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CONNECTIVITY AS THE FACILITATOR OF INTRA-EUROPEAN STUDENT MIGRATION

Keywords: connectivity, student migration, spatial concentration, network analysis

Introduction

There has been both strong growth in the numbers of students studying abroad, and in the ‘talent wars’ (Clegg, 2007) amongst advanced economies seeking to attract and retain the highly skilled (Kuptsch, 2006). This has been matched by significant shifts in international student migration, with the initial dominant flows from developing and/or transition economies to developed ones (Docquier et al., 2007; Lowell & Findlay, 2001), being complemented by increasing awareness of more complex flows between origins and destinations (e.g. Ono & Piper, 2004; Findlay et al., 2006; Waters, 2006; Bhandari & Blumenthal, 2013; Lasanowski, 2011). There has also been, at least with respect to intra-European mobility (Van Bouwel & Veugelers, 2013), a broadening of the theoretical perspectives on international student migration with greater focus on circulation and knowledge transfer (Williams & Baláž, 2014a), identities (King & Ruiz-Gelices, 2003), transnationalism (Kobayashi & Preston, 2007), and employability (Teichler & Janson, 2007). There has also been increasing emphasis on utilising primary individual-level data, both quantitative and qualitative (Van Mol & Timmerman, 2014; King & Ruiz-Gelices, 2003).

Despite the expanding research literature in this field, there are still significant gaps. This paper makes two main contributions. First, it analyses *changes* in the spatial distribution of intra-European student migration stocks in the period 1998-2012, focussing on shifts across three sub-periods in the parallel processes of concentration in poles of attraction, and regionalization, at a time of major institutional shifts such as EU enlargement and the introduction of the ERASMUS programme (Teichler et al., 2011). Network analysis brings a fresh perspective to this spatial analysis.

Secondly, and more importantly, the paper demonstrates, that there are distinctive spatialities of international student mobility that emerge through various forms of

connectivity. While acknowledged (e.g. Beine et al., 2014; Bessey, 2012; Perkins & Neumayer, 2014), to date these have not been fully fleshed out in the existing literature. These connectivity factors, understood as facilitator which reduce the material and psychological costs of migration (Jennissen, 2007: 433), are shown to be more important than traditional push-pull theories as a determinant of this changing spatial distribution.

Methodologically, the paper utilises a macro-scale, national-level study, utilising secondary data. As explained in the methodology section, the paper analyses ‘international student migration’ which includes both credit and degree mobility: there are no a priori reasons why these two different stream should have significantly different connectivity determinants, at the national scale of analysis employed in this paper. There have been a number of studies which have utilised secondary data sources, including Van Mol & Ekamper (2016), who analysed bilateral Erasmus student flows, especially the geography of these flows, at the city level. This paper differs in seeking not only to analyse the distribution of (all student) flows, but also seeks to explain this with reference to the notion of connectivity factors. By focussing on a restricted group of 23 European countries (which still account for 86% of intra-European stocks), and as explained in the methodology section, this paper was able to utilise a more substantial harmonized set of determinants, with less reliance on dichotomous variables, than previous studies.

The paper initially summarises the main trends in the spatial distribution of international student migration at the global and European levels. It then conceptualises the determinants of the pattern of international student migration, contrasting the role of connectivity factors with more traditional push-pull factors. Principle Components Analysis and regression are then used to examine the relationships between student migration stocks and the macro scale determinants in each time period. The conclusions consider both the macro-determinants of student migration, and the implications of the shifting spatial concentration.

Conceptualization

Changing Geographies of European Student Migration

The internationalization of student migration has tended to be articulated at the macro-regional scale, or ‘regional globalism’ rather than the truly global scale (Wildavsky, 2010: 5), due to cultural reasons and persistent barriers to long haul travel (Byun & Kim, 2011).

Europe represents probably the most substantial expression of such regional globalism (Wildavsky, 2010: 5), due in part to the supportive EU institutional framework, including the Bologna process (Weibl, 2014: 38). The Bologna process, initially agreed in 1999, has created a European Higher Education Area, which has reduced many obstacles to the mutual recognition of degrees. Although it has limitations, being based on voluntary commitments (Olssen, 2004), commentators such as Litjens (2005: 208) consider that the Bologna process has elevated a series of largely national educational systems to ‘a higher (European) level’. The success of the Bologna process is underpinned by European student mobility programmes. The Erasmus programme, for example, assisted 272,497 students to participate in credit mobility in 2013/2014, representing one third of all student migration (degree and credit mobility) within the EU/EEA area (European Commission, 2015).

While both the Bologna process and the growth of independent free movers have substantially increased international student migration within Europe, the latter has been highly uneven spatially, and has changed over time. Earlier studies, mostly predating the EU’s eastern enlargement, identified a highly concentrated pattern of student migration. More recent research has examined a greater range of flows between areas of origin and destination, both within Europe (e.g. Ono & Piper, 2004; Findlay et al., 2006; Waters, 2006), and globally (Bhandari & Blumenthal, 2013). In a later paper, Rodríguez González et al. (2011) applied gravity modelling to international student migration in Europe. Most of these analyses did not directly address the changing spatial distribution of student migration.

Gürüz & Zimpher (2011) did provide an overview of student migration over the very long term, from the medieval period to the Bologna process, as well as detailed analyses of changes in some individual country case studies. In another study, Teichler et al. (2011), provided a detailed outline of changes in 32 European countries between 1998-9 and 2006-7. Both studies found considerable differences in the experiences of students in individual countries, against a background of increasing student mobility in Europe. With a few exceptions, such as Spain, Poland and Portugal, there are generally more degree mobility than credit mobility (ERASMUS) students. Teichler et al’s report (2007) is an important pointer towards one of the objectives of this paper, which is to analyse changes

in the spatial distribution of student migration over a longer time frame, one that also encompasses the changes which followed the eastern enlargement of the EU.

