



Moving towards multipolarity: shifts in the core-periphery structure of international student mobility and world rankings (2000–2019)

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Abstract

Over the past 20 years, international student mobility has experienced a three-fold increase, as planned and emerging education hubs have attracted increasing numbers of students. The appeal of alternative destinations is strengthened by their cultural, linguistic, and geographic proximity, as well as a growing number of internationally ranked universities. This article quantifies shifts in international student mobility and world university rankings over a consequential 20-year period (1999/2000–2018/2019) at the beginning of the twenty-first century. It examines shifts in the number of country-to-country connections (density), relative country importance in the network (centrality), and network structure (multipolarity). The results indicate the overall network density steadily increased year-to-year, with a three-fold increase in the number of country-to-country connections, as influence was more widely and evenly distributed among a larger number of core countries within the network. As the number of universities in planned and emerging destinations listed in the rankings doubled, the network structure indicated a movement toward multipolarity, where a more diverse set of countries exerted greater relative influence in the overall network. The results suggest that while core-periphery dynamics in international student mobility persist, they also have begun to shift, as a larger and more diverse subset of planned and emerging educational hubs in Asia, South America, Africa, and the Middle East exert increasing influence in the overall network.

Keywords Education hubs · International student mobility · Network analysis · Transnational higher education · World rankings

International student mobility (ISM) has experienced an almost three-fold increase, from 2.1 million students in 1999/2000 to 5.7 million students in 2018/2019, as the major world university rankings systems (e.g., Academic Rankings of World Universities, Times

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Higher Education, and Quacquarelli Symonds) show signs of an increasingly multipolar world (Hazelkorn 2012). The increase in the number of institutions in the world rankings is often the result of the emerging urban political economy of transnational education zones (Kleibert et al., 2020). Knight (2011) described planned efforts by governments “to build a critical mass of local and international actors strategically engaged in cross-border education, training, knowledge production and innovation initiatives” (p. 227). Evidence of the impact of these planned education hubs has begun to emerge as a growing number of regional higher education hubs attract increasing numbers of students with far more diverse socioeconomic profiles (Cantwell et al., 2018a, 2018b; Marginson, 2016).

Simultaneously, due to the increasing demand for higher education worldwide, more countries have become emerging destinations due to their higher education capacity, national infrastructure, or regional and cultural proximity to international students (Hou & Du, 2020; Kondakci et al. 2018; Macrander, 2017). Students who choose emerging or planned hubs often have different circumstances, goals, and characteristics than a typical long-term degree seeking international student (Kondakci 2011; Wilkins, 2010). Historical, political, and cultural proximity are major pull factors, but the students often have similar push factors from their home countries (Kondakci et al., 2018). Education hubs often provide more affordable opportunities for students to gain an international perspective. Increased international student enrollment can also aid in the development of the host country, including BRICS countries like Brazil, Russia, India, China, and South Africa, as well as other growing destinations like South Korea, Spain, and Morocco.

The core-periphery distinction in ISM has been prevalent for decades (Altbach, 2004; Waters, 2012). However, as the number of planned and emerging educational hubs has grown and diversified, it is critical to understand whether the size and composition of core countries has changed and whether the structure of ISM continues to follow the traditional East–West axis or whether it has become more multipolar. Evidence for a more multipolar structure of ISM requires a longitudinal network analysis that moves beyond raw inbound and outbound data or network analyses of a single year (Vögtle & Windzio, 2016; Yin & Yeakey, 2019). To quantify shifts in ISM during a 20-year period marked by rapid enrollment growth and new destinations requires a methodological approach that documents shifts in the relative country importance and changes in the core-periphery structure.

The purpose of this study was to use network analysis to quantify shifts in ISM over a 20-year period with shifts in university world rankings. We examined shifts in traditional, planned, and emerging educational hubs to identify evidence of a more multipolar network. We aim to make a number of significant contributions to research on international student mobility and university world rankings. First, we provide a comprehensive longitudinal analysis that quantifies significant long-term shifts in student mobility along with trends in university world rankings over a 20-year period. Our data supplement UNESCO data with mobility data from China, which accounts for the major role China has exerted both as a leading source of outbound students and an emerging hub for inbound students (Wen & Hu, 2019). Our longitudinal approach provides a descriptive account of traditional, planned, and emerging hubs over a period of major geopolitical shifts—from the post-9/11 era, to the global financial recession, to the rise of anti-immigrant populist leaders in traditional destinations. Second, we used network analysis, rather than raw inbound and outbound data, to examine shifts in influence in the overall network. Network analysis has a number of advantages over linear approaches that examine inbound and outbound mobility, since it draws attention to both the strength of connections but also which nodes (countries) another node is connected to (Vögtle & Windzio, 2016). It accounts for the importance of influential sending countries in the network, not just destination countries receiving large

numbers of students (De Meo et al., 2011). Finally, we examine long-term shifts in mobility in tandem with shifts in university world rankings, which have been both a structuring mechanism influencing the logic of student mobility but also an indicator of emerging hubs for international students (Hauptman, 2019; Hazelkorn, 2018, 2021).

A longitudinal network analysis of international student mobility is a critical contribution because the common metaphor “education hubs” can be misleading. The term “education hub” evokes an image of a central hub with spokes that connect to nearby countries in the region and the world. ISM functions more like a series of “networked educational hubs.” Networks of hubs exist, where the influence of a particular hub is affected by its connection to other influential hubs. In other words, hubs gain influence both within a given region and by their position within a network by virtue of their connections with other hubs (Kondakci et al., 2018). In addition, although geographical proximity is certainly part of the appeal of education hubs within a region, cultural, ethnic, and linguistic proximity also increasingly shapes student mobility patterns (Wen & Hu, 2019), as well as historical and colonial legacies (Perkins & Neumayer, 2014; Quijano, 2007; Sassen, 1996). Finally, a hub suggests spokes in a singular direction with central focus; whereas a networked hub suggests spokes that are bidirectional and multidirectional in their connections with one another, not just through the hub, but also with each other in a distributed social network structure. It is particularly important to examine shifts in the structure of ISM as the major world university rankings systems indicate increasing multipolarity in global higher education (Hazelkorn, 2012).

