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Migration and Remittances: A network analysis

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ABSTRACT

Applying the network analysis' tools and a large dataset over 2000-2017, this paper provides insights to the patterns and structure of global and regional migration and remittances as well as the connection between these two phenomena inside a complex network. We reveal that even though the structure of migration and remittance networks is slightly altering, the major changes have only occurred in the intensive margin of the networks. In addition, there is a deepening intra-regional trend regarding the structure of migration communities. By contrast, we observe an instability in the structure of migration and remittance communities formed around the U.S.

KEYWORDS

Migration; Remittances; Network analysis; Intra-regional connection

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1. Introduction

Since the last two decades, international migration has become a concerned global phenomenon. According to the United Nations Population Division, between 2000 and 2017, the estimated number of international migrants increased by almost 50%, reaching 258 million in 2017.1 Among others, Asia, and Europe host 6 of every 10 international migrants, corresponding to 31% and 30%, respectively, or persons who reside outside their country of birth. Today than ever before, international migration is becoming much more diverse in terms of origins and destinations of migrants.

Together with this phenomenal trend, research interest on migration flows has also been growing. The focus of most studies is on the determinants of migration as well as its socio-economic impacts on the economy of sending and receiving countries. The motivations for migration may be described as a combination of "push" and "pull" factors. On the one hand, migrants can be pushed out of their home countries due to deteriorating socio-economic, demographic, and political conditions. On the other hand, migrants are pulled into destination countries where they can benefit from low unemployment rate and high wages, good educational system and health care. The migration decision is based on a comparison between the net benefits and costs. In terms of economic benefits, migration can be seen as an insurance factor of households and the prospects of high remittances from abroad may become the key determinant of household decision to migrate. Therefore, a considerable amount of research has been conducted on the topic of migration – remittances – development nexus.

Focusing on Asia and Pacific region, De et al. (2018) argue that remittances resulting sent back to home countries by migrants are a significant source of foreign exchange earnings for many low and middle-income countries. Remittances are relatively stable compared with other sources of capital inflows, foreign direct investment, and become countercyclical, therefore support macroeconomic stability in the remittance-receiving countries. In other words, migration brings positive impacts on economic development of home countries in several ways. First, through remittances, migration contributes to reducing poverty in home countries. Second, due to emigration, the pressure from high unemployment in the home country could be released and thence the domestic wages can be increased. Third, the returning migrants could be also a key factor of economic development in their home countries as they invest into new economic activities, transfer know-hows and technology, create new business networks and so on. In another work, Page and Plaza (2006) also provide a global survey of the analytical and empirical literature on the linkage between migration and remittances. The authors, in particular, address the question of how migrants contribute to the development of their countries of origin. The authors evidence a positive impact of transfers of capital, knowledge, and skills by returning migrants on their home countries' economy.

Despite a growing number of empirical works, the migration – remittances nexus is still a continuing debate due to the great variation in the migration patterns across the region and the extremely complex combination of socio-economic motivations to migrate. In this paper, we attempt to revisit the dynamics of migration and remittance flows as well as the interdependence between these two phenomena in the framework of a network analysis. Instead of focusing on the determinants of migration and remittance flows, we address three important questions: (i) How geographically centralized or dispersed are migration and remittance flows? (ii) Is there a structural change inside the migration and remittance networks? And (iii) is there an interdependence between migration and remittance flows?

In the concerned economic literature, the tools of network analysis have still been under-developed in the research on migration and remittances. For instance, network analysis is adopted in Tranos et al. (2015) to study the structure of migration flows but only in the case of OECD countries. Besides, other existing research interest in

[1] International Migration Report (2017). International Migration Report 2017 Highlights. United Nations.

spatial interaction in migration flows by applying the gravity model.[2] However, the gravity approach only identifies the determinants of migration flows but does not focus on either the patterns or the structure of bilateral migration flows. The gravity model's adoption does not either allow exploring the intrinsic evolution inside migration and remittance flows. Thus, our empirical work contributes to the literature in three ways. First, instead of considering a specific country or economic zone as developed in Tranos et al. (2012), the present paper aims to draw a clear picture on the migration network's evolution at the global level. Second, while international migration has been recently investigated in a global complex network (Tranos et al., 2015), the adoption of network analysis in remittance studies has been still scarce. To fill this knowledge gap, this paper employs network analysis' tools to explore deeply the remittance flows' trend and structure. Third, we examine the possible spatial connection between migration mobility and remittances.

The remainder of this paper is organized as follows. Section 2 provides a brief literature review on the migration-remittances nexus. Section 3 documents the nature of data and the measurement used in the network analysis. The empirical results are analyzed in Section 4. Concluding remarks are in Section 5.