The determinants of student migration flows and stocks

Although this paper advocates the importance of connectivity factors, we first consider more traditional push-pull approaches (dating from Altbach (1998) in particular). According to Lee (1966), push factors are unfavourable attributes of the area one lives in, while pull factor are attributes that attract individuals to a new area. In international student migration studies, they mostly focus on strategic ‘gaps’ between countries. Empirical studies have identified the importance of several push-pull factors, and appropriate indicators to measure these:

- (i) The quality of educational provision, including spending on education (Caruso & de Wit, 2015; Rodríguez González et al., 2011; Wei, 2013) and the reputation of national higher education systems (Ackers, 2005; Gibbons et al., 2015; Kahanec & Králiková, 2011; Van Bouwel & Veugelers, 2013; Rodríguez González et al., 2011; Brezis & Soueri, 2013) are persistently important determinants of international student migration between developed countries. (Perkins & Neumayer, 2014; Rodríguez González et al., 2011; Wei, 2013). They contribute to the creation of ‘centres of gravity’ that attract inward scientific mobility of all types (Mahroum, 2000: 375). Their reputation also represents a positional good (Marginson, 2006: 5), with students being ‘engaged in the strategic and conscious pursuit of ‘advantage’. Moreover, their stock of institutional social capital significantly enhances job prospects for their students (Waters & Leung, 2013).
- (ii) Income gaps and employment opportunities (Caruso & de Wit, 2015; Wei, 2013; Abuosi & Abor, 2015); These are especially important determinant of student migration from developing to developed countries, but economic considerations may be less important for intra-European student migration, especially since intra-European income convergence between the earlier EU member states and new eastern member states in the mid/late 2000s and 2010s (Eurostat, 2016). More recent generic research on migration has complemented the analysis of economic determinants

with non-economic measures, specifically quality of life measures (Baláž et al., 2016), but they have not hitherto been included in systematic analyses of international student migration.

- (iii) Housing and living costs (Rodríguez González et al., 2011; Beine et al., 2014).

Compared to push-pull factors, there has been far less focus on the connectivity factors. In broad terms, connectivity refers to the different communication channels for the exchange of people, goods and knowledge between two or more countries (Jennissen, 2007). Here we focus on connectivity as the facilitators of migration within a migration system constituted of ‘the diverse linkages between places, including flows of information, goods, services and ideas, as well as people’ (Fawcett, 1989: 673). In other words, student migration has to be understood as part of what Madge et al. (2015: 14) term the ‘wide range of historical intellectual movements ... that have constituted both knowledge and “international space” across centuries.

Jennissen (2007: 420) identifies two main types of connectivity – cultural and material. Cultural linkages are multi-dimensional, and include culture (as shared knowledge and values), history and language. Cultural connectivity is rooted, for example, in shared colonial and political histories of similar languages, which tend to reduce the costs of assimilation and migration. Material connectivity most obviously includes technologically influenced geographical proximity (Rodríguez González et al., 2011), but also includes, for example, trade flows. Arguably, visas (or visa free access), also constitute an important form of connectivity (Netz, 2015) although this is likely to be less important in intra-European migration. In addition to these longer term, and societal or international scale groups of connectivity factors, individuals can also construct their own connectivities through networking.

This paper argues that a European substructure of the world student migration system is characterised by its connectivity. Connectivity factors, both cultural and material, emerge from long-term trends in economic and political integration, and also from the existence of international communities based on shared knowledge articulated through cultural and spatial proximities. Spheres of influence emerge from shared histories, and therefore shared knowledge and culture, as well as in terms of political and economic co-operation,

international trade (including tourism) and capital, and these are often inter-related. The international communities in Europe correspond to the traditional but changing spheres of influence of the three major European powers (France, Germany and UK) in terms of policy, trade and culture (Moravcsik, 1991), alongside which there are important minor nodes. These spheres of influence are also influenced by geographical distance and by cultural proximity which is associated with increased trust between trade partners, lowering communication and other transaction costs.

These two main forms of connectivity determine the monetary and socio-psychological costs incurred by individual student migrants. They also contribute to shaping the knowledge possessed by potential migrants, specifically encultured and embedded or institutional knowledge (Williams & Baláž, 2014a). This is recognized by Raghuram (2013: 139) who argues that the spatialities of knowledge are both drivers of student migration, and dependent on student circulation. Although the production of these spatialities of knowledge is beyond the scope of this paper, we review below some of the evidence about how knowledge-related connectivities shape the spatiality of student migration.

There is evidence that cultural proximity influences foreign direct investment and migration (Buch et al., 2006: 2034), as well as trade (Tadesse & White, 2010: 258) while Guiso et al. (2009) consider that bilateral trust mediates the relationships between economic exchanges and cultural proximities. Culturally-rooted perceptions are also influential in knowledge sharing. Measuring cultural proximity is challenging, but researchers have used a range of surrogate measures, including language similarity, religious beliefs and ethnicity, the historical foundations of legal systems and geographical distance (Felbermayr & Toubal, 2010).

Language knowledge constitutes part of the ‘nationally specific’ component of human capital, acquisition of which is essential to allow migrants to achieve the same return to their ‘generic’ knowledge as non-migrants with similar skills (Sjaastad, 1962; Chiswick, 1978). It is closely related to cultural knowledge. Moreover, some languages such as English are ‘ground floor languages’ (Van der Heijden, 2002) which open up careers globally. These contribute to asymmetrical flows to English speaking countries in particular (Marginson, 2006; Lasanowski, 2011; Perkins & Neumayer, 2014, but also

foster the growth of English-taught programmes in other countries (Wächter & Maiworm, 2014: 16). Language knowledge can influence choice of destination in two ways. First, studying in a foreign country requires a good working knowledge of the host country language (Staniscia, 2012; Rodríguez González et al., 2011; Perkins & Neumayer, 2014). Moreover, language is often key to economic and social integration (Raghuram, 2013). Secondly, acquiring improved knowledge of a foreign language significantly enhances career development (Murphy-Lejeune, 2003).

Different connectivity factors have different spatial articulations. The spheres of influence of the three major European powers (France, Germany and the UK) are clearly associated with polarised macro trade patterns and knowledge flows. In contrast, spatial and language proximity are associated with both polarised and regional international trade flows because neighbouring countries account for higher-than-expected shares (on the basis of size) of the total merchandise imports of most countries (Eurostat, 2014).

Patterns of student flows (that is of ‘knowledge-seeking migrants’) also broadly resemble other knowledge flows (Mahroum, 2000; Marginson, 2006), for example, international scientific and technological co-operation, and the knowledge spillovers in business and research. These are typically measured by patenting activities. In terms of spatiality, most joint international patents involve neighbouring countries (regionalisation), and/or major trade partners (spatial concentration), that is Mahroum’s (2000) centres of gravity.

