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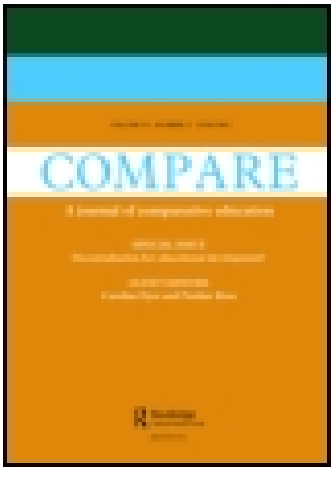



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# The flow of international students from a macro perspective: a network analysis

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This paper provides a network analysis of the international flow of students among 210 countries and the factors determining the structure of this flow. Among these factors, bilateral hyperlink connections between countries and the number of telephone minutes (communication variables) are the most important predictors of the flow's structure, followed by trade, the physical distance between countries, a common border between countries and a common language between two countries. The USA is by far the most central country in the flow of international students, followed by China, the UK, France, Germany, Australia and India. These results are discussed in light of World-System Theory. Future research should examine how the network of international student flows changes over time and consider additional factors to provide a better understanding of the network as an international system.

**Keywords:** flow of international students; network analysis; globalisation and international higher education; internationalisation of higher education; mobility of students



The international flow of students has become an increasingly important research topic because of the increased numbers of foreign students after WWII (Goodwin 1993), which was mainly derived from the impact of internationalisation and globalisation (Maringe, Foskett, and Woodfield 2013; see also Maringe and Foskett 2010). It is estimated that about three million tertiary students studied abroad in 2007 (OECD 2009), reflecting an increase from less than one million in 1980. Economically developed English-speaking countries such as the USA, the UK, Australia, Canada and New Zealand are core destinations of foreign students pursuing higher education abroad (OECD 2009; UNESCO 2008).

In capturing the structural features and patterns of student mobility across different countries, the concept of networks has recently gained wide

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acceptance (e.g., Chadee and Naidoo 2009; Chen and Barnett 2000; Jiang 2014). Contemporary network theories see social structure as consisting of a set of social relationships or links between different actors such as people, organisations, countries or events. Network theories assume that actors and their actions (or influences) are interdependent rather than independent (Wasserman and Faust 1994). Network analysis has been rapidly developed as a key tool for examining various structural concepts. In network analysis, the patterns of relationships and links are measured and visualised by relational metrics and graphs, respectively, which include virtually any network content such as flows of international students, flows of materials, power or advice.

Equipped with these theoretical and analytical perspectives, recent studies have identified that the network of international students has changed dramatically over the last few decades (e.g., the emergence of regional hubs), although the core countries noted above remain at the centre of the network (Chen and Barnett 2000). In addition, Asia is the single largest source of international students and has assumed a more central position in the network (Chadee and Naidoo 2009; Chen and Barnett 2000).

Recent studies of the flow of international students have mainly focused on the factors pulling and pushing students to seek higher education abroad (Mazzarol and Soutar 2001). At the macro level (including both countries and regions), scholars have examined public rationales that attract or compel international students to study abroad. They have suggested that positive developments in host countries, including educational policies to recruit more international students – for example, positive wage differentials, job opportunities, the emergence of organisations facilitating migration and favourable immigration policies – pull international students to seek higher education abroad (Brzozowski 2007; Massey et al. 1993; OECD 2013; UNESCO Institute for Statistics 2012; Wolfeil 2009; Woodfield 2010), whereas negative public developments in one's home country – including economic recessions, low living standards, a lack of economic opportunities and limited access to domestic higher education – push international students to go abroad for their studies (Altbach, Kelly, and Lulat 1985; Massey et al. 1993). In contrast, while increasing domestic higher education opportunities can attract international students to stay in their home countries, other factors can push them away from seeking higher education in a given foreign country (Li and Bray 2007). For example, unwelcoming attitudes toward international students after the 9/11 terrorist attacks in the USA are recognised as an important factor pushing international students away from there (Lee and Rice 2007). Visa problems (CGS 2004) are also regarded as a main cause of decreases in the enrolment of international graduate students in the USA.[1] Further, Kondakci (2011) argues that geographical proximity in itself is not a prime driver of student mobility unless other public rationales, such as linguistic proximity, are also embedded.

At the macro level, scholars have also investigated the flow of international students from the perspective of World-System Theory (e.g., Barnett and Wu 1995).[2] Limited by academic capability and a lack of sufficient technical skills, peripheral countries encourage students to pursue higher education in core countries with desired resources and knowledge to increase the level of education and thus facilitate nation building (Altbach 2003; Chen and Barnett 2000; Knight 2004; Marginson 2006). However, international students from peripheral countries who choose to stay in their host countries after graduation can be an important cause of the so-called 'brain-drain' phenomenon, which leads to the loss of human capital in home countries (Aupetit 2006; Kim, Bankart, and Isdell 2011).[3] International students also benefit host countries that are at the centre of the world system in a number of ways (Heikinheimo and Shute 1986; IIE 2007; Klomegah 2006; Olivas and Li 2006; Zhai 2002). For example, international students can not only make substantial contributions to the US economy (IIE 2007) but also bring ethnic and cultural diversity to American campuses (Aslanbeigui and Montecinos 1998; Klomegah 2006; Lee and Rice 2007; Olivas and Li 2006). From this perspective, the pattern of international student flows from the periphery towards the core can, to a certain extent, reinforce the inequitable distribution of resources and knowledge (Chen and Barnett 2000; Lee 2008; Weiler 1984).

At the country level, other scholars have treated the country of origin as a predictor of the flow of international students and have suggested variables that have differential effects on international students' decisions to stay or return (Altbach 1991; Chadee and Naidoo 2009; Finn 1997; Kim, Bankart, and Isdell 2011). For example, domestic access to higher education is an important factor influencing the flow of international students from China, India, South Korea and Thailand; tuition fees are important for students from Hong Kong, South Korea and Singapore; and global awareness is important for Chinese students (Chadee and Naidoo 2009). Examining stay/return rates for international students in the USA, scholars have found that Chinese and Indian doctoral students are most likely to stay in the USA upon completing their doctoral programme (Finn 1997) and that return rates for Taiwanese and South Korean students have started to increase because of rapid industrialisation and economic growth experienced by these countries in the 1980s and 1990s (Altbach 1991).[4]

Many scholars have claimed that the critical factors influencing the flow of international students are located mainly at the country level (e.g., Altbach 1991; Chadee and Naidoo 2009; Finn 1997; Kim, Bankart, and Isdell 2011), whereas other scholars have argued that for a deeper understanding of this research topic, closer attention should be paid to activities of local agencies and agents such as higher education institutions/programmes, faculty members and students, instead of focusing only on the importance of country effects (e.g., Marginson and Rhoades 2002).

However, few studies have considered the flow of international students at the meso (i.e., institutional or community levels) and micro levels (i.e., individual or private levels). According to Lee (2008), the Internet is one of the most common information sources for international students, and among the possible factors attracting international students, the institution's national ranking and prestige are the most important, followed by assistantship, financial assistance and special education opportunities (Barnett et al. 2014). Kondakci (2011) finds that pre-departure pulling rationales at the private level are more prominent than public rationales for developing countries. Private factors include students' academic preferences, climate and food preferences, attitudes toward host countries and their people, language skills and choice of urban or rural locations. He also claims that after arriving in host countries, international students' academic, cultural and social experiences and the quality of student services in host countries play more significant roles in influencing the mobility of international students.

In addition, cultural, political and historical proximity between home and host countries are known to be important factors of the size and direction of student inflows in developing countries (Kondakci 2011; UNESCO Bangkok 2013). For example, because of the mass-migration history from the Balkans to Turkey, students from the Balkans share common historical, linguistic and cultural backgrounds with people in Turkey and, thus, are more likely to study in Turkey and feel comfortable with their cultural, social and academic experiences (Kondakci 2011). For somewhat similar reasons, Hong Kong has been regarded as one of the most popular destinations for mainland Chinese students for their higher education since the 1997 handover of Hong Kong from the UK (Li and Bray 2007; UNESCO Bangkok 2013). By contrast, cultural and language differences can hinder international students' social relationships with people in host countries and thus produce negative cultural and social experiences that push them away (Grey 2002; Pritchard and Skinner 2002).

