

## **International Student Flows between Asia, Australia, and Russia: A Network Analysis**

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*This paper provides a network analysis of the international flow of students among 23 Asian countries, and Australia and Russia, and the factors determining the structure of this flow. Among these factors, bilateral hyperlink connections between countries is the only significant predictor of the flow's structure. China is the most central country in the flow of international students, followed by Australia, Japan, Republic of Korea, Myanmar, Malaysia, 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 determinants to provide a better understanding of the network as an international system.*

Keywords: International Student Flows, Network Analysis

### **Literature Review**

International student flows have become an increasingly important research topic because of the rapid expansion of foreign students after WWII (Goodwin, 1993). It is estimated that about three million tertiary students studied abroad in 2007 (OECD, 2009), reflecting a large increase from less than a million in 1980 (OECD, 1982). Economically developed English-speaking countries such as the U.S., the U.K., Australia, Canada, and New Zealand are core destinations of foreign students pursuing higher education abroad (OECD, 2009; UNESCO, 2008). Although the network of international students has changed dramatically over the last few decades, these core countries remain at the center of the network (Chen & Barnett, 2000). In addition, Asia is the single largest source of international students and has assumed a more central position in the network (Chen & Barnett, 2000; Chadee & Naidoo, 2009).

Recent studies of the flow of international students have mainly focused on the factors pulling and pushing students to seek higher education abroad. At the macro level, scholars have examined public rationales that attract or compel international students to study abroad and suggested that positive developments in host countries, including positive wage differentials, job opportunities, the emergence of organizations facilitating migration, and favorable immigration policies pull international students to seek higher education abroad (Massey et al., 1993; Brzozowski, 2007; Wolfeil 2009), 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

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(Massey et al., 1993; Altbach et al., 1985). 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 & Bray, 2007). For example, unwelcoming attitudes toward international students after the 9/11 terrorist attacks in the U.S. are recognized as an important factor pushing international students away from the U.S. (Lee & Rice, 2007). Visa problems (CGS, 2004) are also regarded as a main cause of decreases in the enrollment of international graduate students in the US. 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, which emphasizes the core/periphery pattern as a reflection of a hegemonic relationship (Barnett & Wu, 1995). 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 & 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 (Kim, Bankart & Isdell, 2011; Aupetit, 2006). International students also benefit host countries that are at the center of the world system in a number of ways (Heikinheimo & Shute, 1986; IIE, 2007; Klomegah, 2006; Olivas & Li, 2006; Zhai, 2002). For example, international students can not only make substantial contributions to the U.S. economy (IIE, 2007) but also bring ethnic and cultural diversity to American campuses (Aslanbeigui & Montecinos, 1998; Klomegah, 2006; Lee; Rice, 2007; Olivas & Li, 2006). From this perspective, the pattern of international student flows from the periphery toward the core can, to a certain extent, reinforce the inequitable distribution of resources and knowledge (Chen & Barnett, 2000; Weiler, 1984; Lee, 2008).

At the country level, other scholars have treated the country of origin as a predictor of the flow of international students and suggested variables that have differential effects on international students' decisions to stay and return (Altbach, 1991; Chadee & Naidoo, 2009; Finn, 1997; Kim, Bankart & 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 & Naidoo, 2009). Examining stay/return rates for international students in the U.S., scholars have found that Chinese and Indian doctoral students are most likely to stay in the U.S. upon completing their doctoral program (Finn, 1997), and that return rates for Taiwanese and South Korean students have started to increase because of rapid industrialization and economic growth experienced by these countries in the 1980s and 1990s (Altbach, 1991).

Many scholars have claimed that the critical factors influencing the flow of international students are located mainly at the country level, 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/programs, faculty members, and students instead of focusing only on the importance of country effects (Marginson & Rhoades, 2002). Few studies have considered the flow of international students at the meso and micro 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 insti-

tution's national ranking and prestige are most important, followed by assistantships, financial assistance, and special education opportunities (Barnett et al., 2013a). 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.