In addition to these cultural and material connectivities, and their various articulations, individual networking also serves to alleviate the psychological and other costs of migration. Social networks of friends and family – part of their mobility capital - influence student migration (Brooks & Waters, 2010; Van Mol, 2014), and there is evidence that students’ networks abroad are largely formulated before they migrate (Van Mol & Michielsen, 2015). Having friends and family who have been migrants, or who advocate migration, also serve to ‘normalize’ (Beech, 2015) student migration – that is, by strengthening connectivity (see also Efonayi-Mäder & E. Piguet, 2014). Of course, these friends and family tend to be embedded in similar historical and cultural contexts, which reinforces the influence of connectivity factors. More generally, the existence of a substantial number of co-nationals in a destination is one potential source of supportive and compensatory co-ethnic or co-national networks, which can help to reduce both

migration costs (Collins, 2008; Perkins & Neumayer, 2014). Moreover, the boundaries between student migrants and other categories of migrants are increasingly blurred, as student migrants have multiple identities and roles, which also include being workers and therefore benefitting from such networks in finding jobs (Raghuram, 2013: 149). Finally, personal (tacit) knowledge of a foreign country's peoples may encourage and facilitate potential foreign student inflows, and connectivity via tourism is an important means of acquiring such knowledge and reducing the risk (costs) associated with migration (Williams & Baláž, 2014b).

In summary, the importance of connectivity has been recognized in earlier research (Wang, 2005; Findlay et al., 2012) but has largely focused on decisions whether to migrate (for example, Van Mol & Timmerman, 2014; Abuosi & Abor, 2015) whereas this paper analyses the determinants of spatial distribution of student migration. Several studies have examined aspects of connectivity, but this paper provides a fuller conceptualization which also incorporates knowledge flows as being of central importance. As explained in the following methodology section, this feeds into an analysis of a broader range of connectivity measures than have hitherto been employed in the literature. Additionally, most systematic quantitative studies have involved static analyses, have adopted either a single cross sectional analysis, or cover a much shorter time period, with the exceptions of Rodríguez Gonzáles et al. (2011), and Caruso & de Wit (2015). In contrast, this paper adopts a more dynamic perspective by examining three different sub-periods between 1998 and 2012 when there were substantial institutional changes.

Methodology

This paper focuses on intra-European mobility which strongly articulates 'regional globalism' (Wildavsky, 2010: 5) for two main reasons. First, because of a shared regulatory and institutional framework and secondly because there is a distinctive macro regionalization of student migration (OECD, 2013) 81 percent of European students studying abroad stayed in Europe in 2012.

The main data source is the OECD database on Education and Training, containing information on foreign students¹ enrolled by country of origin. The OECD database refers to all educational programmes in tertiary education, that is both credit and degree mobility, so we use the collective description of ‘international student migration’. Although subject to harmonisation, it is collated from national sources and is subject to differences in data collection and codification. Rumbley (2012) outlines several persistent inconsistencies in the recording of students, especially with respect to whether individuals are classified by nationality place of previous residence or education, as well as in the details recorded about the type of mobility and qualifications. Teichler et al. (2011: 162) consider that the recorded data could differ by as much as a quarter from the real mobility flows. There are also changes in definitions over time. While the misclassification of the type of mobility may be a major issue in some instances (e.g. where large numbers of second generation migration are misclassified), and needs to be acknowledged, we consider all student migration as recorded.

Because some countries lacked data for the entire time period, 1998-2012, only 23 European countries are included in the study², all of which participate in EU student mobility schemes and the visa-free European freedom of movement space. However, these 23 countries accounted for some 98 percent of the total GDP and population of the EU27/EEA area and for similar shares of intra-European student migrants (Eurostat, 2014; Eurostat, 2016).

The first stage of the analysis examines changes in spatial concentration over time, using descriptive statistics and network analysis. Given missing data for some years, and there being only minor flows between distant smaller countries (e.g. Estonia and Portugal) resulting in erratic annual changes, only the five major destinations for each country are

¹ Adopted in 2006, the OECD and UIS convention is to use the term ‘international student’ when referring to students crossing borders and the term ‘foreign student’ for non-citizens enrolled outside their home country. The latter includes temporary or permanent residents in the destination. This paper utilises data on foreign students as data on international students are not available prior to 2004.

² Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the UK.

analysed. Five year averages were produced for three periods: 1998-2002, 2003-2007 and 2008-2012, which also helped overcome some data availability limitations for the independent variables. The final matrix had 23 sending by (top) five destination countries by three time periods, providing a matrix with 360 cells. It accounted for 85.8 % of all intra-European student migration within the sample of 23 countries in 1998-2012.

The geographies of international student stocks are analysed using both descriptive statistics and an innovative application of network science (Easley & Kleinberg, 2010) to migration. The nodes (circles in the diagram) in the network are the European countries sending/receiving European students node sizes correspond to their absolute numbers of incoming students. Each node has a degree which is the number of edges (connecting lines) it has to other nodes. The degrees are weighted by edge thickness (volumes of stocks of migrants). The national stocks of intra-European student migrants in the three time periods are visualized using network diagrams, produced using Gephi software. The diagrams identify the gravitation centres of student inflows and important communities (clusters). The Fruchterman-Reingold (FR) layout algorithm arranged the nodes and edges in a web (Figures 1 – 3)³.

The second stage involves modelling the determinants of student migration between the 23 countries, including both push-pull and connectivity variables drawing on the earlier conceptual discussion of connectivity (Fawcett, 1989; Jennissen, 2007). More specifically, the following variables draw on the work of Perkins & Neumayer (2014), Rodríguez et al. (2011), Caruso & de Wit (2015), Bouwel & Veugeleers (2013) and Beine et al. (2014). We have also included a number of standard measures of quality life from the European Social Survey, of patents, and of language proximity, as detailed below.

The 12 push-pull variables included five economic and quality of human capital training measures: (1) income gaps (per capita GDP at purchasing power parity), (2) differences in unemployment rates of tertiary graduates, (3) differences in national investment in higher education (as % of GDP), (4) differences in quality of research outputs (scientific

³ The FR algorithm belongs to a family of force-directed layout algorithms. Nodes are repositioned until they stabilise when the energy of the system is minimized and the system reaches equilibrium state (Fruchterman & Reingold, 1991).

papers per million population), and (5) differences in quality of teaching and research (numbers of Universities in the top 200 in the Times Higher Education World University Rankings).