Traditional, planned, and emerging educational hubs

International student mobility has followed an East–West axis and supported a core-periphery distinction that has been prevalent for decades (Altbach, 2004; Kondakci et al. 2018; Waters, 2012; Wallerstein, 2004). The home countries and destinations of migratory flows are uneven and tend to produce economic advantages that benefit the world’s dominant economic and political powers (Cantwell et al., 2018a, 2018b; Waters, 2012). Traditional destinations exist in a condition of coloniality that has resulted in deep hierarchical inequalities found in historic patterns of international student mobility (Quijano, 2007; Sassen, 1996). The persistence of colonial ties and networks in international migration is also manifested in the contradictions of international students seen as “desired” due to their fee contributions and talent but also “unwanted” due to the politics of migration and the securitization of students (King & Raghuram, 2013; Yao, 2021). Indeed, traditional destinations, like the USA, are so tuition-dependent on international students that a mere 1% increase in international student enrollment increased the likelihood of a shift towards in-person reopening by 18% during the global COVID-19 pandemic (Whatley & Castiello-Gutiérrez, 2021). Nonetheless, the overemphasis on international student enrollment in traditional destinations in absolute terms tends to overshadow the growing importance of planned and emerging destinations in relative terms. Smaller networks exist—and are often hidden—within larger communities. Hence, analytic approaches that focus on relative shifts in migratory flows are necessary to magnify the growing influence of planned and emerging hubs in international student mobility.

A number of countries have made marked attempts to grow their capacity and establish themselves as a “hub” for higher education. Knight and Morshidi (2011) identified three reasons for the creation and growth of regional hubs: cross-border education, a new

emphasis on the importance of region in higher education, and the growing importance for tertiary education in the development of a knowledge economy (Batista, 2021; Choi, 2017; Jafar & Knight, 2020). Countries with planned education hubs share many things in common that have aided in their development as a hub for higher education: a smaller population, higher income, reliance on natural resources, and ability to invest a significant amount of capital in higher education development (Knight & Morshidi, 2011; Kondakci et al., 2018).

Although education hub is a self-proclaimed term (Knight & Morshidi, 2011; Kondakci et al., 2018), several countries have invested significant effort and capital to establish themselves as a destination for international students. The United Arab Emirates, Turkey, Hong Kong, South Korea, Qatar, and Bahrain have partnered with foreign institutions as well as built their own higher education capacity in what have been described as planned educational hubs (Kondakci et al., 2018). Governments in these countries invested significant capital to attract transnational education providers, who created education cities or international educational hubs as part of national economic development agendas. These efforts have also been described as transnational education zones due to their embeddedness in state-led projects designed to compete in the global knowledge economy (Kleibert et al., 2020). Education City in Qatar is among the most well-known, but other examples exist, including the Incheon Global Campus in South Korea, which is part of a new development of Songdo, a smart city outside of Seoul, as well as EduCity, which is part of a large-scale development project in the Iskandar Malaysia special economic zone (Knight, 2013). Recent studies found planned higher education hubs are more prominent in the network, but still play a lesser role compared to the traditional, English-speaking countries (Hou & Du, 2020). Kondakci et al. (2018) theorized that planned hubs particularly benefit from neighboring countries' instability. Additionally, because their academic structures are not as solidified, their internationalization progress is delicate and any change in political and economic situation could reverse ISM gains.

Regional destination student choice to emerging educational hubs appears to be driven more by economic, political, and language ties as opposed to geographic proximity (Hou & Du, 2020; Kondakci et al., 2018; Perkins & Neumayer, 2014). In other words, a student from Pakistan may choose to attend a higher education institution (HEI) in the UAE not necessarily because it is closer, but because of the cultural and economic ties between the two countries. Although the regionalization on its face may appear to lessen the core-periphery hegemony that is prevalent in global ISM, it instead appears that economic inequality manifests at a regional level. For example, Macrander's (2017) social network analysis of four world regions found that inequality was replicated by the wealthier countries in the regions even when policies were created to avoid inequality. In recent years, developing countries have begun to host more students, although they still send more students than they receive (Yeakey & Yin, 2019).

Network analysis of international student mobility

This study builds upon several important analyses of ISM that have used social network analysis (SNA) as a methodology. Most network analyses find small or moderate effects for language commonalities, communication links, higher education capacity, colonial linkages, region or geographical distance, etc. (Chen & Barnett, 2000; Barnett et al., 2015; Vögtle & Windzio, 2016; Yeakey and Yin 2019). Economic factors tend to exert the largest

effects, where wealthier, developed countries attract international students from lesser developed countries (Barnett & Wu, 1995; Hou & Du, 2020; Macrander, 2017; Perkins & Neumayer, 2014). Like other manifestations of globalization, the sources and destinations of these migratory flows are uneven, often resulting in the reproduction of class advantages and certain countries' competitive advantage for internationally mobile students (Glass et al., 2021; Marginson, 2018).

A number of ISM network studies have looked comprehensively at worldwide data by utilizing the UNESCO tertiary mobility dataset over varying periods of time (Barnett et al., 2015; Hou & Du, 2020; Kondakci et al. 2018; Macrander, 2017; Perkins & Neumayer, 2014; Shields, 2013; UNESCO, 2019). The results reflect the core, periphery, and semi-periphery characteristics of World Systems Theory (WST), which hypothesizes that the world economic landscape is structured primarily by wealthier, developed countries extracting labor, commodities, and goods from lesser developed countries (Wallerstein, 2004).

Barnett and Wu (1995) were among the first researchers to examine ISM by using social network analysis. They examined flows from the top 50 sending and receiving countries in 1970 and 1989, and found that US and Western countries were at the network's center, while Asia increased and Africa decreased in network centrality over time. They also found, through examining the gross national production (GNP), that economic rationales became increasingly more decisive, while factors tied to language and colonial similarities waned in importance. Chen and Barnett (2000) used SNA to analyze ISM in 64 countries in 1985, 1989, and 1995. The study found that the networks were indeed divided by core, semi-periphery, and periphery countries, with Asian students predominantly choosing Western and North American countries. They also found that a country's importance in the ISM network became more closely tied over time to its global economic position (Barnett & Wu, 1995).

Shields (2013) examined 206 countries from 1998 to 2008 and found that the ISM network had become centralized, although more countries sent and received students. The ISM networks ran parallel to world trade and politics, demonstrating that ISM can often be a microcosm of greater worldwide linkages (Shields, 2013). Perkins and Neumayer (2014) examined 151 countries from 2005 to 2009 and found that similar to WST, ISM from developing to developed countries accounted for 56% of total ISM, while developed to developing country mobility only accounted for 24.6%. Barnett and colleagues (2015) found four different clusters in their analysis of 210 countries in 2011, mostly differentiated by language and cultures. They found more countries share bilateral and dyadic relationships, but are not typically significant to the overall core. The present research study extends beyond previous ISM network studies by including new countries, variables, and years than previously investigated.