From this perspective, it is not difficult to find the existence of regional hubs in the international flow of students.[5] Kondakci (2011) suggests that in the periphery of the world system are regional hubs attracting students from other regions of the periphery. For example, Turkey is a regional hub that attracts students from the Balkans, the Middle East, Caucasia and Central Asia. Similarly, Mexico has been found to be a regional hub attracting students in other Latin American countries (Cantwell, Luca, and Lee 2009). In a similar vein, Hong Kong and Singapore have attracted students from neighbouring Asian countries (Chan and Ng 2008; Li and Bray 2007). In addition, from a global perspective based on the rapid development and increasing importance of regional trading blocs and reciprocal activities between higher-education systems of countries across such blocs, it is imperative to examine the stratified clusters in the structure of international student mobility at the regional level (Marginson and Rhoades 2002).

The factors predicting the flow of international students at the macro and micro levels described above are not mutually exclusive (Kondakci 2011) because there is a link between individuals and their society (Metcalfe and Fenwick 2009). However, although public factors focusing on various aspects of life in host/home countries are thought to be a significant motivator of students interested in seeking higher education abroad (Kondakci 2011; Mazzarol and Soutar 2001; OECD 2013; Rivzi 2005; Teichler 2004), very little attention has been paid to the effects of student activities on their countries and higher-education policies of other countries. For example, (in)formal learning activities as well as socio-educational class experiences can be mediated in various contexts (e.g., the use of academic services and tools including search engines, class portals and social media) (Biddix, Chung, and Park 2011, 2015; Fadul 2014). In addition, at the global level, although scholars have argued that the mobility of international students is related to the world economy, politics and cultures (Cummings 1993; McMahon 1992; Slaughter and Leslie 1997; Sutton 1993), they have focused mainly on the effects of the global economy, politics and culture on the flow of students. For example, Sutton (1993) points out that the mobility of international students is sensitive to changes in the world economy, and Slaughter and Leslie (1997) claim that the global economy contributes to the commodification of students, faculty members and knowledge-based goods. However, very little is known about the extent to which the flow structure of international students impacts the pattern of the world economy, politics and culture. In particular, very few studies have examined the effect of the student flow on global systems in the context of an information society (Barnett and Wu 1995).

This paper presents a network analysis that examines the flow of international students at the global level and ascertains the antecedents of the mobility structure of international students at the macro level by considering the physical distance between capitals, common borders between countries and common languages shared by countries. This paper contributes to the literature on the flow network of international students at the country level by analysing countries' overall Internet hyperlink connections, telecommunications and trade relations and investigating the relationships between the flow network of international students, world trade and global hyperlink connections.

## Methods

### *Data*

Five different sources were utilised for data collection. First, the data on the number of international students at the tertiary level are obtained from UNESCO (http://stats.uis.unesco.org/unesco) for the latest available year

(usually 2011) for all of the 210 listed countries and territories. Second, the data on physical distance between countries were extracted from Google Maps. They were operationalised as the location of the country's capital, whose latitude and longitude were obtained from Google Maps. The location-to-distance conversion was performed using an R package called 'fields' (available at http://cran.r-project.org/web/packages/fields/index.html). This process was completed using a function that automatically takes a vector of longitude/latitude coordinates and calculates the great-circle distance between all points on the list of coordinates. The calculation is done using the spherical law of cosines to convert the distance into an arc measure based on the assumption of a spherical Earth with a radius of 6378.388 km. Third, the data on hyperlinks between countries specified by their top-level domains (TLDs) were extracted from data in Barnett and Park (2014). For the USA, three TLDs reserved for exclusive use by US institutions (.edu, .gov and .mil) are combined with .us. The hyperlink data were collected during November 2010, using Yahoo. This network indicates the extent to which potential students are able to access information on educational institutions in different countries. Fourth, to operationalise the ability to communicate with host universities in different countries, the data on the number of telephone minutes between countries for 2011 were obtained from TeleGeography (http://www.telegeography.com/) for 188 countries. These data were previously reported in Barnett et al. (2013). Finally, the amount of trade between countries was obtained from the United Nations Trade Statistics Database (http://comtrade.un.org/db).



### *Measures and analysis procedures*

Three analytically complementary approaches were used: network analysis (including cluster analysis), quadratic correlation analysis and regression analysis.

First, for the network analysis, UCINET6.23 was employed to determine the density and centrality of the network and its clusters (hierarchical analysis) (Borgatti, Everett, and Freeman 2002). The network was drawn using its companion program NetDraw (Borgatti 2002), which uses a spring-embedded algorithm with node repulsion and equal-edge-length bias.

Notably, six network measures (i.e., density, in-degree centrality, out-degree centrality, share, betweenness centrality and eigenvector centrality) were used to describe the structure of the flow network of international students and the position of each country:

- Network density is the number of actual links in a network divided by the number of possible links ($n$ ($n$ – ½)).
- In-degree centrality refers to the number of inward links or total inward-link strength (the number of students).

- Out-degree centrality is the number of links directed outward or total outward-link strength. In this case, it is the number of students coming from a country.
- Share is the proportion of all links (or link strength) attributable to a node.
- Betweenness centrality measures the extent to which a node lies along the shortest path connecting all other nodes in the network (Freeman 1979) and is the proportion of all paths linking nodes j and k passing through node i. The betweeness of node i equals the sum of all $b_{jk}$. Therefore, betweenness centrality is a measure of the number of times a node occurs on a geodesic path (Borgatti, Everett, and Freeman 2002).
- Eigenvector centrality is an indicator of a node's overall centrality in a network (Bonacich 1972). The measure is calculated using weights for the first eigenvector and considers the positions of a node's links such that the node is more central if it is linked to more central nodes.

Second, to explore the relationship between the flow network of international students and other networks (e.g., communication network measured by telephone minutes between countries), the quadratic assessment procedure (QAP) correlation was used (Dekker, Krackhardt, and Snijders 2007; Krackhardt 1987).[6]

Third, based on the identification of associations between seven key factors (i.e., student flows, common border, physical distance, languages, communication, hyperlinks and trade) through QAP correlation analysis, their relationships were further modelled through QAP regression methods (Dekker, Krackhardt, and Snijders 2007; Krackhardt 1987) in order to predict the flow of international students through other factors, namely, common border, physical distance, languages, communication, hyperlinks and trade.[7]

It should be noted that the QAP methods have two key advantages over traditional correlation and regression methods. First, they directly test whether two matrices are similar to each other. QAP takes advantage of all dyadic information represented in each matrix and compares each dyadic cell in a network with the corresponding cell in another network. Therefore, it retains the dyad as the unit of analysis. Second, QAP makes no parametric assumptions. This is important because relationships in a network are not independent of one another.

### *Limitations*

There are three limitations related to our data. First, certain countries provide no information on the number of international students studying in their countries. These include Argentina, Bangladesh, China, Egypt, Israel,

Singapore and the UAE. As a result of this systematic bias, the network described in this paper may be somewhat distorted, and therefore any interpretation of the results should be made with caution. Second, regarding hyperlink data, because .com, .org and .net are not exclusive to a specific country such as the USA, they are not included. This might underestimate the centrality of some countries that rely heavily on these top-level domains (Barnett, Chung, and Park 2011). At the same time, however, because this paper focuses on higher education and the USA is composed mainly of .edu websites, no serious issue is expected. Finally, given the limited accessibility to relevant data, we did not further tease out the network structures of student mobility in terms of types of degree, period and motivations.



## Findings

### *The flow network of international students*

Approximately 3.15 million students studied abroad in 2011, in 122 different countries. With over 650,000 international students, the USA is the most frequent destination, followed by the UK, Australia, France, Germany and Japan. China sends the most students abroad (almost 563,000), followed by India, Germany and South Korea. Table 1 shows the exact numbers.