At the individual level, family-related reasons such as the cultural, political, and historical proximity between home and host countries are known to be important determinants of the size and direction of student inflows in developing countries (Knodakci, 2011). For example, because of historical mass-migration from the Balkans to Turkey, students from 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 (Knodakci, 2011). 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 & Skinner, 2002).

From this perspective, it is not difficult to find the existence of regional hubs in the international flow of students. Kondakci (2011) suggests that at 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 (Kondakci, 2011). Similarly, Mexico has been found to be a regional hub attracting students from other Latin American countries (Cantwell et al., 2009). 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 meaningful to examine the stratified clusters in the structure of international student mobility at the regional level (Marginson & Rhoades, 2002).

The factors predicting the flow of international students at the macro and micro levels are not mutually exclusive (Kondakci, 2011) because there is a link between individuals and their societies (Metcalf & Fenwick, 2009). According to Chen and Barnett (2000, p. 435), "international student flows can be treated as another form of communication, describing how countries interact and communicate with each other". From this perspective, instead of studying the factors determining the flow of international students at the micro level, it may be more meaningful to examine how international communication and complex networks that involve the global systems predict the structure of international student flows. With the advancements in communication technology, the global system can be represented by unequal exchanges, including student flows, between powerful information-rich and limited information-poor countries (Barnett et al., 1996). While the capacity for distributing messages in the World-System is centralized, the gap between the core and periphery countries is widening (Barnett et al., 1996). Under such circumstances, it is imperative to study the influence of communication variables at the macro level, such as countries' overall Internet hyperlink connections and telecommunications, in predicting the structure of international student flows.

This paper presents a network analysis that examines international student flows in Asia and ascertains the antecedents of the mobility structure of international students at the macro level by considering the physical distance between Asian capitals, common borders between Asian countries, and common languages shared by Asian countries. This paper contributes to the literature

on the flow network of international students at the country level by analyzing Asian countries' overall Internet hyperlink connections, telecommunications, and trade relations and investigating the relationships between the Asian international student flows, Asian trade, and Asian hyperlink connections. Considering the geographic proximity, Australia and Russia also were included into the network analysis of international student flows.

## Methods

### *Data*

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 23 Asian countries, Australia and Russia. The 23 Asian countries are: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, China Hong Kong, China Macao, Democratic People's Republic of Korea, India, Indonesia, Japan, Laos, Malaysia, Mongolia, Myanmar, Nepal, Papua New Guinea, Philippines, Republic of Korea, Singapore, Thailand, Timor Leste, and Viet Nam. It should be noted that certain countries provide no information on the number of international students studying in their countries. These include Bangladesh, China, and Singapore, which represent important sources of and destinations for international students. As a result of this systematic bias, the network described in this article may be somewhat distorted, and therefore any interpretation of the results should be made with caution.

In addition, the data on a number of factors used to predict the structure of international student flow network among 23 Asian countries, Australia, and Russia are collected, including the physical distance between countries. This is operationalized as the location of the country's capital whose latitude and longitude are obtained from Google Maps. The location-to-distance conversion is performed using an R package called "fields," available at <http://cran.r-project.org/web/packages/fields/index.html>. This process is 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.

The data on the bilateral hyperlinks between 23 Asian countries, Australia, and Russia specified by their top-level domains (ccTLDs) are extracted from data in Barnett and Park (2014). The hyperlink data were collected during November, 2010 using the tool in Yahoo search engine. This network indicates the extent to which potential students are able to access information on educational institutions in different countries. Another indicator of the ability to communicate with host universities in different countries is the telephone. The data on the number of telephone minutes used in communications between countries for 2011 are obtained from TeleGeography (<http://www.telegeography.com/>) for 23 Asian countries, Australia and Russia. These data were previously reported in Barnett et al. (2013b). Finally, the amount of trade between these 25 countries is obtained from the United Nations Trade Statistics Database (COMTRADE) (<http://comtrade.un.org/db>).

### Analysis Procedures

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

The following indicators are used to describe the structure of the flow network of international students between 23 Asian countries, Australia and Russia, and the position of each country: network density, indegree centrality, outdegree centrality, share, betweenness centrality, eigenvector centrality, hierarchical cluster analysis results and QAP correlations. Network density is simply the number of actual links in a network divided by the number of possible links ( $n(n - 1/2)$ ). Indegree centrality refers to the number of inward links or total inward-link strength (the number of students). Outdegree 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 betweenness 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 et al., 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.