Recent network analysis suggests alternative patterns are emerging, potentially due to significant geopolitical shifts that occurred in this 20-year period of the current study (Barnett et al., 2015; Kondakci et al., 2018; Shields, 2013) where patterns of mobility have been influenced by the growth of regional mobility due to the rapid expansion of higher education in emerging economies worldwide (Cantwell et al., 2018a, 2018b; Kondakci et al., 2018). Scholars and international educators have observed that migratory flows show signs of multipolarity (Eisenman & Heginbotham, 2019). They expect shifts in mobility due to the growth of regional hubs in countries like Malaysia, South Korea, and Qatar (Kondakci et al., 2018), the rise of nationalism in traditional destinations like the UK and the USA (Altbach & de Wit, 2017), and the increasing unaffordability of traditional destinations compared with more proximate regional destinations

(Cantwell, 2015). However, it is important to move beyond observation to provide a comprehensive account that quantifies shifts in ISM.

The 20-year period of analysis in this study is particularly important due to the macro-level structural dynamics that occurred in the first two decades of the twenty-first century, which has seen massification of higher education worldwide (Cantwell et al., 2018a, 2018b). The rapid expansion of higher education worldwide has parallel political and economic shifts in global higher education, where real GDP growth, especially in countries across Asia (e.g., Bangladesh, China, India, Turkey, Vietnam) has translated into increased political influence over this period of time. This study focuses on five distinct time periods, which aids with quantifying shifts in traditional, planned, and emerging education hubs over a period marked by geopolitical shifts. 1999/2000–2002/2003 was an era immediately following the 9/11 attacks in the USA; 2003/2004–2006/2007 marked a period of expansion in student mobility; 2007/2008–2010/2011 marked the immediate aftermath of the global recession; 2011/2012–2014/2015 was a period of recovery from the global recession; and 2015/2016–2018/2019 marked a period that includes the rise of nationalism that coincided with increases in economic and political influence of China.

SNAs apply post-foundational approaches to the study of international student mobility that explores how social networks directly shape the geographies of international students (Beech, 2015). Castells (2004) conceptualized the network society as assemblages based on networks, which transcend boundaries, where power is exercised via networks through sets of exclusions and inclusions. Migration researchers demonstrate the ways in which large-scale migrations are embedded in complex, peer, kinship, and ethnic communities already in motion (Beech, 2014; Larsen, 2016). Mobility, in this perspective, is about social relationships, and social networks are “at once structures (and structuring agents) and constantly coming into being, with new connections changing the structures and dynamics of the network” (Beech, 2015, p. 334).

Network theories emphasize the connection between mobilities and networks that enable and constrain an individual’s possibilities for mobility. Network analysis is commonly used within research on student mobility to explain patterns and flows of international students (Kondakci et al., 2018; Macrander 2017; Yeakey & Yin, 2019). Highly ranked HEIs tend to control knowledge production flows, have the best infrastructure, employ the most highly qualified staff, and lead globally in research and development (Macrander, 2017; Wallerstein, 2004). Furthermore, as student demand for international credentials has increased, well-resourced universities have recruited and enrolled international students who often subsidize HEIs (Cantwell, 2015; Macrander 2017; Shen, 2016). Hence, international student mobility is “strongly shaped by the financial interests of those who organize, supply and market elite higher education opportunities within the global economy” (Findlay, 2011, p. 163).

Universities are connectivity spaces that add a territorial dimension to the network, which network theorists refer to as nodes (Larsen, 2016). Our approach bridges recent work in human geography (Findlay et al., 2015; Waters, 2012) with traditional analytic approaches to global labor migration (Mayda, 2010; Wallerstein, 2004). Network analysis allowed us to examine determinants of spatial variations in cross-border study (Perkins & Neumayer, 2014). As such, our findings on emerging patterns of ISM offer scholars new imaginaries, elaborate on the dynamics shaping new patterns of mobility, and emphasize perspectives from non-dominant destinations (Beech, 2014).

Methodology

We used social network analysis to quantify shifts in international student mobility over a 20-year period and examined shifts in [traditional, planned, and emerging educational hubs](#) to identify evidence of multipolarity alongside shifts in university world rankings. The network analysis was conducted on a dataset that included inbound and outbound mobility for 210 countries over a 20-year period from 2000 to 2019. Traditional analyses of inbound and outbound mobility can identify major trends; however, they lack the ability of network analysis to capture smaller networks hidden within larger communities. We developed a typology of traditional destinations, planned hubs, and emerging hubs based on previous research. We identified planned hubs (Bahrain, Hong Kong, Malaysia, South Korea, Turkey, United Arab Emirates, and Qatar) based on empirical literature that demonstrates substantive government planning and investment (Kleibert et al., 2020; Kondakci et al. 2018). We designated traditional destinations as countries with the largest number of inbound students over the 20-year period of the study (e.g., Australia, Canada, France, Germany, Italy, Japan, UK, and USA) that reflect a core-periphery distinction that has been prevalent for decades (Altbach, 2004; Kondakci, 2011; Kondakci et al. 2018). We then identified emerging hubs as destinations that had a marked increase in the number of inbound students over the time period of the study (e.g., Brazil, China, Ghana, India, Morocco, Portugal, Russia, Saudi Arabia, South Africa, Spain, and Ukraine) with efforts to include countries from all world regions (UNESCO, 2019).

Data sources

The primary data source used in this analysis was from UNESCO, and included inbound students from a specific country from 2000 to 2019 (UNESCO, 2019). The UNESCO data are not without limitations. UNESCO defines international students as “students who have crossed a national or territorial border for the purpose of education and are now enrolled outside their country of origin” (UNESCO, n.d.). Hence, students on exchange programs that study for one academic year or less are not included in our analysis, since students on short-term exchange programs are not technically enrolled in an institution outside their home country. Moreover, the data cannot account for students who study at branch campuses of US-based universities. Hence, inferences from our analysis can only be drawn regarding shifts in the network structure of long-term degree mobility.

Second, UNESCO data are collected country-by-country, and there are differences in how countries define what counts as an international student, and, hence, the number of inbound and outbound students reported. For example, although most countries define international students by citizenship, some countries define international students by country of residence. Nonetheless, the impact of these definitional differences is minimal and tends to be randomly distributed across the sample (Richters & Teichler, 2006). There were 101 countries that did not provide inbound country data to UNESCO, which mostly included smaller countries that do not traditionally receive large numbers of international students. Finally, a small number of countries are not included in our sample because UNESCO or the source country does not report bilateral international student flow data (e.g., Singapore, Lebanon, or Algeria).