A further group of push-pull factors is related to the non-monetary costs and benefits of migration: these are acknowledged (Sjaastad, 1962) but seldom directly quantified (but see de Jong et al., 2002; Olgiati et al., 2013; Baláz et al., 2014). Non-monetary factors are proxied by seven variables drawn from three rounds of the European Social Survey (2002-2012). These are differences (or gaps) between national averages for: life satisfaction; satisfaction with quality of education; satisfaction with current economic performance of country; opinions on the state of democracy; and self-reported levels of personal trust, happiness, and religious attitudes (variables 6 - 12). A limitation is that these are aggregate data as the educational attainment of the respondents is not known in all the countries.

Turning to connectivity, three variables were used in relation to language knowledge. The 2001, 2005 and 2012 Eurobarometer surveys provided data on languages known, and languages considered useful to know other than mother tongues (variables 13 and 14). Again, a limitation is that these data are not disaggregated by educational attainment. Additionally, it is assumed to be easier to learn a language belonging to the same or a closely related group of language. The Levenshtein distance for language trees (Serva & Petroni, 2008) was used as to measure the similarity of languages in the students' home and host countries (variable 15).

Spatial proximity (variable 16) was used as an indirect measure of transport costs, and therefore of the transaction costs of knowledge acquisition; this was expressed as road distance (in km) between the capital cities of countries. For economic connectivity, shares of total merchandise imports provide a proxy for international trade (variable 17). Three indicators of international patenting were used as measures of knowledge flows: foreign ownership of domestic inventions (variable 18), domestic ownership of foreign inventions (variable 19) and numbers of patents with foreign co-inventors, as a measure of mutual research co-operation (variable 20).

Proxy measures of international social networks (variable 21) were provided by stocks of foreign nationals by country of birth or, where unavailable, nationality was used instead.

Finally, personal (tacit) knowledge of a foreign country's people is proxied by tourism data, specifically the numbers of nights spent by nationals from destination countries in the students' home countries were utilised (variable 22).

In total, this study uses far more variables (22) than existing studies which have a maximum of 10 independent variables, and a far narrower coverage of connectivity measures. Furthermore, by restricting the study to just 23 countries with more detailed data, it was possible to incorporate only continuous variables, thereby avoiding the use of dummy variables.

The importance of the push-pull and connectivity determinants of intra-European student migration was analysed in three steps. Pearson correlation coefficients established the important explanatory variables. Principle Components Analysis (PCA) dealt with potential multicollinearity and reduce the large number of explanatory variables to a smaller number of factors. Finally, factors scores were used as inputs to linear regression models, where the dependent variable was the share of international student migrants from a country of origin in the top five destinations.

Analysis: Major trends in the geography of student migration

There has been significant growth in international student mobility, with a stock of 1.4 million international students in the EU by 2013 (Eurostat, 2016), of whom 43.6 % originated from other European countries. These intra-European international student migrations are highly polarised, with two thirds moving to just three countries: the UK, Germany and France. Their shares were broadly stable throughout the period 1998-2012, despite the overall growth in numbers and the EU enlargements in the 2000s. Appendix 1 (Table 4) provides background data on individual countries. Outbound international student migration increased across the three time periods in every country except Finland and Greece, and was especially marked in Eastern Europe following the EU eastern enlargements. Most countries experienced increased inward student migration across the time period, but there were modest declines in Italy, Spain and Sweden.

Turning to the overall spatial distribution of student migration, Table 1 highlights three main general features. First, migration from secondary to primary poles of attraction, and secondary to secondary poles accounted for the largest share of total student migrations. Student migration is highly concentrated on the UK, Germany and France Secondly, there

were high growth rates in primary to secondary and secondary to secondary student migrations. The new Member States (post 2004 EU enlargement) accounted for most of the increase in student migrations to secondary centres after 2004. The strong primary to secondary centre student migrations are largely due to outflows from Germany, especially to Austria, the Netherlands and Switzerland, reflecting language and, or spatial proximity factors. Thirdly, neighbouring countries and language proximity more generally accounted for the first and third highest absolute numbers of student migrants, 1998-2012. This overall analysis is based on the absolute rather than the relative (to total student populations) magnitude of the student migrations. Hence, Switzerland is classified as a secondary centre, despite having a higher relative importance of international student migrants than Germany.

Table 1. Intra-European student migration.

Type (P=Primary poles of attraction. S = secondary centre)	Annual average stocks (millions of students)			Growth rates: 2008- 2012 to 1998-2002
	<i>1998-2002</i>	<i>2003-2007</i>	<i>2008-2012</i>	
<i>Total stocks, of which</i>	<i>0.335</i>	<i>0.385</i>	<i>0.495</i>	<i>1.48</i>
P → P	0.044	0.045	0.054	1.22
P → S	0.052	0.066	0.106	2.06
S → P	0.158	0.175	0.200	1.27
S → S	0.081	0.099	0.135	1.67
Neighbour country stocks	0.148	0.187	0.271	1.83
Language proximity stocks	0.129	0.156	0.230	1.78

Source: authors' computation based on the OECD data for 23 countries.

Notes: The centre is defined as France, Germany and the UK, based on their relative importance as destinations. Countries separated by sea distance were considered neighbours if connected via bridge (DK-SE) or tunnel (UK-FR) or when sea distance was shorter than 100 km. Language proximity was established for countries, where at least 10 % of population spoke the language from the same language family (Germanic, Romance and Slavic). Some neighbour and language proximity stocks fall in both categories.

Student migration to primary and secondary centres exhibited both continuity and change in 1998-2012. Continuity is evident in the persistent overall importance of the three main

primary centres. However, there were also changes in the importance of individual primary centres, and their connectivity to secondary centres: the UK was the clear winner, and absolute stocks of migrants increased by 2.40 times, compared to 1.77 times in France, and 1.39 times in Germany between 1998-2002 and 2008-2012. France also benefitted from attracting high numbers of Belgian and Swiss students, but Germany's relative role declined especially in respect of Scandinavia and the Benelux countries. While the UK attracted most secondary to primary centre migrants, France and Germany benefitted from their 'regional' appeal, attracting more students from neighbouring countries and/or shared language areas.