The density of the flow network of international students is .1235. At least 12.35% of the countries are connected by at least one student as either from the home country or in the host country. When 100 students are required for a link between countries, network density drops to .0433 or 4.3%, indicating a relatively sparse network.

Table 1 shows the overall degree centrality, share, in-degree centrality, out-degree centrality, betweenness centrality and eigenvector centrality for all 210 countries. Overall, the USA is the most central country in the network, with an 11.4% share, followed by China (9.7%), the UK (6.7%), France (4.5%), Germany (4.3%), Australia (4.3%) and India (3.6%). In terms of betweenness centrality, the USA is by far the most central country, occupying a role as an information broker in the network. Its betweenness is more than double that of the next most central country, Canada. They are followed by the UK and Russia. Based on eigenvector centrality, the USA is the most central country, followed by the UK, Canada, France and Germany.

The results of the hierarchical cluster analysis reveal that the network is composed of four major clusters. The first group is centered about France, with Tunisia, Algeria and Morocco; the second, about Russia, with Belarus, Ukraine, Uzbekistan and Kazakhstan; and the third, about Germany, with Poland, Switzerland, the Netherlands, Bulgaria, Austria, Italy and Albania. The fourth group is the largest one and is composed of English-speaking countries (the USA, the UK, Canada, Australia, New Zealand and Ireland)

Table 1. Country centrality in international student flow network.

| Country | Degree | Share (%) | Out-degree | In-degree | Between | Eigen |
|---|---|---|---|---|---|---|
| Afghanistan | 5730 | 0.100 | 5730 | 0 | 0.000 | 9.156 |
| Albania | 21,552 | 0.400 | 21,186 | 481 | 0.003 | 8.869 |
| Algeria | 22,432 | 0.400 | 22,432 | 0 | 0.000 | 7.289 |
| Andorra | 1235 | 0.000 | 1235 | 25 | 0.000 | 1.664 |
| Angola | 13,755 | 0.200 | 7048 | 6707 | 0.060 | 6.745 |
| Anguilla | 120 | 0.000 | 120 | 0 | 0.000 | 1.000 |
| Antigua Barbuda | 373 | 0.000 | 268 | 136 | 0.060 | 1.228 |
| Argentina | 9380 | 0.200 | 9380 | 0 | 0.000 | 6.802 |
| Armenia | 7707 | 0.100 | 5741 | 3203 | 0.026 | 9.183 |
| Aruba | 423 | 0.000 | 382 | 41 | 0.003 | 1.078 |
| Australia | 251,338 | 4.300 | 10,302 | 250,610 | 1.314 | 20.772 |
| Austria | 70,498 | 1.200 | 12,727 | 68,468 | 0.341 | 19.686 |
| Azerbaijan | 13,272 | 0.200 | 10,922 | 5691 | 0.039 | 10.112 |
| Bahamas | 2705 | 0.000 | 2705 | 0 | 0.000 | 2.130 |
| Bahrain | 11,165 | 0.200 | 3546 | 8483 | 0.008 | 6.660 |
| Bangladesh | 20,746 | 0.400 | 20,746 | 0 | 0.000 | 9.487 |
| Barbados | 2503 | 0.000 | 1255 | 1629 | 0.208 | 2.329 |
| Belarus | 34,417 | 0.600 | 28,763 | 8481 | 0.115 | 13.371 |
| Belgium | 22,133 | 0.400 | 10,741 | 17,670 | 0.222 | 19.016 |
| Belize | 812 | 0.000 | 812 | 0 | 0.000 | 1.867 |
| Benin | 3528 | 0.100 | 3528 | 0 | 0.000 | 5.973 |
| Bermuda | 1256 | 0.000 | 1227 | 58 | 0.001 | 1.568 |
| Bhutan | 1208 | 0.000 | 1208 | 0 | 0.000 | 3.765 |
| Bolivia | 9565 | 0.200 | 9565 | 0 | 0.000 | 6.858 |
| Bosnia Herzegovina | 12,416 | 0.200 | 12,416 | 0 | 0.000 | 6.989 |
| Botswana | 8519 | 0.100 | 8519 | 0 | 0.000 | 4.533 |
| Brazil | 35,549 | 0.600 | 26,382 | 12,663 | 0.806 | 16.120 |
| British Virgin Islands | 571 | 0.000 | 376 | 225 | 0.016 | 1.492 |
| Brunei | 3293 | 0.100 | 3198 | 184 | 0.001 | 4.922 |
| Bulgaria | 31,318 | 0.500 | 23,865 | 9994 | 0.531 | 13.033 |
| Burkina Faso | 2902 | 0.000 | 2902 | 0 | 0.000 | 4.825 |
| Burundi | 3036 | 0.100 | 1243 | 1813 | 0.580 | 7.463 |
| Cambodia | 3021 | 0.100 | 3021 | 66 | 0.002 | 5.425 |
| Cameroon | 21,711 | 0.400 | 20,093 | 1758 | 0.050 | 9.816 |
| Canada | 118,083 | 2.000 | 45,078 | 86,454 | 3.417 | 22.548 |
| Cape Verde | 5158 | 0.100 | 5158 | 0 | 0.000 | 3.309 |
| Cayman Islands | 941 | 0.000 | 314 | 718 | 0.000 | 1.551 |
| Central African Republic | 83 | 0.000 | 0 | 83 | 0.000 | 0.527 |
| Chad | 3169 | 0.100 | 3169 | 40 | 0.979 | 4.386 |
| Chile | 10,066 | 0.200 | 8197 | 2161 | 0.074 | 8.287 |
| China | 562,859 | 9.700 | 562,859 | 0 | 0.000 | 13.557 |
| Hong Kong | 42,715 | 0.700 | 32,827 | 10,218 | 0.205 | 7.536 |

(*Continued*)

Table 1. (*Continued*).