To determine the strength of the relationship between the flow network of international students and other networks, the quadratic assessment procedure (QAP) correlation and regression methods are employed (Krackhardt, 1987; Dekker et al., 2007). These methods have two key advantages over traditional correlation and regression methods. First, they directly test whether two matrices are similar to each other. The 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, the QAP makes no parametric assumptions. This is important because relationships in a network are not independent of one another. The correlation algorithm proceeds in two steps (Borgatti et al., 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 recomputes 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. Similarly, the 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.

## Results

### *The Flow Network of International Students*

Among 23 Asian countries, Australia, and Russia, approximately 1 million students study abroad in 2011 in 18 different countries. With over 198,000 international students, Australia is the most frequent destination, followed by Japan, Republic of Korea, Russia, Malaysia, Thailand, Macao, and Hong Kong. China send the most students abroad (almost 270,000), followed by Republic of Korea, Malaysia, and India. Table 1 shows the exact numbers.

**Table 1: Country Centrality in International Student Flow Network**

Country	Degree	Share	OutDegree	InDegree	Between	nEigenvec
Australia	198775	21.00%	574	198775	14.787	65.253
Bangladesh	7321	0.77%	7321	0	0	2.269
Bhutan	990	0.10%	990	0	0	0.205
Brunei Darussalam	1148	0.12%	1078	159	0	0.376
Cambodia	1715	0.18%	1715	66	0.125	0.414
China	269588	28.00%	269588	0	0	93.864
China Hong Kong SAR	22844	2.40%	13142	9920	3.014	11.717
China Macao SAR	14013	1.50%	820	13295	0	8.603
DP Republic of Korea	1187	0.12%	1187	0	0	0.348
India	30460	3.20%	27470	3710	9.684	10.057
Indonesia	24508	2.60%	21538	5915	2.954	6.549
Japan	132524	13.90%	4421	130423	57.278	64.717
Lao Peoples DR	3732	0.39%	3553	708	5.894	0.468
Malaysia	47437	5.00%	28064	22815	20.683	15.089
Mongolia	5782	0.61%	5446	934	1.176	1.562
Myanmar	5097	5.40%	5079	50	0	0.959
Nepal	8568	0.90%	8561	23	0	3.131
Papua New Guinea	749	0.08%	749	0	0	0.314
Philippines	4309	0.45%	3015	1690	5.217	1.560
Republic of Korea	86876	9.13%	35871	54234	68.108	43.992
Russian Federation	24852	2.61%	2038	23797	12.990	7.255
Singapore	11129	1.17%	11129	0	0	4.644
Thailand	22649	2.40%	8624	15247	7.553	9.044
Timor Leste	2787	0.29%	2787	0	0	0.163
Viet Nam	22586	2.37%	20195	3194	20.536	6.890