Changes over time in the three sub-periods are analysed using the network science approach (Easley & Kleinberg, 2010), as discussed in the methodology. There were two main findings. First, there is a very high level of interconnection within the 23 countries. Starting at the simplest level of analysis, there was an increase in the *average degree* (number of nodes connected to) from 19.25 in 1998-2002 to 22.83 in 2008-2012. Very few countries have no connections (a minimum of one student) to all the other countries, and over time this has become almost negligible. This is reflected by an increase in *graph density* (the proportion of the maximum possible number of edges on a scale of 0 to 1) from 0.837 to 0.993 between 1998-2002 and 2008-2012. Secondly, and confirming the evidence in Table 1, there was an increase in the *values of the average clustering coefficient* (the proportion of adjacent countries connected to) from 0.855 to 0.991 (on a scale 0 to 1) between 1998-2002 and 2008-2012, confirming increased mutual interconnections in the network of European students.

Whereas the metrics used above are based on the simple numbers of linkages, the weighted clustering coefficients capture more precisely the strength of the interactions. These coefficients decreased over the period, indicating that the increase in non-weighted clustering was caused by the emergence of several relatively small migrations both among the secondary centres, and between these and the primary centres. This contrasts with the observation that in some complex networks, the high-degree nodes tend to form 'cliques' having increasing interaction with equal or higher degree nodes, the so-called 'rich-club phenomenon' (Barrat et al., 2004: 3751). Primary to primary centre student migration had the lowest growth rates, 1998-2012 (Table 1), whereas there were much higher growth rates for primary to secondary, and secondary to primary centre interactions. The outcome

was that the network became more fractured into particular large-scale clusters (Table 2), which were mostly informed by geographical and language proximities: for example, student migrations between Germany and Austria, and France and Belgium. This is confirmed by the modularity statistics which measure the strength of the division of the network into communities (modules or clusters)⁴ characterised by dense connections between nodes within the communities, and sparse connections with other nodes: the modularity of the network increased from 0.096 to 0.152 between 1998-2002 and 2008-2012 (Table 2).

Table 2. Network overview, intra-European student stocks in 1998-2012.

network overview	1998-2002	2003-2007	2008-2012
average degree	19.25	21.91	22.83
average weighted degree	14,014.78	16,198.65	20,800.61
network density	0.837	0.953	0.993
modularity	0.096	0.132	0.152
communities no	3	3	3
node overview			
avg. clustering coefficient	0.855	0.954	0.991
avg. weighted clustering coefficient	0.403	0.321	0.300

Source: authors' computations using Gephi software.

The network diagrams point to two main findings. First, they confirm visually, and in terms of individual edges and nodes, the broad patterns observed in Table 2, including the role of the UK, Germany and France as primary poles of attraction. Secondly, strong secondary-primary centre student migrations are evident within the modules, and many of these seem to be based on language and/culture proximity (AT-DE, SW-DE, BE-FR, IE-UK). There are also some distinctive and changing secondary modules (FI-SE, SK-CZ) in specific periods, which seem to be related to language similarities. Another change

⁴ The modularity measure is computed as the number of links in each community minus the number of links in the same groups in a graph where the links were redistributed randomly (Newman, 2006).

is that while there was a rather loose module of Nordic-Baltic countries (SE, FI, EE, IS, PL) in 1998-2002 and 2003 – 2007 (Figures 1 and 2), this had merged with the UK/France module in 2008-2012. This reflects the general strengthening of the UK as a primary pole across the total time period. Interestingly, the most distinctive secondary to secondary centre student migration was between Slovakia and the Czech Republic in 2008-2012, countries with strong spatial and language proximities. Moreover, the strength of this tie increased over time which demonstrates their persistence more than two decades after the velvet divorce in the former Czechoslovakia, as well as the higher international rankings of Czech universities.

Figure 1. Network diagram for intra-European student migration in 1998-2002.

Figure 2. Network diagram for intra-European student migration in 2002-2007.

Figure 3. Network diagram for intra-European student flows in 2008-2012.

In summary, intra-European student migration demonstrates a distinctive primary versus secondary centre pattern, namely between the UK, France and Germany versus the rest of Europe. This was relatively stable across the period 1998-2012. There were however two important developments. First, there was high growth in primary-secondary, secondary-primary, and secondary-secondary student migrations, which appears to be associated with the Eastern enlargement (see Appendix 1), and spatial and/or language proximities (see Table 2). Secondly, the primary centres built stronger ties with their neighbours, and well-knit clusters emerged over time. The determinants of these student migrations are considered in the following section.

Analysis: The determinants of international human capital training

This section analyses the determinants of the shares of the top five destination countries in the total stocks of student migrants from each country of origin. It begins by considering the correlations between the independent variables (see methodology) and then models these relationships.

13 of the 22 Pearson correlation coefficients between the independent variables and the dependent variable were significant at the 0.05 level (Table 5) in at least one of the three time periods. The push-pull determinants in general had lower correlation coefficients than the connectivity determinants. Only three push-pull coefficients were significant: unemployment rates for tertiary graduates, HEI investment, and the quality of universities. In contrast, ten of the connectivity determinants were significant at the 0.01 level. While merchandise imports were highly correlated in 1998-2002, they were less so by 2008-2012 because whereas Germany increasingly dominated exports, student migration became more concentrated on the UK. Three patent variables, which were proxies for knowledge flows, were significantly correlated throughout but the correlation values decreased, reflecting their close association with merchandise imports. Connectivity to different forms of tacit knowledge was also important: with stocks of foreign-born population, language, inward tourism and spatial proximity being significant. These correlations appear to reflect both globalities in the form of centres of gravity (Mahroum, 2000) in respect of the economic variables and educational excellence, and also regional indicators in terms of language and, to a lesser extent, spatial distance. These relationships will be further analysed later.

(a) we tried the Direct Oblimin and (b) both Varimax and Direct Oblimin methods generated very similar results in terms of the factor structure and factor loadings.

Principal components analysis (PCA) was used to address hypotheses relating to push-pull and connectivity factors. Both the Direct Oblimin and the Varimax rotation methods generated similar results in terms of factor structure and factor loadings. Hence, the Varimax rotation with eigenvalues over 1 was used to reduce high numbers of variables to a small number of factors. PCA also deals with the multicollinearity amongst the independent variables. This produced four major factors, which cumulatively accounted

for 75.4%, 74.9% and 71.2% of the total variance in the respective time periods. Both the Kaiser-Olkin-Mayer (KMO) test and Bartlett sphericity tests confirmed satisfactory solutions (see Tables 6.1 – 6.3, Appendix 2). It should be noted that if an alternative PCA is calculated, for example for 1998-2002, it yields five factors which explain just 76.6% of the total variance, indicating that many socio-psychological variables made little additional contribution to the analysis. For this reason, we elected to utilise the four factor solution.