| Country | Degree | Share (%) | Out-degree | In-degree | Between | Eigen |
|---|---|---|---|---|---|---|
| Macao | 15,053 | 0.300 | 1728 | 13,459 | 0.027 | 5.400 |
| Colombia | 22,305 | 0.400 | 22,305 | 0 | 0.000 | 8.597 |
| Comoros | 3082 | 0.100 | 3082 | 0 | 0.000 | 2.077 |
| Congo | 6111 | 0.100 | 6063 | 48 | 0.395 | 8.646 |
| Cook Islands | 209 | 0.000 | 209 | 0 | 0.000 | 0.587 |
| Costa Rica | 3079 | 0.100 | 2089 | 1424 | 0.029 | 6.978 |
| Croatia | 7418 | 0.100 | 6949 | 645 | 0.019 | 8.308 |
| Cuba | 30,229 | 0.500 | 1788 | 28,699 | 0.687 | 13.281 |
| Cyprus | 34,125 | 0.600 | 25,316 | 10,227 | 0.050 | 12.596 |
| Czech Republic | 39,863 | 0.700 | 11,941 | 34,596 | 0.179 | 18.332 |
| D Republic of Congo | 5501 | 0.100 | 5501 | 0 | 0.000 | 5.769 |
| Denmark | 13,607 | 0.200 | 3657 | 12,258 | 0.064 | 7.606 |
| Djibouti | 1621 | 0.000 | 1621 | 0 | 0.000 | 14.551 |
| Dominica | 756 | 0.000 | 756 | 0 | 0.000 | 2.815 |
| Dominican Republic | 3301 | 0.100 | 3301 | 0 | 0.000 | 2.374 |
| North Korea | 2050 | 0.000 | 2050 | 0 | 0.000 | 5.321 |
| Ecuador | 9823 | 0.200 | 9823 | 0 | 0.000 | 7.037 |
| Egypt | 11,596 | 0.200 | 11,596 | 0 | 0.000 | 9.640 |
| El Salvador | 3490 | 0.100 | 3086 | 713 | 0.042 | 5.515 |
| Equatorial Guinea | 1181 | 0.000 | 1181 | 0 | 0.000 | 2.996 |
| Eritrea | 935 | 0.000 | 882 | 53 | 0.001 | 5.487 |
| Estonia | 4047 | 0.100 | 3914 | 994 | 0.010 | 7.885 |
| Ethiopia | 5087 | 0.100 | 5087 | 0 | 0.000 | 9.165 |
| Fiji | 8723 | 0.200 | 1575 | 7242 | 0.149 | 3.189 |
| Finland | 18,089 | 0.300 | 7268 | 13,980 | 0.395 | 17.867 |
| France | 259,975 | 4.500 | 54,468 | 232,252 | 2.898 | 22.248 |
| Gabon | 1801 | 0.000 | 1563 | 394 | 0.062 | 4.956 |
| Gambia | 931 | 0.000 | 931 | 0 | 0.000 | 4.524 |
| Georgia | 9069 | 0.200 | 8652 | 802 | 0.043 | 9.233 |
| Germany | 251,893 | 4.300 | 103,212 | 182,306 | 2.878 | 21.916 |
| Ghana | 9928 | 0.200 | 7833 | 2538 | 0.504 | 11.044 |
| Gibraltar | 661 | 0.000 | 661 | 0 | 0.000 | 0.882 |
| Greece | 47,376 | 0.800 | 29,770 | 20,927 | 0.193 | 15.612 |
| Grenada | 4298 | 0.100 | 541 | 4119 | 0.421 | 4.268 |
| Guatemala | 2722 | 0.000 | 2722 | 0 | 0.000 | 6.448 |
| Guinea | 5459 | 0.100 | 5459 | 0 | 0.000 | 5.833 |
| Guinea Bissau | 2278 | 0.000 | 2278 | 0 | 0.000 | 3.548 |
| Guyana | 801 | 0.000 | 785 | 25 | 0.006 | 2.177 |
| Haiti | 3575 | 0.100 | 3575 | 0 | 0.000 | 3.495 |
| Holy See | 9196 | 0.200 | 7 | 9196 | 0.000 | 13.673 |
| Honduras | 3560 | 0.100 | 2905 | 790 | 0.023 | 5.763 |
| Hungary | 19,144 | 0.300 | 7989 | 14,441 | 0.212 | 14.619 |
| Iceland | 3001 | 0.100 | 2623 | 792 | 0.003 | 8.392 |

(*Continued*)

Table 1. (*Continued*).

| Country | Degree | Share (%) | Out-degree | In-degree | Between | Eigen |
|---|---|---|---|---|---|---|
| India | 209,773 | 3.600 | 200,971 | 11,762 | 1.604 | 17.763 |
| Indonesia | 37,059 | 0.600 | 34,089 | 6058 | 0.045 | 9.750 |
| Iran | 41,174 | 0.700 | 38,371 | 2944 | 0.100 | 12.645 |
| Iraq | 9635 | 0.200 | 9635 | 0 | 0.000 | 10.351 |
| Ireland | 26,989 | 0.500 | 19,625 | 11,716 | 0.121 | 16.541 |
| Israel | 13,555 | 0.200 | 13,555 | 0 | 0.000 | 9.916 |
| Italy | 98,423 | 1.700 | 43,832 | 61,008 | 0.763 | 20.877 |
| Ivory Coast | 6153 | 0.100 | 6153 | 0 | 0.000 | 5.832 |
| Jamaica | 2132 | 0.000 | 1865 | 581 | 0.560 | 3.683 |
| Japan | 174,289 | 3.000 | 40,476 | 141,617 | 1.685 | 20.298 |
| Jordan | 36,130 | 0.600 | 10,904 | 27,384 | 0.324 | 13.246 |
| Kazakhstan | 43,643 | 0.800 | 36,571 | 11,926 | 0.086 | 10.765 |
| Kenya | 13,313 | 0.200 | 13,313 | 0 | 0.000 | 10.237 |
| Kiribati | 1006 | 0.000 | 1006 | 0 | 0.000 | 1.371 |
| Kuwait | 13,875 | 0.200 | 12,323 | 2206 | 0.078 | 8.033 |
| Kyrgyzstan | 17,833 | 0.300 | 2712 | 16,275 | 0.023 | 9.437 |
| Laos | 4022 | 0.100 | 3836 | 715 | 0.079 | 4.526 |
| Latvia | 3893 | 0.100 | 3078 | 1705 | 0.023 | 10.249 |
| Lebanon | 12,124 | 0.200 | 12,124 | 0 | 0.000 | 10.351 |
| Lesotho | 186 | 0.000 | 186 | 0 | 0.000 | 2.796 |
| Liberia | 522 | 0.000 | 522 | 0 | 0.000 | 3.539 |
| Libya | 6983 | 0.100 | 6983 | 0 | 0.000 | 8.344 |
| Liechtenstein | 1135 | 0.000 | 953 | 569 | 0.000 | 1.814 |
| Lithuania | 10,702 | 0.200 | 8248 | 2896 | 0.044 | 10.376 |
| Luxembourg | 7500 | 0.100 | 6969 | 1227 | 0.003 | 8.024 |
| Macedonia | 6209 | 0.100 | 5137 | 1398 | 0.009 | 14.059 |
| Madagascar | 1846 | 0.000 | 689 | 1157 | 0.008 | 4.983 |
| Malawi | 2030 | 0.000 | 2030 | 0 | 0.000 | 5.119 |
| Malaysia | 105,952 | 1.800 | 53,860 | 56,189 | 0.846 | 17.968 |
| Maldives | 1864 | 0.000 | 1864 | 0 | 0.000 | 3.640 |
| Mali | 4206 | 0.100 | 3790 | 448 | 0.044 | 5.489 |
| Malta | 1191 | 0.000 | 1178 | 13 | 0.002 | 4.094 |
| Marshall Islands | 220 | 0.000 | 220 | 0 | 0.000 | 0.644 |
| Mauritania | 3502 | 0.100 | 3494 | 145 | 0.051 | 3.734 |
| Mauritius | 7620 | 0.100 | 7597 | 38 | 0.134 | 6.028 |
| Mexico | 26,066 | 0.400 | 26,066 | 850 | 0.017 | 8.526 |
| Micronesia | 0 | 0.000 | 0 | 0 | 0.000 | 0.000 |
| Monaco | 426 | 0.000 | 426 | 0 | 0.000 | 1.541 |
| Mongolia | 10,118 | 0.200 | 9776 | 969 | 0.026 | 8.619 |
| Montenegro | 4659 | 0.100 | 3886 | 805 | 0.039 | 5.433 |
| Montserrat | 52 | 0.000 | 52 | 0 | 0.000 | 0.915 |
| Morocco | 50,341 | 0.900 | 42,772 | 8086 | 2.693 | 14.214 |
| Mozambique | 2711 | 0.000 | 2711 | 0 | 0.000 | 6.249 |
| Myanmar | 6284 | 0.100 | 6266 | 50 | 0.000 | 5.576 |
| Namibia | 1752 | 0.000 | 529 | 1248 | 0.152 | 5.993 |

(*Continued*)

Table 1. (*Continued*).