In addition to UNESCO data, we obtained inbound international student data from the Ministry of Education (2020) in China. The dataset is available in Mandarin to those

residing in China; we obtained these data from a Chinese scholar who translated the country names in the dataset to English. The inclusion of these data marks a significant contribution to the scholarship and understanding of how ISM has evolved. Almost all published network studies do not include China (see Hou & Du, 2020 for an exception) although China has continued to play a significant role in the ISM landscape over the past 20 years (Wen & Hu, 2019).

The dataset contained a total of 371,189 country pairs (about 18,560 pairs per year) over a 20-year period (2000–2019). Researchers tabulated data with country of origin (based on ordinary residence), destination (based on university country), and year. The dataset can be conceptualized in the form of a series of directed links (the number of students moving from country A to country B) to attend a university in a given year. We removed country pairs with a weight of 0 (no exchange of students in a given year). The final dataset contained 214 nodes (countries and territories) and over 134,402 edges (links) that were used to construct the network that represented a 20-year timespan.

Additionally, we used rankings data from Times Higher Education (THE) and Quacquarelli Symonds (QS) based in the UK and the Academic Ranking of World Universities (ARWU), also known as the Shanghai Rankings, based in China. These data allowed us to investigate the extent to which shifts in centrality measures paralleled shifts in [world university rankings](#). ARWU focuses only on research and academic factors, while QS and THE include international characteristics like the staff and student numbers (Hauptman Komotar, 2019). Academic reputation is also a large proportion of the calculations for QS (50%) and THE (33%), but ARWU does not consider reputation. Instead, ARWU weighs citations (60%) and researchers that publish in influential journals much more heavily than QS (20%) or THE (30%) (QS, 2019; Shanghai Ranking Consultancy, 2019; THE, 2019). Although THE, QS, and ARWU use different factors to compute rankings, the top-ranked institutions typically fall in similar spots (Hazelkorn, 2014), so the use of all three ranking systems allowed the most common ranking factors to be considered in our analysis.

Data analysis

Social network analysis was employed for the analysis to determine the density and centrality of the network and its clusters (Borgatti et al., 2002), and was visualized using Gephi 0.9.1 software (Bastian et al., 2009). Based on the theoretical typology presented above, our analysis focused on changes in the density, centrality, and network structure over time. We used graph density measures of a directed network to measure how close the network was to being complete. We used betweenness centrality measures to measure the influence and frequency of a node (country) in the network and eigenvector centrality to measure the extent to which a node (country) is connected to other influential nodes in the network. We used the Yifan Hu algorithm to generate visualizations of the network structure (Hu, 2011). The algorithm combines a force-directed model that is conducive to the visualization of large networks. We provide additional details of our analyses in the next section to place the results in the context of their meaning within network analysis.

We opted to aggregate data over a series of five 4-year periods (1999/2000–2002/2003, 2003/2004–2006/2007, etc.) to minimize the effect of a particular year, as well as to aid in the interpretability of the results to focus on large-scale shifts, rather than noise that might arise from year-to-year variability. These time periods also allow observations related to mobility with the geopolitics of the era. For example, 1999/2000–2002/2003 was an era immediately following the 9/11 attacks in the USA, 2003/2004–2006/2007 marked a

period of expansion in student mobility, 2008–2011 marked the immediate aftermath of the global recession, 2011/2012–2014/2015 was a period of recovery from the global recession, and 2015/2016–2018/2019 marked a period that includes the rise of nationalism in a number of traditional destinations. Except for geographic data, all variables used in the analysis were time-varying, including student flows, so that changes in student flows could be analyzed in relation to dynamic, changing global networks. The nature of the network is directed (countries sending and receiving students) and weighted in terms of the number of sending and receiving students.

We used descriptive statistics to analyze the number of institutions ranked in global rankings organizations, which included ARWU, QS, and THE. In 2019, each organization ranked close to 1000 HEIs, which has steadily increased since global rankings began in 2003. We operationalized ranking as the proportion of HEIs from each country from 2003 to 2019. For example, if a country had 30 ranked institutions and 500 total institutions were ranked that year, the ranking indicator was calculated to be 6%, whereas if a country had 30 ranked institutions out of 1,000 total ranked institutions that year, it was calculated to be 3%. We then took the mean of the weighted ranking percentage for each of the five time periods for the 26 countries grouped as traditional, emerging, or planned. Finally, we averaged the weighted percentage for all three global rankings systems.

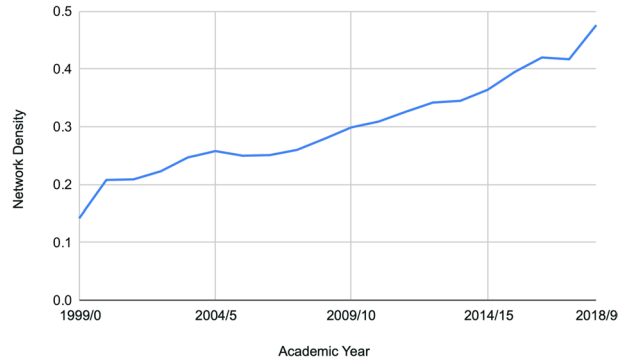
Results

In this section, we describe changes to the network structure (the total set of relationships between actors) by examining trends in three common network indicators: density (proportion of realized ties in a network relative to the total number of possible ties) and centralization (the extent to which key actors occupy central positions within the network), as well as a visualization of the network structure. The network is force-directed and weighted in terms of the number of inbound and outbound long-term degree seeking students. The results of the network analysis are reported using ISO ALPHA-3 country codes. We also report the percentage of ranked institutions for each country in traditional, emerging, and planned hubs.

Density

Network density describes how close a network is to complete, ranging from 0 to 1. Greater density indicates that the total number of actual countries that are exchanging long-term degree seeking students is closer to the total number of all such possible exchanges between countries. A complete network has a density equal to 1 with all possible edges, i.e., all nodes (countries) are linked to all the other nodes (countries) in the network. Our analysis indicates that the density of the ISM network tripled from the 1999/2000 academic year (0.142) to the 2018/2019 academic year (0.476) (see Fig. 1). In other words, while only 14.2% of all possible country-to-country links existed in 1999/2000, by 2018/2019, the number of actual country-to-country links was almost one-half, 47.6%, of all possible country-to-country links. The results indicate the network is over three times as dense, as the number of country-to-country connections has increased three-fold over a 20-year time period.