2. Literature review

The literature on migration is abundant and provides theoretical guidance to understand the nature and the impacts of migration. Several researchers (e.g., Massey et al., 1993; Hammar et al., 1997; Faist and Faist, 2000; Bijak, 2006; Hagen-Zanker, 2008; de Haas, 2010) tend to classify migration theories by taking into consideration a set of important factors, notably the origin of each theory, theory disciplines, and migration patterns. With respect to our research objectives, we only provide a short review on the neoclassical theory and the New Economics of Labor Migration (NELM).

The neoclassical theory is considered as the oldest and best-known theory of migration, which examines the effects of migration on economic development. The most well-known model is the Lewis model (Lewis, 1954) that analyzes economic development in the context of a "labor-surplus economy". According to Lewis (1954), a developing country experiences a dual economy characterized by a small, urban, and industrialized sector surrounded by a large, rural and traditional sector. Labor in the industrial sector has a positive marginal productivity, while labor in the agricultural sector is surplus with zero marginal productivity. Due to an income gap between these two sectors, the traditional sector's labor has incentives to move to the urban industrial sector. The Lewis model assumes that because of sufficiently high rural population, rural labor moving to the urban sector is unlimited at a subsistence wage level in each period without reducing the agricultural output. Consequently, a low level of urban wages can be maintained, that in turn promotes capital accumulation over time and later leads towards economic transformation. In general, the dual economy theory initialed by Lewis (1954) explains economic transformation through saving growth and labor transfer channels. Todaro (1969, 1970) and then Harris and Todaro (1970), still relying on technological dualism, develop theoretical models to study migrations from the countryside to the city due to the wage gap between these two sectors. The Todaro migration model (Todaro, 1969 and 1970), explains the rural-urban migration as an economically rational process despite a high level of urban unemployment. In this model, rural workers decide to migrate to the urban zone if expected urban income exceeds average rural income. The Todaro migration model is also referred to as the Todaro Paradox, in which an autonomous increase in urban job creation causes the level and rate of unemployment to rise. Todaro (1976) uses the data for 14 less developed countries (LDCs) to see what the elasticities of migration with respect to job probability would have to be to check for the Todaro Paradox. The author finds that these elasticities are small enough, so that the paradox can be expected to hold for most LDCs. The Harris-Todaro model (Harris and Todaro,

[2] See further Poot et al. (2016) for the application of gravity model in the migration research.

1970) is an equilibrium version of the Todaro migration model. Considering informal-sector activities and outright unemployment, this model predicts that expected incomes will be equated across rural and urban sectors. According to Massey et al. (1993), the neoclassical theory and its extension explain that international migration is caused by geographic differences in the supply of and demand for labor: "Countries with a large endowment of labor relative to capital have a low equilibrium market wage, while countries with a limited endowment of labor relative to capital are characterized by a high market wage, as depicted graphically by the familiar interaction of labor supply and demand curves." (Massey et al., 1993, p. 433). Massey et al. (1993) also point out another important assumption of the neoclassical theory that the international labor flows initially happen in labors markets and that other markets do not have any influence on international migration. In the neoclassical theory, the expected impacts of migration on sending-countries concern an expected high reduction of poverty, overpopulation, and unemployment.

The new economics of labor migration criticizes the neoclassical assumption that people move to another country permanently to maximize lifetime earnings (Stark and Levhari, 1982; Stark, 1984; Stark and Bloom, 1985; Katz and Stark, 1986; Taylor, 1986; Stark, 1991). According to Stark and Levhari (1982), the expected-income hypothesis developed in the neoclassical theory, "… is void of any explicit decisional risk content; the hypothesis does not incorporate a random variable (multiplicative or other), and the implied utility function is linear" (p. 191). The first key argument of NELM is that migration is a family-based decision. Second, even in the absence of wage differentials, households may have strong migration incentives to diversify their risks. Third, migration can be influenced not only by labor market's policies but also by the policies that shape insurance markets, capital markets and so on. Gheasi and Nijkamp (2017) show three critical points of the NELM: (i) the demand side of the labor migration is ignored; (ii) limited application for wealthy and urban regions; and (iii) no explication for the case in which an entire family decides to migrate.

