72.97%	72.97%
Africa	82.69%	82.69%	84.62%	82.69%	78.85%	78.85%
Americas	37.50%	31.25%	37.50%	34.38%	34.38%	34.38%

Table 20: Average Distances to Germany

	Mean	Min	Max	S.D.
Entire Sample	5558.68	173.52	18824.75	3400.29
OECD	3358.35	173.52	18824.75	4836.79
Non-OECD	6014.46	763.73	12098.41	2835.89
Europe	1714.48	173.52	5148.39	1298.98
Africa	5862.82	1648.64	9571.16	1961.70
Americas	8742.11	6035.33	12098.41	1521.89
Asia	7365.06	3013.15	18824.75	3479.58

C Additional Estimation Results

Table 21: OLS vs. Poisson without continent dummies, 1997

	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.809***	0.757***	0.696***	0.696***
	(0.051)	(0.046)	(0.051)	(0.051)
log of geodesic dist.	-0.387***	-0.381***	-0.385***	-0.385***
	(0.072)	(0.066)	(0.068)	(0.068)
log of population	0.134**	0.136***	0.251***	0.251***
	(0.052)	(0.050)	(0.054)	(0.054)
log of GDP per capita	0.012	-0.012	0.039	0.039
	(0.057)	(0.048)	(0.066)	(0.065)
1 = unfree country	-0.484***	-0.468***	-0.800***	-0.800***
	(0.117)	(0.109)	(0.171)	(0.171)
1 = contiguity	-0.259	-0.2	-0.340***	-0.339***
	(0.161)	(0.159)	(0.109)	(0.109)
1 = 1 = landlocked	0.092	0.099	0.161	0.161
	(0.106)	(0.098)	(0.112)	(0.112)
Constant	0.911	1.289**	-0.244	-0.236
	(0.710)	(0.606)	(1.025)	(1.027)
Observations	146	150	150	146
R-squared	0.91	0.92		
Log pseudolikelihood			-2700.582	-2694.4602

For all additional estimation results: Robust standard errors are given in parentheses, ***, **, and * denote 1%, 5%, and 10% significance levels, respectively.

Table 22: OLS vs. Poisson without continent dummies, 1998

	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.786***	0.749***	0.747***	0.744***
	(0.055)	(0.052)	(0.061)	(0.061)
log of geodesic dist.	-0.396***	-0.410***	-0.381***	-0.380***
	(0.083)	(0.080)	(0.067)	(0.067)
log of population	0.169***	0.190***	0.244***	0.243***
	(0.054)	(0.057)	(0.051)	(0.051)
log of GDP per capita	-0.087	-0.100**	0.016	0.017
	(0.056)	(0.050)	(0.042)	(0.042)
1 = unfree country	-0.478***	-0.438***	-0.742***	-0.742***
	(0.124)	(0.121)	(0.160)	(0.160)
1 = contiguity	-0.197	-0.157	-0.330***	-0.328***
	(0.193)	(0.184)	(0.113)	(0.113)
1 = landlocked	-0.492*	-0.412*	0.142	0.143
	(0.286)	(0.221)	(0.141)	(0.142)
Constant	1.188*	1.232*	-0.278	-0.257
	(0.672)	(0.642)	(0.721)	(0.722)
Observations	143	151	151	143
R-squared	0.88	0.89		
Log pseudolikelihood			-3166.8738	-3139.2409

Table 23: OLS vs. Poisson without continent dummies, 1999

	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.852***	0.771***	0.795***	0.794***
	(0.049)	(0.045)	(0.065)	(0.065)
log of geodesic dist.	-0.289***	-0.313***	-0.317***	-0.316***
	(0.069)	(0.069)	(0.073)	(0.073)
log of population	0.131***	0.154***	0.234***	0.234***
	(0.050)	(0.051)	(0.051)	(0.051)
log of GDP per capita	-0.099*	-0.109**	0.025	0.026
	(0.051)	(0.047)	(0.051)	(0.051)
1 = unfree country	-0.523***	-0.512***	-0.671***	-0.672***
	(0.120)	(0.108)	(0.154)	(0.154)
1 = contiguity	-0.169	-0.119	-0.318***	-0.317***
	(0.160)	(0.162)	(0.111)	(0.111)
1 = landlocked	-0.089	-0.082	-0.065	-0.065
	(0.160)	(0.146)	(0.256)	(0.257)
Constant	0.728	1.114*	-0.907	-0.897
	(0.588)	(0.583)	(0.626)	(0.628)
Observations	148	155	155	148
R-squared	0.91	0.92		
Log pseudolikelihood			-3359.2306	-3346.1858