Fig. 1 Network density from the 1990/2000 to the 2018/2019 academic year



Centralization

To measure change in influential nodes in the network, we used betweenness centrality and eigenvector centrality measures from 1999/2000 to 2018/2019 for countries in three types of destinations. This included traditional destinations, planned hubs, and emerging hubs based on a typology of higher education hubs outlined in the previous sections. Betweenness centrality measures indicate the degree to which nodes are “bridges” between nodes in the network, where the sum of the weights of the edges is minimized. Higher betweenness centrality values indicate a node (country) exerts more capacity, influence, and frequency in the network. If, for example, a particular country receives more inbound students from countries in the network that do not receive inbound students from each other to the same degree, then the measures of centrality in a directed weighted network are greater and indicate the greater influence of the node (country) in the entire network. Eigenvector centrality measures indicate relativized influence (0.00–1.00) of a node (country) over the whole network based on the weight and direction (number of inbound students) of edges in the network. Thus, eigenvector centrality goes a step further than betweenness centrality by also factoring the extent to which a node (country) is connected to other influential nodes in the network. Scores closer to 1 indicate greater relative influence over the whole network, not just nodes directly connected to it.

Results showed a precipitous drop in betweenness centrality measures of traditional destinations, which indicated that the overall influence of these destinations in the flow of the network has decreased over the 20-year period. Planned hubs indicated mixed realities. On the one hand, the influence of these hubs has increased as indicated by increases in the eigenvector centrality measures, which demonstrate these countries are growing in the number of total connections to other nodes and the strength of those connections. However, like traditional destinations, some planned education hubs are less influential relative to the overall network. This includes Hong Kong, which is indicated in relatively flat betweenness centrality measures. Others have gained influence in the network, like the United Arab Emirates and Qatar. Finally, the results indicated that emerging regional hubs are increasing in the amount and strength of their connections. Brazil, Portugal, Morocco, South Korea, China, Russia, the Ukraine, South Korea, India, and South Africa experienced large increases in eigenvector centrality measures, so they are now among the countries that have the most connections with other nodes and increases in the strength of those connections. Like traditional destinations, these countries have seen their relative influence in the overall network increase with increases in the number of total connections with other countries

and the number of inbound students from those countries. The precipitous drop in centrality measures of traditional destinations and the corresponding increase in centrality measures for other destinations indicate multipolarity. The results indicate that influence is more widely and evenly distributed within the core of the network, as the number of countries in the core has increased.

Network structure

We used the Yifan Hu algorithm to generate visualizations of these interconnections at five 4-year time periods to structure our analysis and mitigate any fluctuations in a particular year. The visualization in Fig. 2 illustrates relative node size based on betweenness centrality measures, highlighting increasing multipolarity in the growing number of countries at the core of the network. We removed nodes with a very low number of connections to enhance the readability of the visualizations. The figure illustrates how relatively few traditional destinations (e.g., USA, UK, Canada, France, and Japan) and sending countries (e.g., China and India) exerted outsized influence in the network in 1999/2000–2002/2003, whereas by 2015/2016–2018/2019, the influence of traditional destinations waned as a growing number of emerging hubs (e.g., Brazil, Portugal, Russia, Saudi Arabia, South Africa, and Ukraine) and planned hubs (e.g., Turkey and South Korea) gained influence over time. The more similar node size over time illustrates how more countries began to exchange more students at more equal rates. Overall, a more diverse set of countries exert greater influence in a more multipolar network. Nonetheless, it is important to note that a significant proportion of the total number of connections remain clustered in a subset of interconnected nodes.

World university rankings

Table 1 includes the average centrality measures, as well as the average percentage of institutions in the world rankings, for each time period. The increase in eigenvector centrality measures documents increased connections with other important actors in the network, and the increase (or decrease) in betweenness centrality measures documents changing influence in the overall network. Table 2 aggregates these data by traditional, planned, and emerging hub grouping to illustrate the change over time in each type of destination.

The tables illustrate a number of notable patterns: first, a significant decline in the importance of traditional destinations in the network and the corresponding increase in influence of planned and emerging hubs, as illustrated by the change in betweenness centrality measures over time; second, whereas traditional destinations comprised about 2 in 3 institutions in the world rankings in 1999/2000–2002/2003, it declined to about 1 in 2 institutions by 2015/2016–2018/2019. Emerging hubs and planned hubs doubled their presence in the league tables, making up about 1 in 4 institutions, largely led by the growing influence of China as both a destination and among institutions listed in the league tables.

Discussion

This study makes a series of contributions towards an improved understanding of the emerging multipolar geography of international student mobility. The results indicate that as ISM has experienced a three-fold increase, the number of country-to-country