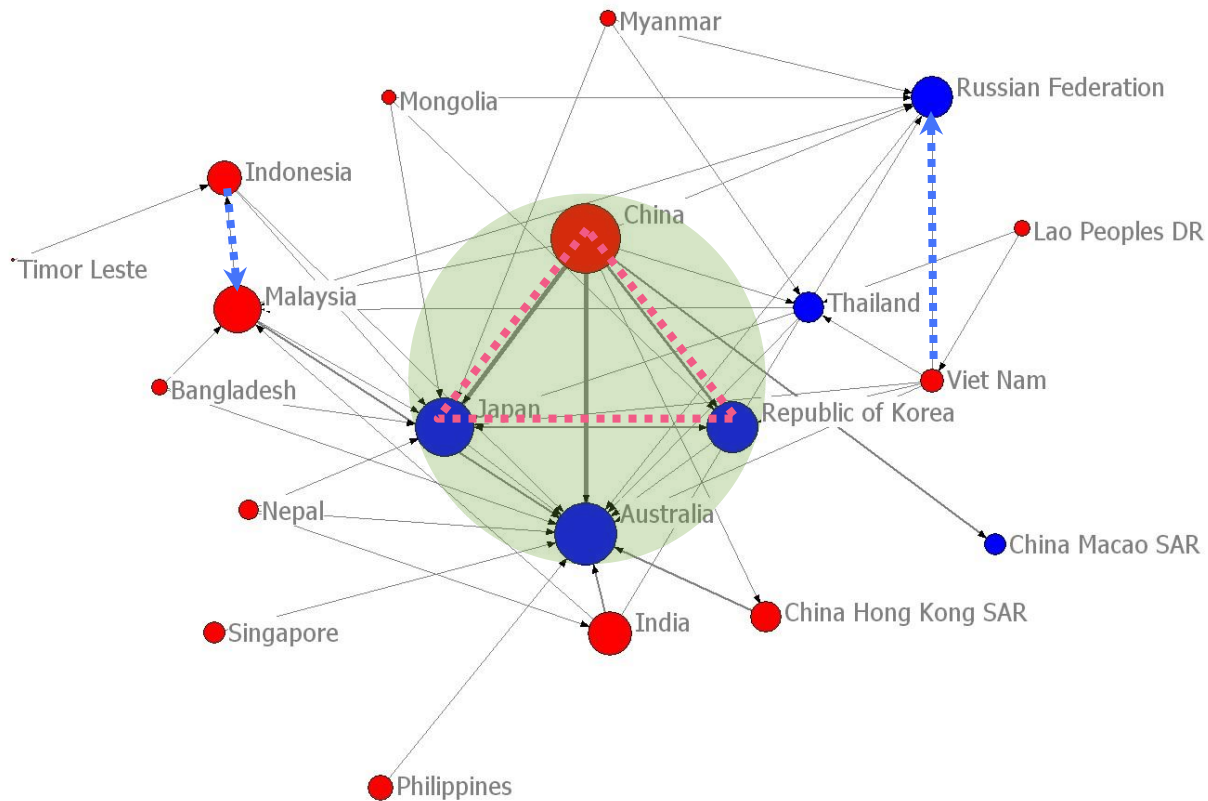
The density of the flow network of international students is .375. At least 37.5% of the countries are connected by at least one student as either from the home country or in the host country. When 1000 students are required for a link between countries, network density drops to .08 or 8%, indicating a relatively sparse network.

Table 1 shows the overall degree centrality, share, indegree centrality, outdegree centrality, betweenness centrality, and eigenvector centrality for 23 Asian countries, Australia, and Russia. Overall, China is the most central country in the network, with an 28% share, followed by Australia (21%), Japan (13.9%), Republic of Korea, (9.13%), Myanmar (5.4%), Malaysia (5%), and India (3.2%). In terms of betweenness centrality, Republic of Korea is the most central country, occupying a role as an information broker in the network, followed by Japan, Malaysia, Viet Nam, Australia, and India. Based on eigenvector centrality, China is the most central country, followed by Australia, Japan, and Republic of Korea.

The results of the hierarchical cluster analysis reveal that the central cluster of the network is composed of four countries: Australia, China, Japan, and Korea. The whole network is centered about this core. In addition, there are two regional dyads, including Russia and Viet Nam, Malaysia and Indonesia. Figure 1 visualizes the flow network of international students between 23

Asian countries, Australia, and Russia. Node size is based on the overall degree centrality of countries.

**Figure 1: International Student Flows Network between Asia, Australia, and Russia**



The darker the line connecting two countries, the larger the number of students are studying in the country at the end of the arrowhead. A total of 808 students (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.

**Table 2: Means and Standard Deviations for all Network**

	Mean	S.D.
Student Flows	808	5709
Common Border	0.12	0.326
Great Circle Distance	2395.05	1511.09
Languages	0.29	0.45
Log Telephone	0.45	0.85
Log Hyperlinks	2.57	2.05
Log Trade	6.09	4.19

*Predicting the Network Structure*

A number of different networks are used as predictors of the flow of international students between 23 Asian countries, Australia, and Russia. These networks include common borders, the physical distance, common languages, the number of telephone minutes used, bilateral hyperlink connections, and the amount of trade between countries.