| Country | Degree | Share (%) | Out-degree | In-degree | Between | Eigen |
|---|---|---|---|---|---|---|
| Nauru | 132 | 0.000 | 132 | 0 | 0.000 | 0.526 |
| Nepal | 24,266 | 0.400 | 24,205 | 77 | 0.013 | 8.632 |
| Netherlands | 35,618 | 0.600 | 12,351 | 27,505 | 0.593 | 17.042 |
| Netherlands Antilles | 9 | 0.000 | 0 | 9 | 0.000 | 0.103 |
| New Zealand | 35,736 | 0.600 | 4662 | 35,721 | 0.243 | 14.887 |
| Nicaragua | 2502 | 0.000 | 2502 | 0 | 0.000 | 5.460 |
| Niger | 3221 | 0.100 | 2198 | 1105 | 0.065 | 5.353 |
| Nigeria | 39,000 | 0.700 | 39,000 | 0 | 0.000 | 11.971 |
| Niue | 72 | 0.000 | 72 | 0 | 0.000 | 0.664 |
| Norway | 22,109 | 0.400 | 12,947 | 13,004 | 0.400 | 18.420 |
| Oman | 5799 | 0.100 | 4866 | 1664 | 0.020 | 7.875 |
| Pakistan | 34,572 | 0.600 | 34,271 | 356 | 0.116 | 12.448 |
| Palau | 0 | 0.000 | 0 | 0 | 0.000 | 0.000 |
| Palestine | 11,225 | 0.200 | 11,225 | 0 | 0.000 | 7.821 |
| Panama | 2380 | 0.000 | 2380 | 0 | 0.000 | 4.923 |
| Papua New Guinea | 1019 | 0.000 | 1019 | 0 | 0.000 | 2.216 |
| Paraguay | 2342 | 0.000 | 2342 | 0 | 0.000 | 4.733 |
| Peru | 15,002 | 0.300 | 15,002 | 0 | 0.000 | 8.386 |
| Philippines | 13,560 | 0.200 | 11,835 | 2439 | 0.129 | 10.870 |
| Poland | 43,767 | 0.800 | 31,237 | 16,278 | 0.619 | 17.778 |
| Portugal | 20,517 | 0.400 | 12,917 | 10,853 | 0.217 | 13.825 |
| Puerto Rico | 0 | 0.000 | 0 | 0 | 0.000 | 0.000 |
| Qatar | 7016 | 0.100 | 2768 | 5272 | 0.058 | 8.778 |
| South Korea | 179,400 | 3.100 | 126,524 | 58,150 | 1.505 | 17.189 |
| Moldova | 14,678 | 0.300 | 14,037 | 1519 | 0.011 | 9.426 |
| Romania | 36,042 | 0.600 | 25,422 | 13,358 | 0.262 | 15.291 |
| Russia | 162,147 | 2.800 | 49,572 | 127,747 | 2.897 | 20.518 |
| Rwanda | 2839 | 0.000 | 2778 | 81 | 0.121 | 7.947 |
| Saint Kitts Nevis | 481 | 0.000 | 481 | 0 | 0.000 | 1.351 |
| Saint Lucia | 1530 | 0.000 | 1390 | 224 | 0.138 | 2.185 |
| Saint Vincent Grenadines | 892 | 0.000 | 892 | 0 | 0.000 | 1.757 |
| Samoa | 654 | 0.000 | 654 | 0 | 0.000 | 1.445 |
| San Marino | 791 | 0.000 | 791 | 0 | 0.000 | 0.618 |
| Sao Tome Principe | 2424 | 0.000 | 2424 | 0 | 0.000 | 1.377 |
| Saudi Arabia | 52,105 | 0.900 | 41,503 | 13,216 | 0.573 | 16.510 |
| Senegal | 11,917 | 0.200 | 11,917 | 0 | 0.000 | 6.400 |
| Serbia | 19,935 | 0.300 | 10,854 | 9390 | 0.107 | 8.998 |
| Seychelles | 367 | 0.000 | 367 | 0 | 0.000 | 2.497 |
| Sierra Leone | 641 | 0.000 | 641 | 0 | 0.000 | 4.326 |
| Singapore | 20,009 | 0.300 | 20,009 | 0 | 0.000 | 6.610 |
| Slovakia | 33,160 | 0.600 | 30,883 | 7839 | 0.037 | 12.425 |

(*Continued*)

Table 1. (*Continued*).

| Country | Degree | Share (%) | Out-degree | In-degree | Between | Eigen |
|---|---|---|---|---|---|---|
| Slovenia | 3848 | 0.100 | 2446 | 1821 | 0.060 | 8.613 |
| Solomon Islands | 2999 | 0.100 | 2999 | 0 | 0.000 | 1.672 |
| Somalia | 2082 | 0.000 | 2082 | 0 | 0.000 | 4.992 |
| South Africa | 38,544 | 0.700 | 6145 | 32,415 | 0.098 | 10.545 |
| Spain | 70,877 | 1.200 | 23,268 | 55,573 | 1.222 | 19.328 |
| Sri Lanka | 16,133 | 0.300 | 16,133 | 0 | 0.000 | 8.931 |
| Sudan | 4271 | 0.100 | 4271 | 0 | 0.000 | 9.775 |
| Suriname | 750 | 0.000 | 750 | 0 | 0.000 | 1.933 |
| Swaziland | 3949 | 0.100 | 3846 | 103 | 0.009 | 2.863 |
| Sweden | 35,013 | 0.600 | 14,763 | 24,831 | 0.438 | 19.038 |
| Switzerland | 39,948 | 0.700 | 11,155 | 37,205 | 0.476 | 20.131 |
| Syria | 12,616 | 0.200 | 12,616 | 0 | 0.000 | 10.032 |
| Tajikistan | 9634 | 0.200 | 6540 | 3362 | 0.011 | 6.336 |
| Thailand | 41,136 | 0.700 | 26,202 | 17,927 | 0.344 | 7.257 |
| Timor Leste | 3680 | 0.100 | 3680 | 0 | 0.000 | 2.307 |
| Togo | 3287 | 0.100 | 2837 | 535 | 1.089 | 5.660 |
| Tokelau | 0 | 0.000 | 0 | 0 | 0.000 | 0.000 |
| Tonga | 1460 | 0.000 | 1460 | 0 | 0.000 | 1.412 |
| Trinidad Tobago | 6067 | 0.100 | 5585 | 945 | 0.289 | 4.219 |
| Tunisia | 20,321 | 0.300 | 19,483 | 1130 | 0.013 | 8.283 |
| Turkey | 59,403 | 1.000 | 49,077 | 18,354 | 1.923 | 16.759 |
| Turkmenistan | 14,493 | 0.200 | 14,493 | 0 | 0.000 | 6.007 |
| Turks Caicos | 221 | 0.000 | 221 | 0 | 0.000 | 1.041 |
| Tuvalu | 401 | 0.000 | 401 | 0 | 0.000 | 0.736 |
| Uganda | 3363 | 0.100 | 3363 | 0 | 0.000 | 7.711 |
| Ukraine | 56,158 | 1.000 | 35,117 | 25,437 | 0.067 | 12.488 |
| UAE | 8458 | 0.100 | 8458 | 0 | 0.000 | 6.059 |
| UK | 387,920 | 6.700 | 23,091 | 387,648 | 2.938 | 22.877 |
| Tanzania | 5823 | 0.100 | 5605 | 272 | 2.030 | 9.368 |
| USA | 663,387 | 11.400 | 51,776 | 653,962 | 7.920 | 23.053 |
| Uruguay | 2187 | 0.000 | 2187 | 0 | 0.000 | 4.679 |
| Uzbekistan | 23,542 | 0.400 | 23,420 | 287 | 0.011 | 9.184 |
| Vanuatu | 1694 | 0.000 | 1694 | 0 | 0.000 | 1.376 |
| Venezuela | 15,027 | 0.300 | 13,267 | 1898 | 0.098 | 8.698 |
| Viet Nam | 50,385 | 0.900 | 47,981 | 3246 | 0.446 | 10.194 |
| Yemen | 5928 | 0.100 | 5928 | 0 | 0.000 | 7.157 |
| Zambia | 4950 | 0.100 | 4950 | 0 | 0.000 | 8.260 |
| Zimbabwe | 20,465 | 0.400 | 19,640 | 848 | 0.054 | 9.916 |
| Mean | 27,645 | 0.500 | 14,650.338 | 14,650.338 | 0.265 | 7.932 |
| SD | 74,998 | 0.013 | 43,248.445 | 60,087.465 | 0.782 | 5.699 |

and some in East Asia (China, Japan, South Korea, Singapore, Indonesia, Macao, Hong Kong, India, Nepal, Vietnam, Thailand and Malaysia) as well as some other countries (Turkey, Saudi Arabia and Nigeria). As in the case