Table 24: OLS vs. Poisson without continent dummies, 2000

	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.850***	0.769***	0.860***	0.858***
	(0.062)	(0.053)	(0.056)	(0.057)
log of geodesic dist.	-0.284***	-0.312***	-0.295***	-0.295***
	(0.083)	(0.083)	(0.066)	(0.066)
log of population	0.126**	0.169***	0.230***	0.230***
	(0.055)	(0.056)	(0.052)	(0.052)
log of GDP per capita	-0.062	-0.062	0	0
	(0.066)	(0.063)	(0.058)	(0.058)
1 = unfree country	-0.434***	-0.431***	-0.554***	-0.554***
	(0.123)	(0.116)	(0.132)	(0.132)
1 = contiguity	-0.114	-0.055	-0.327**	-0.325**
	(0.178)	(0.185)	(0.128)	(0.128)
1 = landlocked	-0.153	-0.144	0.037	0.037
	(0.125)	(0.121)	(0.095)	(0.094)
Constant	0.596	0.623	-1.305*	-1.292*
	(0.695)	(0.677)	(0.696)	(0.698)
Observations	146	155	155	146
R-squared	0.91	0.91		
Log pseudolikelihood			-3395.5661	-3379.4206

Table 25: OLS vs. Poisson without continent dummies, 2001

	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.841***	0.796***	0.901***	0.899***
	(0.058)	(0.047)	(0.054)	(0.054)
log of geodesic dist.	-0.262***	-0.214***	-0.203***	-0.203***
	(0.087)	(0.077)	(0.056)	(0.056)
log of population	0.195***	0.179***	0.237***	0.237***
	(0.046)	(0.044)	(0.050)	(0.050)
log of GDP per capita	-0.095*	-0.114**	-0.045	-0.044
	(0.056)	(0.054)	(0.054)	(0.054)
1 = unfree country	-0.524***	-0.543***	-0.532***	-0.531***
	(0.099)	(0.098)	(0.123)	(0.123)
1 = contiguity	-0.088	0.048	-0.207*	-0.206*
	(0.169)	(0.155)	(0.125)	(0.125)
1 = landlocked	-0.235	-0.279*	-0.563***	-0.562***
	(0.186)	(0.166)	(0.196)	(0.196)
Constant	-0.366	-0.09	-2.124***	-2.114***
	(0.820)	(0.653)	(0.805)	(0.809)
Observations	144	154	154	144
R-squared	0.92	0.92		
Log pseudolikelihood			-3653.026	-3634.5013

Table 26: OLS vs. Poisson without continent dummies, 2002

	log(students)	log(students+1)	Poisson	Poisson > 0
log of student stock	0.924***	0.862***	0.889***	0.888***
	(0.045)	(0.039)	(0.040)	(0.040)
log of geodesic dist.	-0.201***	-0.211***	-0.246***	-0.246***
	(0.077)	(0.069)	(0.052)	(0.052)
log of population	0.138***	0.129***	0.219***	0.219***
	(0.043)	(0.043)	(0.032)	(0.032)
log of GDP per capita	-0.045	-0.066	-0.009	-0.008
	(0.059)	(0.056)	(0.055)	(0.055)
1 = unfree country	-0.352***	-0.371***	-0.459***	-0.459***
	(0.115)	(0.112)	(0.100)	(0.100)
1 = contiguity	-0.056	-0.032	-0.232**	-0.231**
	(0.161)	(0.152)	(0.096)	(0.096)
1 = landlocked	0.011	0.026	-0.065	-0.065
	(0.122)	(0.116)	(0.093)	(0.093)
Constant	-0.829	-0.069	-1.635***	-1.630***
	(0.645)	(0.603)	(0.475)	(0.477)
Observations	144	152	152	144
R-squared	0.92	0.93		
Log pseudolikelihood			-2989.7596	-2977.8447