Even though the neoclassical theory and the NELM propose two different approaches on the origin of migration, these two theories support the role of migration on economic development. In the neoclassical theory, the expected impacts of migration on sending-countries are to reduce the level of poverty, overpopulation and unemployment. In the NELM, not only income is maximized, but also risk is minimized, and status is maximized. Under this perspective, income resources from migrants might thus be beneficial to their families in sending-countries. Massey (1988) argue that migration and economic development are linked because the processes of capital substitution, enclosure and market penetration eliminate the rural economy and lead to an increase in the number of persons who are willing to move to seek better opportunities elsewhere. According to the author, theoretical perspectives stress the importance of viewing migration as a key factor of economic development. De Haas (2010) also confirms the heterogeneity of migration impacts and emphasize the vital role of states in shaping favorable conditions for positive development effects of migration to occur.

Regarding the migration – remittances nexus, a few theoretical studies support the crucial role of remittances in explaining the migration pattern. Stark (1999) argues that when information about the skill level of each migrant worker is unknown at destination, the wages of migrant workers are based on the average product of the migrant community. In such situation, high-skilled migrant workers would benefit from dissuading low-skill migrant workers, they should be willing to pay low-skilled workers to stay. In other words, remittances transferred from migrants to non-migrants should be motivated not by altruistic considerations but rather by pure self-interest. However, Stark and Wang (2002) propose an opposite idea about the strategic remittances. The authors suggest that "the number of low-skill migrants depends on the number of high-skill migrants; that the reason high-skill migrants make transfers is that transfers raise their income net of the transfers; that it is optimal for high-skill migrant workers to support or subsidize migration by low-skill workers; and that low-skill workers cannot migrate unless high-skill workers migrate" (Stark and Wang, 2002, p. 163).

Hatton and Williamson (2005) also consider remittances as a motive of migration. In fact, the migration

decision partially depends on the poverty constraint that would be mitigated by the relaxation of credit constraints. According to the authors, remittances from previous migrants play a crucial role in relaxing the credit constraint. So that, expected remittances transferred to their family in the home country to escape poverty should become an important motive of new migrants. More recently, de Haas (2010) proposes a theoretical framework to explain the direct economic consequences of remittances to the non-pecuniary consequences such as their impact on inequality, education and further migration. The author suggests that these underexposed effects of remittance transform the broader social, cultural, and economic contexts in migrant sending communities, which in turn induces further migration. Furthermore, growing remittances from the host country have another effect in the form of cultural and social change, which then has a reciprocal impact on the non-migrant's tendency to move out the home country in the future.

There has also been a growing empirical literature focusing on the impacts of remittances on migration. Using the data from Egypt, Turkey and Morocco, Van Dalen et al. (2005) tend to address the question of which is main determinant, altruism, or self-interest, of migration. The authors argue that the motives of migration vary among countries and that both motives can be identified as driving forces behind remittance behavior. On the one hand, the family links and the net potential earnings of migrants have stronger impacts on remittances than the net potential earnings of the households in the country of origin. On the other hand, growing remittance flows would lead to an increase in the migration intentions of family members still staying in the country of origin. In an empirical study applied for Tonga and Fiji, Leeves (2009) also find evidence of a positive effect of remittances on migration intention. Particularly, this impact is stronger in a country with longer history of migration and more considerable in the households with current migrants than those without migrants.

Dimova and Wolff (2015) focus on the possibility for remittances to trigger chain migration with the use of longitudinal data from Bosnia and Herzegovina. They indicate that remittances have a significant positive impact on the migration prospects of those remaining in the country of origin. Dimova and Wolff also argue that highly educated, healthy and young individuals are those most likely to migrate. In this context, the impact of prospective migration on both the labor market and the rest of the economy in the home country is likely to be negative. In other words, the prospective migration could result in further brain drain and demographic imbalance for the origin country. Using a large household survey data from Moldova and employing simultaneous equations model, Piracha and Saraogi (2016) support the role of remittances in shaping migration flows in migrant sending countries. On the one hand, they find evidence of a dual causality between receipt of remittances by non-migrants and their migration intentions. On the other hand, the authors also show that remittances not only relieve credit constraints in the home country but also act as a signaling device of success of migrants in the host country. The positive impact of remittances on migration is also recently concluded in Grigoryan and Khachatryan (2018) who use the 2011 household data to identify the determinants of migration in Armenia. According to the authors, remittances allow the potential migrants to facilitate the migration process, serving as a resource rather than as a contractual tool between migrants and non-migrants.

Docquier et al. (2012) investigate both theoretically and empirically the relationship between remittances and migrants' education. The authors develop a theoretical model in which the immigration policy consists of two dimensions: restrictiveness and selectivity. Accordingly, the relationship between remittances and migrants' education is ambiguous and depends on the immigration policy in destination countries: a positive effect of education in the case of more restrictive and less skill-selective immigration policy. This argument is also empirically confirmed.