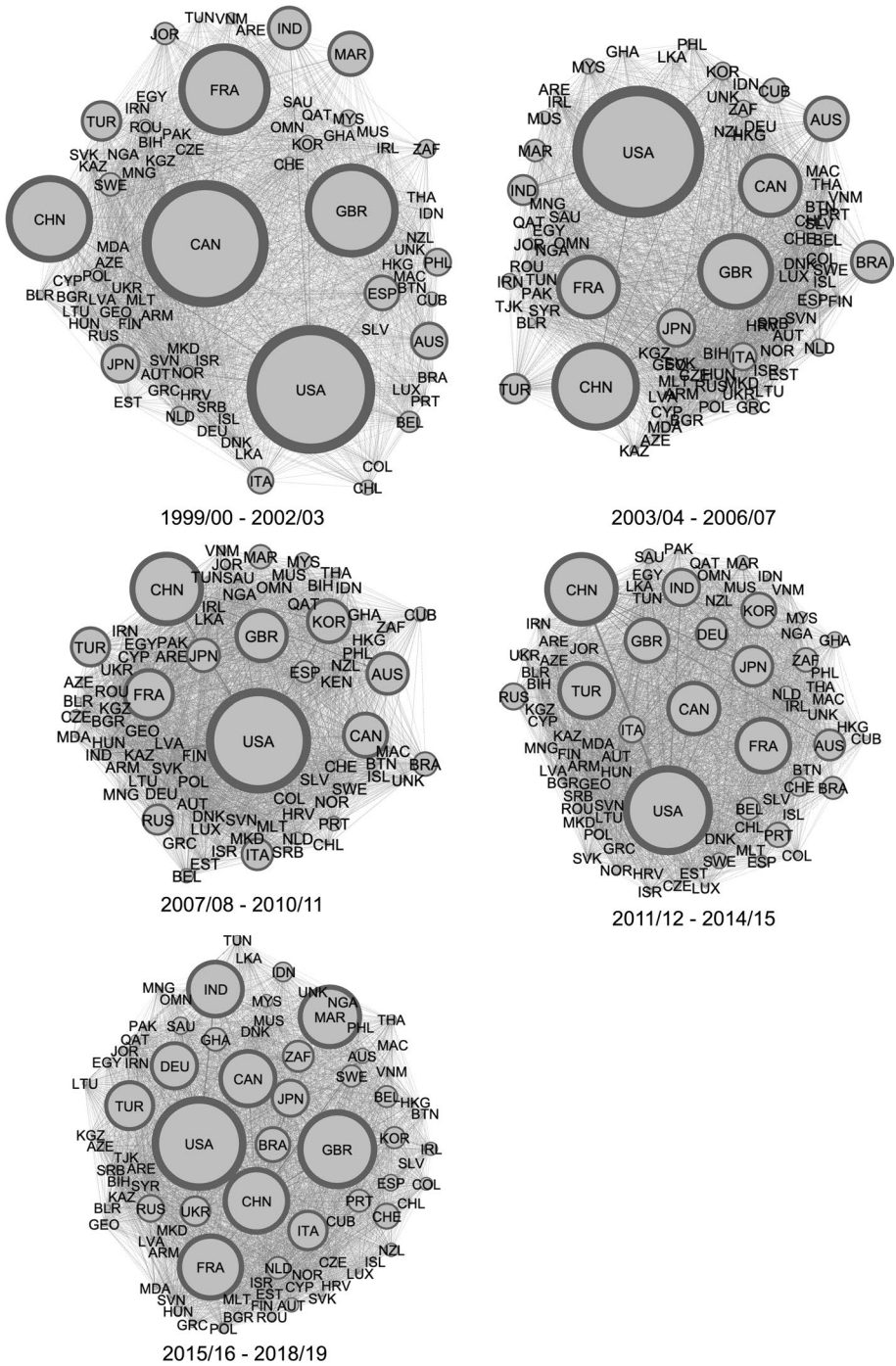


Fig. 2 Yifan Hu network visualization

Table 1 Betweenness centrality, eigenvector centrality, and percent of institutions in world rankings from 1999/2000 to 2018/2019 in 4-year increments

Traditional destinations	USA			GBR			AUS			CAN		
	Bvtn	Eigen	% WR	Bvtn	Eigen	% WR	Bvtn	Eigen	% WR	Bvtn	Eigen	% WR
1999/2000–2002/2003	1619.305	0.996	33.23%	1010.199	0.987	8.33%	292.354	0.760	2.60%	1326.940	0.991	4.21%
2003/2004–2006/2007	1771.882	1.000	30.74%	1022.065	0.998	11.42%	564.673	0.993	5.40%	829.585	0.986	4.68%
2007/2008–2010/2011	1487.630	1.000	29.37%	762.214	0.999	11.17%	615.309	0.992	3.88%	653.310	0.989	4.72%
2011/2012–2014/2015	1132.996	1.000	25.96%	590.659	0.996	10.05%	397.421	0.972	4.66%	675.545	0.987	4.37%
2015/2016–2018/2019	899.451	1.000	19.41%	741.438	0.997	8.12%	140.706	0.971	3.83%	546.622	0.982	3.16%
Change over time	-719.855	0.004	-13.82%	-268.762	0.000	-0.21%	-151.648	0.211	1.23%	-780.318	-0.009	-1.05%
Percent change over time	-44.5%	0.4%	-41.59%	-26.6%	0.0%	-2.52%	-51.9%	27.8%	47.31%	-58.8%	-0.9%	-24.94%
1999/2000–2002/2003	425.883	0.969	5.69%	386.699	0.711	7.12%	339.240	0.967	2.77%	1125.384	0.984	4.15%
2003/2004–2006/2007	485.141	0.960	5.99%	684.315	0.836	7.09%	347.779	0.973	3.78%	815.651	0.972	4.05%
2007/2008–2010/2011	490.028	0.942	4.98%	701.132	0.844	7.22%	461.718	0.962	2.67%	726.845	0.970	3.51%
2011/2012–2014/2015	519.288	0.951	3.76%	488.040	0.847	7.34%	337.871	0.987	3.53%	707.459	0.970	3.76%
2015/2016–2018/2019	357.321	0.948	4.94%	638.430	0.860	5.52%	380.844	0.992	3.63%	629.286	0.967	3.67%
Change over time	-68.562	-0.022	-0.75%	251.731	0.149	-1.60%	41.603	0.024	0.86%	-496.098	0.017	-0.48%
Percent change over time	-16.1%	-2.2%	-13.18%	65.1%	21.0%	-22.47%	12.3%	2.5%	31.05%	-1.7%	-11.57%	
Planned regional hubs	TUR	MYS	ARE	QAT	BHR	HKG	KOR					
1999/2000–2002/2003	435.581	0.748	0.20%	189.324	0.651	0.83%	0.000	0.000	0.00%	6.461	0.111	0.00%
2003/2004–2006/2007	387.201	0.791	0.07%	191.176	0.619	0.63%	0.000	0.000	0.00%	4.638	0.081	0.00%
										0.040	0.00%	9.972
										0.183	1.50%	1.65%
										0.288	1.62%	1.57%

Table 1 (continued)