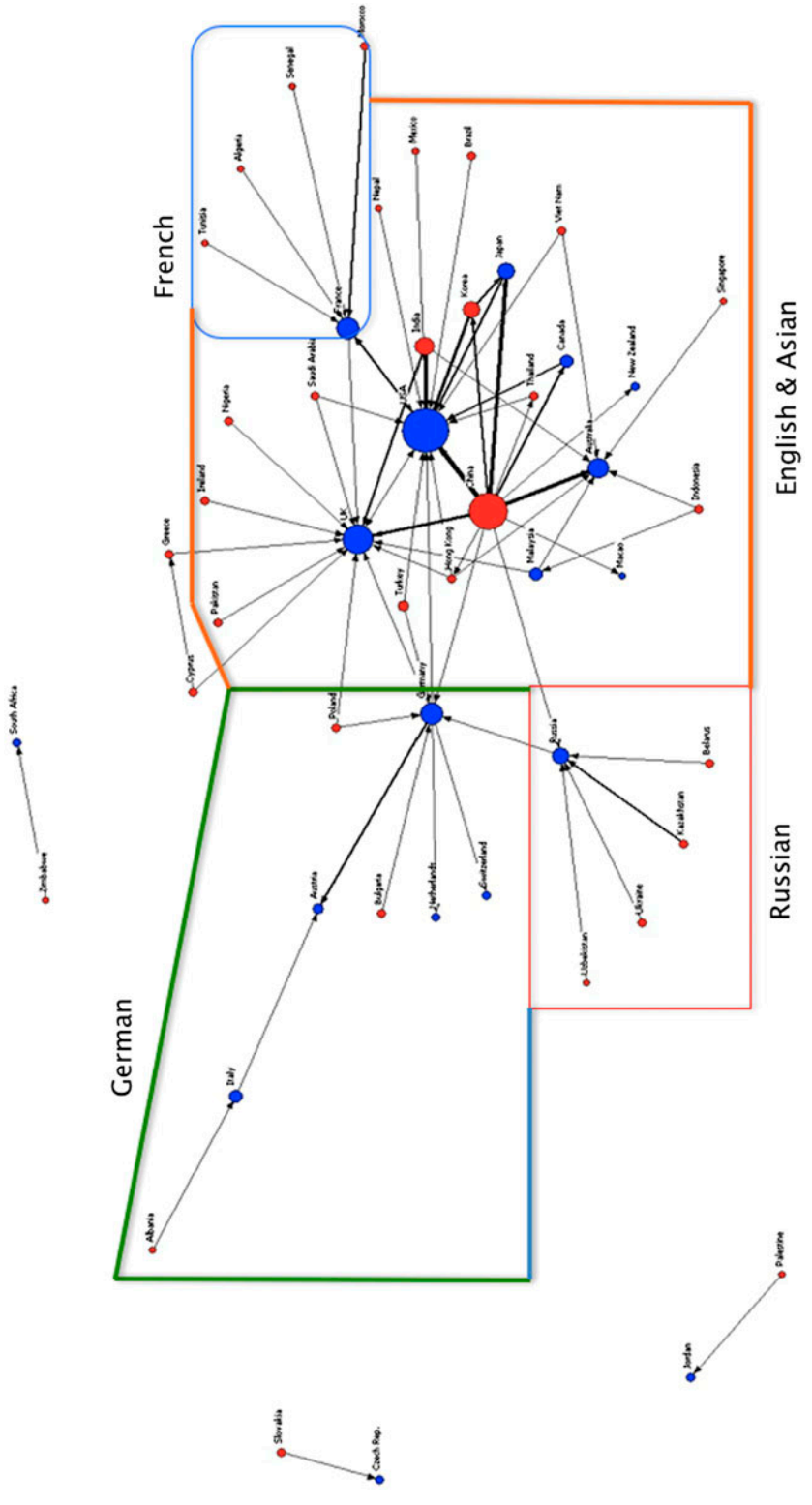


Figure 1. International student flows network.

of the whole network, this group is centred about the USA and the UK. These clusters suggest that language and culture are important factors influencing the network structure, which may also have some implications in terms of colonial and regional linkages.

Figure 1 visualises the flow network of international students. Node size is based on the overall degree centrality of countries, and the darker the line connecting two countries, the larger the number of students that are studying in the country at the end of the arrowhead. A total of 7325 students (half of the mean number of students) are required for a line to be drawn. Red countries send more students abroad than they receive, and blue ones receive more than they send. Figure 1 shows the four major clusters. In addition, there are a number of regional dyads, including Greece and Cyprus, Jordan and Palestine, the Czech Republic and Slovakia, and Zimbabwe and South Africa, suggesting that Greece, Jordan, the Czech Republic and South Africa are countries having certain tractions in the dyadic relationships with their counterpart countries in their respective regions.



### *Predicting the network structure*

A number of different networks are used as predictors of the flow of international students. These networks include the physical distance, common borders, common languages, bilateral hyperlink connections, the number of telephone minutes and the amount of trade between countries.

To predict the structure of the flow network of international students, both QAP correlation and regression analysis methods are employed. To control for extreme values and normalise highly skewed distributions, a log transformation is used for telephone, hyperlink and trade networks. Table 2 shows the means and standard deviations for these networks and Table 3 shows the QAP correlations between the predictors and the flow network of international students. There are weak but significant correlations between flow network, physical distance (the closer two countries, the larger the number of students), common borders, total hyperlinks, the number of telephone minutes and the amount of trade. The student flow is correlated

Table 2. Means and standard deviations for all networks.

| | Mean | SD |
|---|---|---|
| Student flows | 15.42 | 77.53 |
| Common border | 0.02 | 0.13 |
| Great circle distance | 4909.69 | 2793.33 |
| Languages | 0.19 | 0.39 |
| Log telephone | 0.07 | 0.36 |
| Log hyperlinks | 1.48 | 1.62 |
| Log trade | 6.86 | 1.69 |

Table 3. Quadratic assessment procedure correlations among networks.

| | Student flows | Common border | Distance | Languages | LTele | LHyper | LTrade |
|---|---|---|---|---|---|---|---|
| Student flows | 1.0 | | | | | | |
| Common border | 0.128* | 1.0 | | | | | |
| Great circle distance | −0.126* | −0.195* | 1.0 | | | | |
| Languages | 0.025 | 0.081* | 0.015 | 1.0 | | | |
| Log telephone | 0.239* | 0.212* | −0.140* | 0.053* | 1.0 | | |
| Log hyperlinks | 0.247* | 0.104* | −0.085* | −0.045 | 0.358* | 1.0 | |
| Log trade | 0.213* | 0.082* | −0.184* | −0.037 | 0.264* | 0.573* | 1.0 |

Notes: *$p < .01$; $n = 188$; LTele = Log telephone, LHyper = Log hyperlinks, LTrade = Log trade.



Table 4. Quadratic assessment procedure multiple regressions.

| R-square | Adj R-Sqr | Probability | # of Obs |
|---|---|---|---|
| 0.103 | 0.103 | > .001 | 33,672 |
| Independent | Standardised coefficient | Significance | |
| Intercept | 0.000 | | |
| Trade (log) | 0.078 | 0.000 | |
| Common border | 0.062 | 0.000 | |
| Great circle distance | −0.068 | 0.000 | |
| Languages | 0.023 | 0.009 | |
| Telephone (log) | 0.145 | 0.000 | |
| Hyperlinks (log) | 0.139 | 0.000 | |

with the physical distance ($r = -.126$; $p < 0.001$), common borders ($r = .128$; $p < 0.001$), telephone minutes ($r = .239$; $p < 0.001$), hyperlinks ($r = .247$; $p < 0.001$) and the amount of trade ($r = .213$; $p < 0.001$). There are no significant correlations between language and student flow ($r = .025$; $p = .061$), the physical distance ($r = .015$; $p = .301$), total hyperlinks ($r = -.045$; $p = .103$) and trade ($r = -.037$; $p = .158$). Language is weakly correlated with telephone minutes ($r = 053$; $p = .012$) and common borders ($r = .081$; $p < 0.001$).