**Table 3: QAP Correlations among Networks**

	Student Flows	Common Border	Distance	Languages	LTele	LHyper	LTrade
Student Flows	1.0						
Common Border	0.080	1.0					
Great Circle Distance	0.082	-0.303*	1.0				
Languages	-0.074	-0.029	-0.041	1.0			
Log Telephone	0.138*	0.043	-0.020	0.064	1.0		
Log Hyperlinks	0.241*	0.072	0.078	-0.088	0.632*	1.0	
Log Trade	0.216*	0.000	0.161	-0.053	0.478*	0.654*	1.0

p < .01  
n = 22

**Table 4: QAP Multiple Regressions**

R-square	Adj R-Sqr	Probability	# of Obs
0.077	0.065	0.001	462.000

Independent	Standardized Coefficient	Significance
Intercept	0.000	
Trade (log)	0.097	0.086
Common Border	0.091	0.041
Great Circle Distance	0.079	0.089
Languages	-0.047	0.197
Telephone (log)	-0.016	0.396
Hyperlinks (log)	0.171	0.008



To predict the structure of the flow network of international students, both the QAP correlation and regression analysis methods are employed. To control for extreme values and normalize highly skewed distributions, the 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 between 22 countries. China Hong Kong, China Macao, and Timor Leste are not included into the analysis of QAP correlations. There are weak but significant correlations between the flow network, total hyperlinks, the number of telephone minutes used, and the amount of trade. The student flow is correlated with telephone minutes used ( $r = .138$ ;  $p = .012$ ), hyperlinks ( $r = .241$ ;  $p < 0.001$ ), and the amount of trade ( $r = .216$ ;  $p = 0.002$ ). There are no significant correlations between student flow and common border ( $r = .08$ ;  $p = .073$ ), the physical distance ( $r = .082$ ;  $p = .14$ ), languages ( $r = -.074$ ;  $p = .152$ ). Common border is significantly correlated with physical distance ( $r = -.303$ ;  $p < 0.001$ ). There are relatively strong correlations between the number of telephone minutes used, total hyperlinks, and the amount of trade. Telephone minutes used is correlated with hyperlinks ( $r = .632$ ,  $p < 0.001$ ), and the amount of trade ( $r = .478$ ,  $p < 0.001$ ). Total hyperlinks is correlated with the amount of trade ( $r = .654$ ,  $p < 0.001$ ).

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, bilateral hyperlink connection is the only significant predictor of the flow structure of international students among 23 Asian countries, Australia, and Russia.

### *Discussion*

The results indicate that the whole flow network of international students is centered about Australia, China, Japan, and South Korea. At the country level, China is the most central country in the network, followed by Australia, Japan, Republic of Korea, Myanmar, Malaysia, and India. The results reveal a center-periphery network structure consistent with world-system theory. The core countries in the world system, Australia and Japan, receive most of the international students, whereas semi-periphery and periphery countries such as China, South Korea, India, and Malaysia 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 & Barnett, 2000; Weiler, 1984; Lee, 2008), the impact of this pattern should be investigated from a dynamic perspective. For example, while South Korea is 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. Among 23 Asian countries, Australia, and Russia, South Korea not only send many students (35,871) abroad, but are also the third most frequent destinations for international students (54,234). In terms of betweenness centrality, Republic of Korea is the most central country indicating its role as an information broker in the network.