	Bwin	Eign	% WR	Bwin	Eign	% WR	Bwin	Eign	% WR	c	Eign	% WR	Bwin	Eign	% WR	Bwin	Eign	% WR
2007/2008–2010/2011	568.877	0.805	0.30%	236.732	0.855	0.29%	15.916	0.182	0.00%	14.794	0.487	0.00%	1.139	0.000	0.00%	3.202	0.433	1.21%
2011/2012–2014/2015	718.506	0.882	0.63%	138.010	0.708	0.50%	99.850	0.914	0.20%	55.032	0.697	0.00%	25.352	0.170	0.00%	9.976	0.687	0.75%
2015/2016–2018/2019	793.846	0.892	1.24%	224.895	0.714	0.75%	74.803	0.828	0.40%	62.997	0.887	0.10%	10.280	0.534	0.14%	18.653	0.799	0.65%
Change over time	358.265	0.144	1.04%	35.571	0.063	-0.08%	74.803	0.828	0.40%	56.536	0.776	0.10%	7.956	0.494	0.14%	8.681	0.616	-0.85%
Percent change over time	82.2%	19.2%	520.00%	18.8%	9.7%	-	-	-	-	875.0%	696.9%	-	342.4%	123.1%	-	87.1%	336.7%	-
Emerging regional hubs																		
	BRA			RUS			IND			CHN			ZAF					
1999/2000–2002/2003	94.379	0.170	0.48%	22.929	0.055	0.40%	157.070	0.165	0.86%	848.643	0.526	2.27%	216.866	0.009	0.75%			
2003/2004–2006/2007	215.022	0.187	0.61%	26.639	0.092	0.57%	409.151	0.588	0.69%	1168.906	0.553	2.60%	219.133	0.008	0.37%			
2007/2008–2010/2011	345.577	0.516	0.76%	440.534	0.577	0.57%	490.424	0.827	0.62%	1046.024	0.575	3.41%	108.393	0.183	0.55%			
2011/2012–2014/2015	288.891	0.674	0.91%	334.956	0.572	0.53%	539.020	0.566	0.82%	1211.796	0.881	4.13%	316.949	0.874	0.69%			
2015/2016–2018/2019	347.101	0.775	2.02%	260.442	0.802	1.23%	554.456	0.956	1.98%	1332.976	0.592	7.15%	305.351	0.750	0.88%			
Change over time	252.723	0.605	1.54%	237.513	0.746	0.83%	397.386	0.791	1.12%	484.334	0.066	4.88%	88.485	0.742	0.13%			
Percent change over time	267.8%	355.0%	320.83%	1035.9%	1348.9%	207.50%	253.0%	480.4%	130.23%	57.1%	12.4%	214.98%	40.8%	8715.5%	17.33%			
	PRT			UKR			MAR			ESP			GHA			SAU		
1999/2000–2002/2003	105.846	0.497	0.15%	0.000	0.000	0.00%	536.414	0.072	0.00%	450.554	0.966	2.00%	0.000	0.000	0.00%	71.443	0.260	0.00%
2003/2004–2006/2007	130.294	0.826	0.10%	22.418	0.069	0.00%	285.275	0.384	0.00%	229.843	0.931	1.15%	0.000	0.000	0.00%	141.892	0.718	0.00%
2007/2008–2010/2011	203.574	0.863	0.20%	15.398	0.110	0.00%	344.516	0.401	0.00%	313.507	0.953	1.43%	0.000	0.000	0.00%	87.244	0.695	0.17%
2011/2012–2014/2015	316.169	0.946	0.62%	145.041	0.412	0.00%	177.623	0.394	0.03%	156.974	0.575	2.35%	204.827	0.329	0.00%	177.229	0.785	0.56%
2015/2016–2018/2019	215.249	0.831	0.79%	288.200	0.991	0.40%	593.289	0.860	0.13%	154.606	0.558	2.90%	227.072	0.521	0.05%	162.328	0.933	0.67%

Table 1 (continued)

	Bwm	Eign	% WR	Bwm	Eign	% WR	Bwm	Eign	% WR	Bwm	Eign	% WR	Bwm	Eign	% WR			
Change over time	109.403	0.334	0.64%	288.200	0.991	0.40%	56.875	0.788	0.13%	-295.948	-0.408	0.90%	227.072	0.521	0.05%	90.885	0.673	0.67%
Percent change over time	103.4%	67.2%	426.67%	-%	-%	-%	10.6%	1090.2%	-%	-65.7%	-42.2%	45.00%	-%	17.0%	0.01%	127.2%	259.0%	-%

Note: *Bwm*, median betweenness centrality for the time period; *Eign*, eigenvector centrality for time period; % *WU*, average percentage of institutions included in the Academic Ranking of World Universities (ARWU), Times Higher Education (THE), and QS World University Rankings (QS) out of the total number of institutions listed for that year in each respective ranking system

USA, United States; *GBR*, United Kingdom; *AUS*, Australia; *CAN*, Canada; *FRA*, France; *DEU*, Germany; *ITA*, Italy
TUR, Turkey; *MYS*, Malaysia; *ARE*, United Arab Emirates; *QAT*, Qatar; *BHR*, Bahrain; *HKG*, Hong Kong
BRA, Brazil; *RUS*, Russian Federation; *IND*, India; *CHN*, China; *ZAF*, South Africa; *KOR*, South Korea; *PRT*, Portugal; *UKR*, Ukraine; *MAR*, Morocco; *ESP*, Spain; *GHA*, Ghana; *SAU*, Saudi Arabia

Table 2 Total betweenness centrality and total percent of ARWU ranked institutions by traditional, planned, and emerging hubs

Time period	Size of network Total mobile students worldwide	Traditional destinations		Planned hubs		Emerging hubs	
		Total betweenness centrality	Total % WR	Total betweenness centrality	Total % WR	Total betweenness centrality	Total % WR
1999/2000–2002/2003	2.1 M–2.6 M	6526.004	68.1%	643.663	4.2%	2504.143	6.9%
2003/2004–2006/2007	2.7 M–3.1 M	6521.091	72.2%	599.803	3.9%	2848.572	6.1%
2007/2008–2010/2011	3.3 M–4.0 M	5898.188	67.5%	840.660	3.8%	3395.190	7.7%
2011/2012–2014/2015	4.1 M–4.8 M	4849.279	63.4%	1046.727	4.3%	3869.475	10.6%
2015/2016–2018/2019	5.1 M–5.7 M	4334.096	52.3%	1185.475	6.3%	4441.070	18.2%
Change over time		–2191.908	–15.8%	541.812	2.1%	1936.927	11.3%
Percent change over time		–33.6%	–23.2%	84.2%	50.2%	77.35%	163.4%

connections has also increased, making the network over three times as dense in 2018/2019 than in 1999/2020. They also indicate influence is more widely and evenly distributed among the core countries within the network, as the raw number of countries that make up the core has increased, along with a more even distribution of relative influence of core countries in the overall network. Finally, as the number of universities in planned and emerging destinations listed in the ARWU, THE, and QS rankings has almost doubled, the network structure indicates a movement toward multipolarity, where a more diverse set of countries now exert greater relative influence in the overall network. A multipolar future for ISM has significant implications for research and theory.