Because many of the antecedents are related, a QAP multiple regression analysis is conducted to determine their independent and combined effects on the flow structure of international students. Table 4 shows the best-performing model. Among all the indicators, telephone minutes (0.145; $p < .001$) and bilateral hyperlink connections (0.139; $p < .001$), the communication variables, are the most significant predictors of the flow structure of international students, followed by the amount of trade (0.078; $p < .001$), the physical distance (−0.068; $p < .001$), common borders (0.062; $p < .001$) and common languages (0.023; $p < .01$).

## Discussion

The findings indicate some nuanced impacts of language on the flow of international students. Specifically, the network of international student flows is clustered into four groups differentiated by their language and culture. However, the QAP correlation indicates only a weak correlation between the student flow and language. This seems to be mainly because China sends the most number of students abroad and a majority of international students from China are studying in non-Chinese-speaking countries such as the USA, the UK, Australia, Canada, France, Germany, Japan, Korea and Russia.[8]

The heavy flow of international students in European countries also weakens the predictive power of language because Europeans speak many different languages.

At the country level, the USA is by far the most central country in the international student network, followed by China, the UK, France, Germany, Australia and India. The results reveal a center-periphery network structure consistent with World-System Theory. The core countries in the world system, the USA, the UK, Australia, France, Germany and Japan, receive most of the international students, whereas semi-periphery countries such as China, India and South Korea, and periphery countries, Malaysia and Vietnam, send most of the international students to other countries. Although scholars have argued that the pattern of the flow of international students from the periphery toward the core reinforces the inequitable distribution of resources and knowledge as a result of the brain drain (Chen and Barnett 2000; Lee 2008; Weiler 1984), the impact of this pattern should be investigated from a dynamic perspective. For example, Maringe and Carter (2007) reported that the decision-making and motivations of African students who come to study in England are complex and therefore cannot be simply reduced to the perspective of brain drain. In addition, although South Korea and China are gradually moving from the semi-periphery to the core, the flow pattern of international students is likely to be reshaped and have differential effects on the global economy, politics and culture. Indeed, the diversification of overseas destinations of South Korean and Chinese

students and the growing flows of South Korean and Chinese students within East Asia have been observed since 2000 (UNESCO Bangkok 2013).

Findings also show that countries such as Greece, Jordan, the Czech Republic and South Africa have certain levels of tractions in the dyadic relationships with their counterpart countries in their respective regions. In this regard, Kondakci's (2011) view of Greece, Jordan, the Czech Republic and South Africa as regional hubs attracting students within their geographic regions seems to be somewhat overestimated. In the periphery of the world system, these countries are not so much regional hubs as favourable destinations for their respective counterpart countries (i.e., Cyprus, Palestine, Slovakia and Zimbabwe).

Based on all these findings, we suggest that future research should pay more attention to the emerging stratifications and regional clusters of the mobility network of international students and investigate the relationship between the flow of international students and the regional economy, politics, culture and institutional features of higher education systems.

In this article, we predict the flow network of international students from physical distance, common borders, total hyperlink connections, the number of telephone minutes and the amount of trade between countries. Somewhat unexpectedly, sharing the same language is not a strong predictor, even though for some periphery countries, such as Mexico, sharing the same language is an important factor of international student mobility. However, this finding is understandable, given the fact that Chinese students are the majority of international students and still the vast majority of them choose English-speaking countries for study abroad. In line with the importance of language, the effect of the communication variables (i.e., telephone minutes and bilateral hyperlinks) on shaping the structure of international student flows could be understood. Notably, the number of telephone minutes shows the most significant association with the structure of international student flows (see Table 4). This finding suggests that family linkages might play a role in international student flows; for example, for international students, their (and their families') easy access to telephone communication with host universities in their home countries might be important. However, given the nature of our study as quantitative analysis, we call for scholars to further investigate why and how such communication aspects shape critically the flow of international students through more qualitative-oriented studies. In addition, although the percentage of the variance explained in the predictive model is low ($R^2 = .103$), indicating that communication explains a small portion of the total variance in the flow of international students, we think that quantitative researchers would benefit from taking communication into account in the investigation of the flow of international students.

Despite the limited feature of data in our study, we think that the importance of the communication variables in shaping the pattern of international student flows may be resonated with the fundamental characteristic of our

era as an information and network society (cf. Castells 2000). This argument could be further advanced by bilateral hyperlinks, the second most significant predictor of international student flows. In order to understand the relation between bilateral hyperlinks and international student flows in the information society (Webster 2007), it is imperative to investigate the effects of the Internet. The Web Index is the first multidimensional measure relating the World Wide Web to global development and human rights (About the Web Index n.d., para. 1). The indicators of the Web Index include the four areas of universal access, freedom and openness, relevant content and empowerment. Universal access measures whether countries have invested in affordable access to a high-quality Internet infrastructure, as well as investment in education and skills that citizens need to use the Web. Freedom and openness assesses the extent to which citizens enjoy rights to information, opinion, expression, safety and privacy online. Relevant content emphasises the extent to which different stakeholders can access relevant information in the language that they are most comfortable with and via platforms and channels that are widely available. Empowerment measures the difference that the web is making to people, and the extent to which the use of the web by stakeholders is fostering positive impacts on four key areas: society, economy, politics and the environment. The various Web Indexes correlate highly with a number of the international student flow network's centrality scores (Table 5). The overall degree centrality is correlated with the rank of Web Index score ($r = -.31$; $p < 0.01$), Web Index score ($r = .32$; $p < 0.01$), universal access ($r = .31$; $p < 0.01$), relevant content ($r = .33$; $p < 0.01$), impact and empowerment ($r = .45$; $p < .001$). Eigenvector centrality correlates with the rank of Web Index score ($r = -.60$; $p < 0.001$), Web Index score ($r = .61$; $p < 0.001$), universal access ($r = .60$; $p < 0.001$), freedom and openness ($r = .39$; $p < .001$), relevant content ($r = .55$; $p < 0.001$), impact and empowerment ($r = .69$; $p < .001$). In-degree centrality correlates with the rank of Web Index score ($r = -.43$; $p < 0.001$), Web Index score ($r = .44$; $p < 0.001$), universal access ($r = .39$; $p < 0.001$), relevant content ($r = .41$; $p < 0.001$), impact and empowerment ($r = .56$; $p < .001$). Betweenness degree centrality correlates with the rank of Web Index score ($r = -.34$; $p < 0.01$), Web Index score ($r = .35$; $p < 0.01$), universal access ($r = .30$; $p < 0.01$), relevant content ($r = .31$; $p < 0.01$), impact and empowerment ($r = .49$; $p < .001$).[9] In addition, the overall degree centrality, eigenvector centrality and in-degree centrality all highly correlate with the impact of the use of the web on the development of society, economy and politics, the affordability of building high-quality Internet infrastructure and the creation of web content that can satisfy users' needs. Working together, these web indicators create different ecological environments that facilitate and block communicative activities on a global scale, and thus contribute to the formation of the flow of international students. In particular, these Web Indexes play a more important role in

Table 5. Correlations of the Web Index with the centrality scores of international student flows.