**Table 5: Correlations of the Web Index with the centrality scores of International Student Flows**

		sf Degree	sf Out-degree	sf In-degree	sf Between	sf Eigen
Rank	Pearson Correlation	-0.341	0.201	<b>-.713**</b>	<b>-.658*</b>	-0.437
	Sig.	0.232	0.491	0.004	0.010	0.119
Web Index	Pearson Correlation	0.380	-0.190	<b>.753**</b>	<b>.683**</b>	0.478
	Sig.	0.181	0.514	0.002	0.007	0.084
Access	Pearson Correlation	0.410	-0.057	<b>.637*</b>	<b>.595*</b>	0.495
	Sig.	0.145	0.846	0.014	0.025	0.072
Education	Pearson Correlation	0.366	-0.156	<b>.690**</b>	0.330	0.400
	Sig.	0.198	0.595	0.006	0.249	0.156
Affordability	Pearson Correlation	0.431	-0.014	<b>.613*</b>	<b>.630*</b>	0.522
	Sig.	0.124	0.962	0.020	0.016	0.056
Infrastructure	Pearson Correlation	0.372	-0.011	0.532	<b>.703**</b>	0.483
	Sig.	0.190	0.970	0.050	0.005	0.080
Rel. Content	Pearson Correlation	0.374	-0.071	<b>.605*</b>	<b>.574*</b>	0.453
	Sig.	0.188	0.810	0.022	0.032	0.104
Web Use	Pearson Correlation	0.341	-0.030	0.513	0.467	0.401
	Sig.	0.232	0.920	0.061	0.092	0.155
Content Cre	Pearson Correlation	0.382	-0.121	<b>.672**</b>	<b>.667**</b>	0.479
	Sig.	0.178	0.681	0.008	0.009	0.083
Free&Open	Pearson Correlation	0.158	-0.434	<b>.732**</b>	<b>.548*</b>	0.250
	Sig.	0.589	0.121	0.003	0.043	0.389
Free of Web	Pearson Correlation	0.158	-0.434	<b>.732**</b>	<b>.548*</b>	0.250
	Sig.	0.589	0.121	0.003	0.043	0.389
Impact	Pearson Correlation	0.401	-0.124	<b>.706**</b>	<b>.712**</b>	0.495
	Sig.	0.156	0.673	0.005	0.004	0.072
Political Imp	Pearson Correlation	0.287	-0.290	<b>.744**</b>	<b>.707**</b>	0.379
	Sig.	0.319	0.314	0.002	0.005	0.181
Socail	Pearson Correlation	0.338	-0.033	0.516	<b>.677**</b>	0.438
	Sig.	0.238	0.911	0.059	0.008	0.117
Econ Impact	Pearson Correlation	0.489	-0.007	<b>.685**</b>	<b>.574*</b>	<b>.556*</b>
	Sig.	0.076	0.982	0.007	0.032	0.039

\*\* . Correlation is significant at the 0.01 level (2-tailed); \* . Correlation is significant at the 0.05 level (2-tailed).

The results show that Malaysia is a hub attracting students from Indonesia, which provides support for Kondakci's (2011) argument that at the periphery of the world system there are regional hubs that attract students from other peripheral countries. From this perspective, future research should pay more attention to the stratification 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 institutions. It should be noted that certain countries such as Bangladesh, China, and Singapore, which are important sources of and destinations for international students, do not provide information on the number of international students studying in their countries. Therefore, any interpretation of the results should be made with caution.

In this article, the flow network of international students among 23 Asian countries, Australia, and Russia were predicted from physical distance, common borders, total hyperlink connections, the number of telephone minutes used, and the amount of trade between countries. Although the flow network significantly correlated with hyperlink connections, the number of telephone minutes used, and the amount of trade between countries, bilateral hyperlink connections is the only significant factor in determining the structure of international student flows among 23 Asian countries, Australia, and Russia. From this perspective, this paper calls for scholars to take communication into account in the investigation of the flow of international students within the context of information society, which is featured by the rapid development of information and communication technologies (Webster, 2007). However, the percentage of the variance explained in the predictive model is low ( $R^2 = .077$ ), indicating that communication explains only a small portion of the total variance in the flow of international students among 23 Asian countries, Australia, and Russia.