The results indicate a significant shift underway in patterns of ISM, which has been prevalent for decades, dominated by traditional destinations like the USA, Canada, the UK, and France. Although these countries remain top destinations for international students, their relative influence significantly waned with the rise of planned and emerging hubs over the 20-year period of the study. While the influence of traditional destinations in the overall network remains significant, it dwindled to roughly one-half of what it once was 20 years earlier. All the while, planned educational hubs, particularly Turkey and South Korea, began to exert comparable influence in the network. And, although slightly less influential, Malaysia, India, Brazil, Portugal, South Africa, Russia, and the Ukraine began to exert substantially more influence. Gulf States that invested in transnational exchange zones (e.g., Qatar, Bahrain, and the United Arab Emirates), as well as emerging hubs (e.g., Saudi Arabia), began to exert more influence in the network, although they remained less influential than the aforementioned countries. China's growing influence resulted from its role as a sending country to traditional destinations, as well as its growing importance as an emerging destination for international students.

The big picture view indicates seismic changes in ISM. At the turn of the century, a half-dozen or so traditional destinations dominated ISM. Only 20 years later, about two dozen countries exerted substantial influence in a multipolar exchange network. This represents a 300% increase in the number of influential ISM countries. Indeed, the results suggest the beginning of a shift from an East–West axis, which has been prevalent for decades (Altbach, 2004; Waters, 2012), to a more multipolar network, where more countries are sending inbound and outbound students at more equal rates to more destinations (Hazelkorn, 2021). To be clear, the East–West axis remains and there is no reason to believe international student enrollment will not continue to increase in traditional destinations. However, the increase in inbound mobility to planned and emerging hubs has increased at a faster rate than traditional destinations, with exchanges among a larger and more diverse set of countries, resulting in the increase in relative influence of more countries and a more multipolar network structure. The increasing influence of this larger subset of core countries has coincided with the rise of transnational exchange zones (Kleibert et al., 2020), as well as the growing demand for higher education (Cantwell et al., 2018a, b) which has resulted in greater intra- and cross-regional exchange based on cultural, linguistic, and geographic proximity (Hou & Du, 2020; Kondakci et al. 2018; Macrandar, 2017). Although previous network studies have documented evidence of multipolarity at a single moment in time (Kondakci et al., 2018; Wen & Hu, 2019), the current study quantifies shifts in ISM and the movement towards multipolarity over a consequential 20-year period marked at the beginning of the twenty-first century.

The results also indicate that, while university world rankings still matter, a shift may be occurring in terms of how they matter and for whom. Most strikingly, traditional destinations accounted for almost two-thirds of universities in the league tables in 1999/2000–2002/2003 but just about one-half in 2015/2016–2018/2019, whereas emerging

hubs accounted for less than 10% of universities listed in 1999/2000–2002/2003, but accounted for almost 20% of universities in the tables in 2015/2016–2018/2019, largely due to the increase in the number of Chinese universities listed in the tables (Hazelkorn, 2018). Equally dramatic, however, is that increased influence in the network is not always associated with an increase in ranked institutions. For example, Ukraine has emerged as a destination for students from former-Soviet republics, e.g., Azerbaijan and Turkmenistan, but it only has a few universities in two of the three major global rankings tables. Likewise, Turkey, Russia, Brazil, and South Africa also emerged as new destinations but comprise a fraction of institutions listed in the tables. Broadly speaking, this may indicate that emerging patterns of mobility in some cultural corridors and geographic regions are also being shaped by overall improvements in educational quality as well as affordability (Perkins & Neumayer, 2014; Waters, 2012). There is no question that rankings continue to structure mobility to traditional destinations (Hazelkorn, 2018, 2021). However, as more countries send and receive students at more equal rates to more geographically and culturally proximate destinations, it is possible that rankings may not matter as much to new generations of price sensitive, middle-class students seeking tertiary-level education (Glass et al., 2021; Macrander, 2017; Marginson, 2016, 2018).

Finally, the results suggest implications for the long-standing core-periphery patterns of ISM, where migratory flows reflect movement from the peripheral countries to core countries as hypothesized in the World Systems Theory (Wallerstein, 2004). To be clear, a small handful of traditional, wealthy destinations continue to dominate the network, such that there is no reason to believe core-periphery patterns of ISM will not remain in some form (Altbach, 2004; Kondakci, 2011; Kondakci et al. 2018). The results exhibit core-periphery structures in directed networks, which exhibit the pattern of a well-connected core with a periphery connected to the core, but sparsely connected to other nodes in the periphery (Elliott et al., 2020). The core-periphery structure persists due to a number of inter-related factors: first, the production of scientific papers is concentrated in countries with the material resources to support a large number of research universities where rankings, which heavily weight the production of scientific papers, act as a reinforcement mechanism (Hazelkorn, 2018, 2021). Second, geopolitical asymmetries are structural in nature and produce reinforcement mechanisms highly resistant to change, such that inequalities tend to persist over time (Cantwell et al., 2018a, b; Wallerstein, 2004; Waters, 2012). Finally, despite the three-fold growth in ISM and incremental shifts in the network structure, international student mobility continues to take place in the context of long-standing asymmetries of power that privileges the production of knowledge in countries in the center and the diffusion of that knowledge of countries in the periphery (Medina, 2013).

Nonetheless, the results also suggest two shifts in the core-periphery structures in the first two decades of the twenty-first century: First, whereas the core countries in the network used to be solely in North America and Europe, the network structure indicates that the core now also includes countries in Africa (e.g., South Africa), South America (e.g., Brazil), the Middle East (e.g., Turkey), and Asia (e.g., China, India, and South Korea). Second, although a small number of wealthy countries have gained disproportionate economic advantage in the past, there is evidence that the growing influence of planned and emerging education in relative terms is providing a counterbalance to this long-standing power of traditional destinations. Greater intra-ASEAN student mobility, as well as regionalization in South America and the Arab States, suggests that the increasing influence of these emerging destinations are likely to persist (Batista 2021; Choi, 2017; Jafar & Knight, 2020). Hence, economic inequality manifests at a regional level (Macrander, 2017).

The results suggest directions for further research. As the share of the world population living in cities is expected to grow to 68% by 2050 (World Bank, 2018), disparities have arisen between rural and urban populations within countries, not merely the well-documented disparities between countries. City-to-city networks operate with their own logics of exchange beyond those of nation-states (Kleibert, et al., 2020). Top-ranked global research universities are often embedded within global cities that attract highly skilled work for the growing middle class (Marginson, 2018). Hence, urbanization, with the rapid growth of the urban middle class in countries with growing economies, suggests further analysis that examining city-to-city networks would produce valuable insights of the restructuring of ISM. We would be remiss to not note the need for research that examines the impact of COVID-19 on international education and exchange given the precipitous drop in inbound mobility to traditional destinations, as the post-COVID world represents a new geopolitical era that should be examined in further analysis as data become available (Choudaha, 2021).

Declarations

Conflict of interest The authors declare no competing interests.

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