| | | SF Degree | SF In-degree | SF Out-degree | SF Between | SF Eigen | SF Share |
|---|---|---|---|---|---|---|---|
| Rank | *r* | −0.310 | −0.432 | 0.024 | −0.344 | −0.592 | −0.310 |
| | Sig. | 0.005 | 0.000 | 0.831 | 0.002 | 0.000 | 0.005 |
| Web Index | *r* | 0.317 | 0.439 | −0.022 | 0.354 | 0.609 | 0.317 |
| | Sig. | 0.004 | 0.000 | 0.844 | 0.001 | 0.000 | 0.004 |
| Access | *r* | 0.313 | 0.389 | 0.038 | 0.300 | 0.595 | 0.313 |
| | Sig. | 0.004 | 0.000 | 0.736 | 0.006 | 0.000 | 0.004 |
| Education | *r* | 0.251 | 0.367 | −0.040 | 0.266 | 0.507 | 0.251 |
| | Sig. | 0.024 | 0.001 | 0.723 | 0.016 | 0.000 | 0.024 |
| Affordability | *r* | 0.358 | 0.410 | 0.085 | 0.331 | 0.597 | 0.358 |
| | Sig. | 0.001 | 0.000 | 0.450 | 0.003 | 0.000 | 0.001 |
| Infrastructure | *r* | 0.258 | 0.302 | 0.056 | 0.235 | 0.553 | 0.256 |
| | Sig. | 0.020 | 0.006 | 0.619 | 0.035 | 0.000 | 0.021 |
| Relevant content | *r* | 0.327 | 0.411 | 0.031 | 0.313 | 0.552 | 0.327 |
| | Sig. | 0.003 | 0.000 | 0.787 | 0.004 | 0.000 | 0.003 |
| Web use | *r* | 0.235 | 0.309 | 0.004 | 0.191 | 0.449 | 0.234 |
| | Sig. | 0.035 | 0.005 | 0.972 | 0.087 | 0.000 | 0.036 |
| Content creation | *r* | 0.399 | 0.487 | 0.054 | 0.423 | 0.619 | 0.399 |
| | Sig. | 0.000 | 0.000 | 0.632 | 0.000 | 0.000 | 0.000 |
| Free and open | *r* | 0.062 | 0.239 | −0.196 | 0.188 | 0.389 | 0.063 |
| | Sig. | 0.584 | 0.032 | 0.079 | 0.094 | 0.000 | 0.579 |
| Free of web | *r* | 0.062 | 0.239 | −0.196 | 0.188 | 0.389 | 0.063 |
| | Sig. | 0.584 | 0.032 | 0.079 | 0.094 | 0.000 | 0.579 |
| Impact | *r* | 0.447 | 0.556 | 0.044 | 0.485 | 0.687 | 0.447 |
| | Sig. | 0.000 | 0.000 | 0.696 | 0.000 | 0.000 | 0.000 |
| Political impact | *r* | 0.320 | 0.446 | −0.026 | 0.373 | 0.635 | 0.320 |
| | Sig. | 0.004 | 0.000 | 0.817 | 0.001 | 0.000 | 0.004 |
| Social impact | *r* | 0.458 | 0.548 | 0.070 | 0.504 | 0.629 | 0.459 |
| | Sig. | 0.000 | 0.000 | 0.537 | 0.000 | 0.000 | 0.000 |
| Economic impact | *r* | 0.490 | 0.578 | 0.090 | 0.497 | 0.676 | 0.489 |
| | Sig. | 0.000 | 0.000 | 0.424 | 0.000 | 0.000 | 0.000 |

Note: SF = student flow.



attracting students to pursue higher education abroad. For example, Barnett et al. (2014) found that the USA and the UK have the highest in-degree centrality in the network of international students and at the same time they have very high Web Index scores. Similarly, Lee and Park (2012) reported that universities in the USA and the UK dominated central positions in various network structures of web visibility, which appears to enhance US and UK universities' international visibility and reputation among key stakeholders, such as prospective students.[10] However, it should be pointed out that there are no significant correlations between out-degree centrality and any of the Web Indexes. Thus, scholars should also examine the relations

between web development at the global level and unequal distribution of academic human resources (Barnett et al. 2014).

Future research also should examine the changes in the network of flows of international students over time and include additional predictor variables to examine this network as a multilevel system. At the macro level, the country of origin has been shown to be a predictor of the flow of international students (Altbach 1991; Chadee and Naidoo 2009; Finn 1997; Kim, Bankart, and Isdell 2011). In addition, individual countries' economic growth and their higher-education policies should be taken into account. Further, instead of focusing only on country effects, more attention should be paid to activities of various institutions and agents. At the meso level, the rankings and quality of higher-education institutions and the cost factors related to higher education study (e.g., accommodation and living costs) have been reported as important predictors of the flow structure of international students (Bein, Noel, and Ragot 2012). Also, we note that based on neo-institutional theory or actor network theory, some scholars pay special attention to how international organisations (e.g., the World Bank, UNESCO, the OECD and the EU) have shaped global education governance (e.g., Chabbott 2003; Lee, Thayer, and Madyun 2008; Resnik 2006). Despite this, since our analytical model did not include the possible role of key international organisations in the flow of international students, future studies need to chart this terrain. In addition, factors such as the cultural, political and historical proximity between home and host countries may be important predictors of the flow of international students (Chan and Ng 2008; Kondakci 2011). Furthermore, the academic network can be considered an autopoietic and self-organising system requiring the sharing of information among scholars and students (Barnett et al. 2014; Manturana and Varela 1980). In this regard, it should be meaningful to examine the relationship between self-organised academic networks and the flow network of international students.

In sum, this paper presents a network analysis of the flow of international students among 210 countries and describes the network and the factors influencing its structure at the country level. Among the predictor variables, total Internet hyperlink connections and the number of telephone minutes are the most important predictors of the structure of international student flows. These results are discussed in light of world-system theory. Finally, future research should examine how the flow network of international students changes over time and consider additional predictor variables to investigate this network as a multilevel system.

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## Notes

1. Similar barriers related to visa and immigration are found in the UK and Australia.
2. In the theory, 'world-system' refers to transnational or regional division of labour or role, which partitions the world into core countries, semi-periphery countries and periphery countries (Wallerstein 1974). As such, World-System Theory emphasises the core/periphery pattern as a reflection of a hegemonic relationship. Put differently, World-System Theory is the macro-level approach to world stratification systems.
3. As Teferra (2005) pointed out, 'brain drain' may be an outmoded concept in capturing the emerging phenomenon of the global mobility of highly skilled immigrants, given the complexity shaping the global mobility of highly skilled experts such as intellectual diaspora. In this context, he suggests the need for scrutinising the concept of brain drain from the perspective of brain circulation.
4. This suggests that international students are not a monolithic entity in terms of their motivations, mobility patterns and demographic profiles. Brooks and Walters (2011) illuminated not just the commonalities but also differences of mobile students from East Asia, Europe and the UK in terms of their motivations, objectives and experiences. Some further numeric information about the heterogeneities can be found in statistics from UNESCO (UNESCO Institute for Statistics 2012).
5. For the conceptual discussion of educational hubs, see Knight (2011).
6. The QAP correlation algorithm proceeds in two steps (Borgatti, Everett, and Freeman 2002). First, it computes the Pearson correlation between corresponding cells of two networks. Second, it randomly permutes rows and columns (synchronously) of one matrix and re-computes the correlation hundreds of times to determine the number of times that a random measure is greater than or equal to the measure calculated in the first step. A low proportion ($< 0.05$) suggests a strong relationship between networks that is unlikely to have occurred by chance.
7. Similar to the QAP correlation procedure, the QAP regression algorithm has two steps. First, it performs a standard multiple regression analysis across corresponding cells of dependent and independent matrices. Second, similar to the QAP correlation, it randomly permutes rows and columns of the dependent matrix and re-computes the regression, repeating this step hundreds of times to estimate standard errors for the statistics of interest. For each coefficient, the program determines the proportion of random permutations that yield a coefficient as extreme as the one computed in the first step.
8. The finding also suggests that China still appears to face the issue of brain drain. At the same time, however, recent studies of Chinese students who

returned home from their study abroad suggest that China is starting to benefit from brain circulation, given that most of the returnees not only bring new cognitive skills but also engage in new processes of professionalisation and socialisation in their home society (e.g., Gu 2012).

9. It should be recalled that the USA is by far the most central country in terms of betweenness centrality in international student flows. Along with this finding, the high correlations between betweenness centrality and various Web Indexes suggest that the USA plays a role as an information broker in the network of international student flows, which is supported by the strong and positive features of the Web based in the USA.
10. Drawing from the highly positive correlations between various measures of web-visibility and university rankings, Lee and Park (2012) also concluded that certain features of web visibility can function as a proxy measure of university reputation.

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