In order to understand the relation between communication and international student flows in the information society, 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 Web Index include 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 emphasizes the extent to which different stakeholders can access relevant information in the language that they are most comfortable 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). Indegree centrality correlates with the rank of Web Index score ( $r = -.713$ ,  $p = 0.004$ ), Web Index score ( $r = .753$ ,  $p = 0.002$ ), universal access ( $r = .637$ ,  $p = 0.014$ ), freedom and openness ( $r = .732$ ,  $p = 0.003$ ), relevant content ( $r = .605$ ,  $p = 0.022$ ), impact and empowerment ( $r = .706$ ,  $p = .005$ ). Betweenness degree centrality correlates with the rank of Web Index score ( $r = -.658$ ,  $p = 0.01$ ), Web Index score ( $r = .683$ ,  $p = 0.007$ ), universal access ( $r = .595$ ,  $p = 0.025$ ), freedom and openness ( $r = .548$ ,  $p = 0.043$ ), relevant content ( $r = .574$ ,  $p = 0.032$ ), impact and empowerment ( $r = .712$ ,  $p = .004$ ). Eigenvector centrality only correlates with the economic impact ( $r = .556$ ,  $p = .039$ ). Specifically, indegree centrality and betweenness centrality, all highly correlate with the impact of the use of the Web on the development of politics

and economy, citizens' enjoyment of rights to information, opinion, expression, safety and privacy online, the creation of Web content that can satisfy users' needs, and the affordability of building high quality internet infrastructure. Indegree centrality also highly correlates with countries' investment in education and skills that citizens need to use the Web. Working together, these web indicators create different ecological environments that facilitate and block communicative activities among 23 Asian countries, Australia, and Russia, and thus contribute to the formation of the flow of international students between these countries. In particular, these Web Indexes play a more important role in attracting students to pursuit high education abroad. For example, Australia, Japan, and Republic of Korea have the highest indegree centrality in the network of international students among Asian countries, and at the same time they have the highest Web Index score. However, it should be pointed out that there are no significant correlations between outdegree centrality and any of the Web Indexes. Thus, scholars should also examine the relations between Web development at the country level and unequal distribution of academic human resources (Barnett, et al, 2013).

This paper contributes to the research on international student flows by examining communication as a significant factor in predicting the flow network of international students. In the era of globalization, advancements in satellite networks, smart phones, and the internet challenge the meaning of physical borders in the process of international interaction. A holistic global system, which binds people together in a common fate, is being created as the result of the rapid development of communication technologies (Kegley & Wittkopf, 2001). While innovative communication technologies increase the information processing capacity of individuals, social organizations, and societies, patterns of complex interdependence have been reshaped on a global scale, making communication a significant factor in predicting international interactions. Although international student flows reflect how countries interact and communicate with each other, to date, the effects of communication on international student flows have been generally overlooked. This paper is the first study to employ network analysis to examine the relationship among the networks of international student flows, internet hyperlink connections, and international telecommunication. Future research is planned to examine the effects of the improvements in communication technology and the strengthening of global communication ties on the flow network of international students.

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 multi-level system. At the macro level, the country of origin has been shown to be a predictor of the flow of international students (Altbath, 1991; Chadee & Naidoo, 2009; Finn, 1997; Kim, Bankart & Isdell, 2011). In addition, individual countries' economic growth and their higher-education policies should be taken into account. At the meso level, higher-education institutions' national rankings and prestige can be regarded as important predictors of the flow structure of international students. Scholars should also investigate how nongovernmental organizations such as the World Bank, the IMF, and UNESCO and regional organizations such as the APEC and ASEAN are related to the dynamic evolution of the flow network of international students. At the micro level, family-related reasons such as the cultural, political, and historical proximity between home and host countries may be important predictors of the flow of international students (Knodakci, 2011). Furthermore, the academic network can be considered an autopoietic and self-organizing system requiring the sharing of information among scholars and students (Manturana & Varela, 1980; Barnett, et al., 2013a). In this regard, it should be meaningful to examine the

relationship between self-organized academic networks and the flow network of international students.

In sum, this paper presents a network analysis of the flow of international students among 23 Asian countries, and describes the network and the factors influencing its structure at the country level. Among the predictor variables, total Internet hyperlink connections is the only significant predictor of the structure of international student flows. These results are discussed in light of world-system theory. Future research is planned to examine the effects of the improvements in communication technology and the strengthening of global communication ties on predicting the structure of international students flow. Finally, future research also should examine how the flow network of international students changes over time and consider additional predictors to investigate this network as a multilevel system.

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