Factor One, ‘Connectivity’, combined all three patent variables, merchandise imports, stocks of foreign population, and tourist flows. It explained approximately one third - 35.0%, 33.8% and 31.8% - of the total variance in the respective time periods. These variables are inter-related because they imply, and depend on, various forms of knowledge transfer. Factor Two, ‘Universities and useful language’, loads strongly on language considered useful and quality of universities, and is a mixture of connectivity and push-pull elements (17.3%, 18.4% and 16.1%). The factor embodies increasing emphasis on positionality (Marginson, 2006), especially in the subsequent job market, as defined by selecting high-quality universities in well-funded educational systems, and acquiring major world languages, especially English and, to a lesser extent, French and German. The UK, France and Germany also have higher spending on tertiary education and relatively large numbers of excellent Universities.

Factor Three, ‘Language and spatial proximity’ (14.2%, 13.1% and 13.1%) had high loadings on the connectivity factors of road distance, language known and the Levenshtein distance of the European languages. These variables are likely to be correlated because many neighbouring countries speak virtually identical or similar languages, although there are some exceptions – such as Sweden and Germany - where, nevertheless, there is substantial student migration. The fourth factor, ‘Inputs and outputs of higher education’, loaded mainly on differences in unemployment amongst tertiary graduates, and investment in higher education, i.e. on traditional push-pull factors (9.0%, 9.6% and 10.3%).

The factor scores were used as inputs to linear regressions which were run for each of the time periods 1998-2002, 2003-2007 and 2008-2012. The dependent variable was the

number of international student migrants from a country of origin in the top five destinations (Table 3). The regressions explained relatively high levels - 60.8%, 51.6% and 51.8% - of the total variance in the dependent variable but declined by nine percentage points across the time period. This reflects the general shifts in the correlation values, as well as the exceptionally strong growth of migration stocks in the UK, in contrast to, for example, the growing or persistent importance of Germany in trade and patenting.

Table 3. Linear regression of pull-push and connectivity factors with student migration.

	1998-2002			2003-2007			2008-2012		
	B	t	Sig	B	t	Sig	B	t	Sig
Constant	x	18.028	0.000	x	19.104	0.000	x	16.593	0.000
Factor 1	0.676	10.191	0.000	0.638	9.121	0.000	0.496	7.118	0.000
Factor 2	0.345	5.194	0.000	0.308	4.408	0.000	0.432	6.195	0.000
Factor 3	-0.189	-2.844	0.006	-0.169	-2.412	0.018	0.321	4.603	0.000
Factor 4	0.116	1.746	0.084	0.066	0.949	0.345	0.042	0.596	0.553
Adjusted R ²	0.608***			0.516***			0.518***		

Source: authors' computations.

Notes: B = standardised regression coefficient. *** significant on 0.001 level.

In summary, factors one to three, in this respective rank order, consistently have the highest B values in all three time periods. These factors are highly significant throughout. The 'Connectivity' factor remained the strongest predictor of the distribution of intra-European student migrants, but its relative importance decreased over time. The decrease is probably related to spatial re-orientation of the explanatory variables (of intra-Europeans flows in tourism, trade and knowledge in particular). The relative importance of factors two and three, on the other hand, increased between 1998-2002 and 2008-2012. In factor two, this reflects how the quality of universities became increasingly important for intra-European students in an increasingly competitive job market. In factor three, the key seems to be the increasing preference for language and spatial proximity, and this is associated with the above-average increase in international student migration to

neighbouring countries and/or those with language proximity. The importance of factor four declined over time, mainly due to diminishing disparities in unemployment rates amongst tertiary graduates, and this became statistically insignificant in 2003-2007 and 2008-2012. In summary, the most important determinant of international student migration is the set of knowledge-related connectivities.

Discussion and conclusions

This paper aims to provide a more detailed analysis of the changing spatial distribution of student migration at a time of major institutional shifts, using a novel application of network analysis to identify primary versus secondary centres of attraction. It has also evaluated the importance of connectivity, as opposed to traditional push-pull factors, as determinants of these spatial distributions across three time periods.

Not only is the spatial distribution of intra-EU student migration highly concentrated in three main communities (UK, France, Germany), but it has become further polarised since 1998. In context of more and more countries aiming to increase their shares of the ‘global higher education business’ (Raghuram, 2013: 147), the UK emerged as the major winner at the intra-European scale. In contrast, increasing student migration to France and Germany was based more on building denser linkages with their immediate neighbours rather than at the pan European scale.

The main finding is that connectivities were more important than traditional push-pull factors as determinants of international student migration. Among the latter, which refer to economic and non-economic gaps between countries of origin and destination, both income gaps and non-economic variables, describing satisfaction with private life and public institutions (European Social Survey, 2002-2012), were not significantly correlated with student migration. These may be important for labour migration but not for student migrants. Instead, the quality of higher education and excellence in teaching and research were the most important push-pull ‘gap’ variables. This broadly confirms the findings of earlier studies of international student migration amongst relatively more developed countries (Rodríguez González et al., 2011; Van Bouwel & Veugelers, 2013; Wei, 2013): it is also further evidence of the positionality that stems from the quality and, or reputation of degrees (Marginson, 2006).

The findings of our analysis indicate that the connectivity determinants, indicated by patterns of human mobility, language, and trade and knowledge distribution networks, were more significant than push-pull factors. Language knowledge/usefulness and ethnic ties are also strong predictors of student migration. A key contribution of this paper, therefore, is to situate the analysis of international student migration in a network-based conceptual and analytical framework. It resonates with the arguments of Robertson (2010) that student migration is part of the wider networks of knowledge production, and of Raghuram (2013) that international migration is important to extending the spatial reach of centres of knowledge.

Students are attracted to particular places, but while differences in educational quality and reputation are important in shaping the spatial distribution so also is the broader political economy that lies behind the wider networks of knowledge production. One of the main consequences of globalization has been to increase the competition between universities and university systems. This is of course not played out in abstract economic spaces, but rather intra-European student migrations follow some long-established pathways of exchange in trade, tourism and knowledge. The 'trade in students' has many similarities with trade in goods, knowledge and tourism. The pathways are defined by some long-established determinants (language, geography, cultural and political affinities between the countries), but also by some new developments, notably the emergence of English as a global language. Our conclusion on stability of long-established pathways in student exchange in Europe corroborates findings by Chen et al (2000). Chen et al performed a network analysis of World student flows in 1985, 1989 and 1995. They found the international student exchange network remained relatively stable. The finding suggested the academic hegemony was consistent with world economic and political performance.

The intersection of new trajectories and established pathways produces a system of primary and secondary poles of attractions which have both global (macro-regional) and regional components, although these sometimes overlap. In the case of language knowledge, the global component is expressed in the dominant role of English and, to a lesser extent, German and French. The UK, France and Germany accounted for over 70 % of total international student migrant stocks in Europe – far more than their share of the total student population. The global component is also expressed in the importance of Germany, UK and France for almost every European country in terms of merchandise

trade and patent cooperation. However, migration incurs both material and socio-psychological costs for the participants so that, unsurprisingly, globalization is also resisted. This is articulated, to some extent, in the regional component and, for example, in the growth in migration between secondary poles. Not least, this is because the trade and knowledge networks interwoven with international student migration have both regional and global dimensions. Moreover, the decision to migrate to neighbouring countries speaking similar languages (for example, Belgium-France, UK-Ireland, Austria-Germany), or to countries linked by shared national minorities (for example, Finland and Sweden, and Slovakia and Hungary) is a form of resistance to the seemingly inevitable concentration of student migration in the primary poles of attraction as a consequence of globalization.

Finally, we contend that this study of how connectivities shape the geographies of international student mobility is important not only in understanding the European case considered here, but also provides a framework for developing a more sophisticated analysis of student mobility. Future research can apply this approach to a range of regions, and can also seek to further refine the conceptualization and operationalisation of connectivities. Future research can also address some of the limitations of the study. In particular, the OECD did not allow us to distinguish between credit and degree mobility. While we have no a priori reasons to expect their determinants are different at the national scale, a more disaggregated analysis could explore this issue. Additionally, the various ESS measures of the psychic costs of migration, such as satisfaction, were mostly not significant in this research, although they have been shown to be important in generic research. Future research, can investigate whether this also applies if and when more disaggregated data are available for educational attainment across all European countries.

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Appendix 1

Table 4. Inbound and outbound international student migration in 1998-2012.

From	Outbound			To	Inbound		
	1998-2002	2003-2007	2008-2012		1998-2002	2003-2007	2008-2012
Austria	10,331	11,002	13,992	Austria	19,022	21,986	42,396
Belgium	8,428	9,258	10,896	Belgium	17,223	25,346	31,847
Czech Rep.	3,460	6,241	11,731	Czech Rep.	3,535	12,503	24,791
Germany	41,355	58,454	102,965	Germany	64,418	71,291	67,178
Denmark	4,994	5,551	5,652	Denmark	3,871	6,315	12,404
Estonia	1,380	2,863	3,886	Estonia	0	0	714
Greece	50,525	37,885	33,838	Greece	23	502	893
Spain	21,278	24,085	24,917	Spain	21,840	15,130	20,171
Finland	8,306	9,350	8,649	Finland	1,965	2,843	3,374
France	39,970	46,435	53,991	France	31,681	36,598	39,369
Hungary	5,360	6,756	8,286	Hungary	2,578	4,888	7,026
Ireland	16,613	21,531	26,269	Ireland	3,771	843	7,452
Italy	36,305	38,457	46,945	Italy	12,578	13,683	11,382
Luxembourg	5,369	6,457	7,432	Luxembourg	210	190	1,954
Netherlands	10,140	10,062	14,837	Netherlands	6,047	16,405	32,696
Norway	9,305	10,025	11,587	Norway	3,176	4,230	5,249
Poland	14,019	26,525	41,952	Poland	1,116	1,935	5,134
Portugal	9,643	12,507	17,798	Portugal	446	2,699	4,358
Sweden	8,830	9,888	12,723	Sweden	12,214	17,366	10,610
Slovakia	5,154	15,836	29,717	Slovakia	369	736	6,245
Slovenia	1,512	2,054	2,445	Slovenia	0	0	264
Switzerland	5,949	6,970	8,568	Switzerland	17,830	23,302	33,506
UK	13,455	11,561	12,982	UK	104,993	121,431	150,615

Source: authors' computations. Note: sample of 23 countries analysed in the correlation, factor and regression analysis.

Appendix 2: Correlation and Principal Components Analysis

Table 5. Pearson correlations between potential determinants of and student out migration, by time period.

Variable / Period	1998-2002	2003-2007	2008-2012
<i>Pull-push factors</i>			
1 GDP (in PPS) difference	0.003	-0.003	-0.074
2 Unemployment by tertiary graduates	-0.198*	-0.188*	-0.071
3 HE investment	-0.206*	-0.104	-0.213*
4 Papers per million population	-0.030	-0.051	-0.107
5 Quality of Universities (THEWUR)	-0.326**	-0.292**	-0.370**
<i>Non-monetary and benefits of migration (ESS)</i>			
6 Life satisfaction	0.040	0.003	-0.015
7 Satisfaction with quality of education	0.061	0.035	0.003
8 Satisfaction with current economic performance	0.076	0.072	0.061
9 Opinions on the state of democracy	0.137	0.069	0.014
10 Self-reported levels of personal trust	0.053	-0.069	-0.061
11 Self-reported levels of personal happiness	0.042	0.057	0.019
12 Self-reported levels of religious attitudes	0.090	0.125	0.168
<i>Connectivity factors</i>			
13 Language known	0.493**	0.487**	0.559**
14 Language useful	0.310**	0.211*	0.306**
15 Language distance	-0.139	-0.194*	-0.275**
16 Road distance	-0.228*	-0.221*	-0.099
17 Merchandise import shares	0.678**	0.642**	0.488**
18 Patents foreign ownership	0.615**	0.545**	0.412**
19 Patents domestic ownership	0.460**	0.462**	0.240**
20 Patents co-authorship	0.617**	0.605**	0.418**
21 Stock of foreign born population	0.632**	0.641**	0.586**
22 Nights spent	0.694**	0.671**	0.594**

Source: authors' computations. Economic data based on Eurostat (2014). Investment data in tertiary education for 1998-2002 approximated by annual average data 1999-2002. Papers based on Thomson Scientific database. Quality of education and research based on The Times Higher Education World University Rankings (THEWUR), top 200: data for 1998-2002 based on 2004-2007. Variables 6-12 taken from the European Social Survey, surveys undertaken in 2002, 2006 and 2012 (European Social Survey, 2002 - 2012). Data on language skills based on Special Eurobarometer No 54, 243 and 386 (European Commission, 2001, 2006, 2009 and 2012). Language proximity as measured by the Levenshtein distance for language trees (Serva & Petroni, 2008). Spatial proximity based on driving distances between European capitals: <http://www.travelnotes.org/Europe/Distances/index.htm>. Patents data extracted from the OECD database. Stocks of foreign population extracted from OECD International Migration Database: Nationality used where country of birth data unavailable. Stocks estimated from the general relationship between inflows/outflows and stocks for some smaller countries.

Notes: * significant on 0.05 level; ** significant on 0.01 level.

Table 6.1. Principal components analysis for period 1998-2002.

	Component (total variance explained)			
	1 (34.96%	2 (17.33%	3 (14.19%	4 (9.01%
Patents – co-authorship	0.930	0.124	-0.090	-0.075
Stock of foreign-born population	0.870	-0.142	-0.124	0.062
Merchandise import shares	0.862	-0.028	-0.206	0.086
Patents domestic ownership	0.849	0.036	-0.045	-0.166
Nights spent	0.814	0.177	-0.065	0.058
Patents foreign ownership	0.788	0.254	-0.115	-0.052
Language useful	-0.037	0.863	-0.060	0.102
Universities	-0.154	-0.847	-0.228	0.035
Language distance	-0.049	0.102	0.844	0.038
Road distance	-0.210	0.056	0.763	0.122
Language known	0.227	0.537	-0.623	0.159
HEI investment	-0.101	-0.370	-0.016	-0.785
Unemployment by tertiary graduates	-0.210	-0.468	0.144	0.672

Note. Rotation Method: Varimax with Kaiser Normalization Rotation converged in 6 iterations. Kaiser-Meyer-Olkin test = 0.746. Bartlett's test of sphericity: Approx. Chi-Square = 720.005, df = 78, Sig = 0.000. Total variance explained: 75.5%.

Table 6.2. Principal components analysis for period 2003-2007.

	Component (total variance explained)			
	1 (33.78%	2 (18.41%	3 (13.05%	4 (9.63%
Patents – co-authorship	0.912	0.107	-0.073	0.016
Stock of foreign-born population	0.794	-0.090	-0.126	-0.090
Merchandise import shares	0.881	-0.119	-0.133	0.108
Patents domestic ownership	0.832	0.051	-0.108	-0.072
Nights spent	0.795	0.200	-0.039	-0.060
Patents foreign ownership	0.871	0.092	-0.035	0.091
Language useful	0.027	0.837	0.043	0.180
Universities	-0.053	-0.867	-0.309	-0.010
Language distance	-0.058	0.059	0.859	0.040
Road distance	-0.165	0.172	0.679	-0.080
Language known	0.187	0.578	-0.576	0.246
HEI investment	0.034	-0.196	0.112	-0.877
Unemployment by tertiary graduates	-0.041	-0.671	0.067	0.587

Note. Rotation Method: Varimax with Kaiser Normalization Rotation converged in 6 iterations. Kaiser-Meyer-Olkin test = 0.729. Bartlett's test of sphericity: Approx. Chi-Square = 760.179, df = 78, Sig = 0.000. Total variance explained: 74.9%.

Table 6.3. Principal components analysis for period 2008-2012.

	Component (total variance explained)			
	1 (31.75%)	2 (16.14%)	3 (13.06%)	4 (10.30%)
Patents – co-authorship	0.909	0.059	0.030	-0.077
Merchandise import shares	0.898	-0.118	0.171	0.005
Stock of foreign-born population	0.687	0.090	0.273	0.000
Patents domestic ownership	0.756	-0.018	0.153	-0.135
Nights spent	0.755	0.136	0.129	-0.058
Patents foreign ownership	0.872	0.045	-0.072	0.072
Language useful	-0.022	0.825	-0.004	0.046
Universities	-0.107	-0.846	0.307	0.098
Language distance t	-0.125	0.043	-0.781	-0.164
Road distance	-0.153	0.263	-0.671	0.088
Language known	0.234	0.559	0.619	0.130
HEI investment	-0.008	-0.489	-0.057	-0.686
Unemployment by tertiary graduates	-0.121	-0.179	0.085	0.879

Note: Rotation Method: Varimax with Kaiser Normalization Rotation converged in 6 iterations. Kaiser-Meyer-Olkin test = 0.722. Bartlett's test of sphericity: Approx. Chi-Square = 671.939, df = 78, Sig = 0.000. Total variance explained: 71.2%.

Table 7: Descriptive statistics

period	1998-2002		2003-2007		2008-2012	
	Mean	St Dev	Mean	St Dev	Mean	St Dev
Student abroad share (dependent)	17.46	14.39	17.06	14.39	16.95	14.38
Patents – co-authorship	13.75	12.26	13.71	11.16	13.18	11.42
Stock of foreign-born population	16.19	20.93	15.80	18.42	15.68	16.42
Merchandise import shares	13.27	11.81	13.56	11.80	13.36	11.72
Patents domestic ownership	12.81	13.90	12.30	13.30	11.56	13.41
Nights spent	10.78	11.56	10.57	10.07	9.60	8.93
Patents foreign ownership	13.38	12.74	12.80	10.54	12.76	11.39
Language useful	31.43	29.40	31.48	28.97	31.66	30.10
Universities	-6.10	12.70	-6.56	12.75	-6.62	12.53
Language distance	3.38	2.41	3.35	2.38	3.38	2.38
Road distance	1224.80	794.69	1170.43	746.81	1098.33	697.31
Language known	29.72	30.78	29.52	30.54	29.53	30.96
HEI investment	1.14	0.62	1.06	0.35	1.03	0.34
Unemployment by tertiary graduates	1.47	1.36	1.19	0.75	1.01	0.63