Overall, the study on remittances should not be divorced from that on the migration impacts, and vice versa the study on migration motives would be flawed without taking into consideration prospective remittances. However, as far as we know, no previous empirical research has investigated the interaction between migration and

remittances at the worldwide level. Thus, our following empirical study is aimed at filling this knowledge gap. In addition, according to Aleshkovski and Iontsev (2016), one of the important features of recent trends of international migration is widening geography of international migration flows by involving practically all the countries of the world in migration flows. In this context, it would be of special interest to investigate the geographical dimension of the linkage between migration and remittances through a network analysis.

3. Network measurement and Data setting

The present paper applies network analysis to investigate migration and remittances structures because these phenomena are often embedded within social networks. On one hand, migration decisions are influenced by personal networks and social connections, such as family ties, friendships, and job opportunities. On the other hand, remittances, which are money transfers back to the home country by migrants, are also often sent through social connections. Network analysis allows identifying the structure of social networks involved in migration and remittance behavior and revealing important information about the dynamics of these phenomena. Furthermore, network analysis can provide insights into the role of individual actors and the overall network structure. Through a network analysis, we can also gain a better understanding of how migration and remittances unfold and how they impact individuals and communities.

This section first provides an outline of indicators used in a network analysis to explore, describe, and synthetize migratory processes and remittance trends. A network refers to a structure where each node indicates a place (country), and the links (called edges) connecting two nodes represents the number of people or funds moving from one country to another country. There are two kinds of edges in a network. A directed edge means that the nodes are connected, and one head of the edge has an arrowhead indicating a one-way link. An undirected edge implies that the nodes are connected but there is no arrowhead to indicate the linkage direction between the nodes. A network can be defined as a directed one (all edges are directed) or an undirected one (no edge is directed). In this study, we use a set of indicators to analyze the structure of migration and remittance network in terms of its properties. These indicators allow us to address a set of important questions: (i) Do certain countries play more important role than others in the network? (ii) Is the network structure is dense or sparse? (iii) Does network contain certain clusters of countries?

First, the degree centrality of a node is the simplest measure of the node position in a network, indicating the number of edges it has. The higher the degree centrality, the more central the node is. In a weighted network the degree centrality values are not equivalent and weighted according to their strength. The degree centrality is classified into:

In-degree centrality is a count of the number of ties directed to the node (head endpoints)

$$d(i) = \sum_{j=1}^{N-1} m_{ij} \tag{1}$$

Where *N* is the number of nodes in network. $m_{ij} = 1$ if the node (country) *j* is directed to the node (country) *i*.

Out-degree centrality is the number of ties that the node directs to others (tail endpoints)

$$d(i) = \sum_{j=1}^{N-1} m_{ij} \tag{2}$$

$m_{ij} = 1$ if the node i is directed to the node j.

Second, the closeness centrality quantifies the node's relationship to all other nodes in the network by considering the indirect connections from that node. Higher closeness centrality indicates higher influence on other notes. In a directed network, we distinguish the in-closeness centrality and the out-closeness centrality.

In-closeness centrality indicates the shortest path from other nodes to the node i: the higher In-Closeness Centrality, the higher influence of node i on other nodes.

$$c(i) = \sum_{j=1}^{N} \frac{1}{d_{ji}} \tag{3}$$

Where d_{ji} is the shortest path from node j to node i.

Out-Closeness Centrality indicates the shortest path from node i to other nodes: the higher Out-Closeness Centrality, the easier for node i to be influenced by other nodes.

$$c(i) = \sum_{j=1}^{N} \frac{1}{d_{ji}} \tag{4}$$

Where d_{ji} is the shortest path from node i to node j.

Third, the Betweenness centrality is a measure of how important a node is in the average pathway between other pairs of nodes. A node located on the shortest path between other nodes can play an intermediate role that helps any two nodes without direct contract reach each other indirectly. Nodes with higher betweeness centrality are located at the core of the network.

$$b(i) = \sum_{j,k \neq 1} \frac{g_{jik}}{g_{jk}} \tag{5}$$

Where g_{jik} is the shortest path between node j and node k that contains node I, and g_{jk} is the shortest path between node j and node k.

Over the last decades, a large number of empirical works have considered social networks as important factor to investigate student school performance (Calvó-Armengol et al., 2009), job opportunity (Calvó-Armengol and Zenou, 2005), criminal behavior (Calvó-Armengol and Zenou, 2004), firms' corporate governance (Fracassi and Tate, 2012), investment decisions (Hvide and Östberg, 2015) as well as investment decision of mutual fund managers (Cohen et al., 2008), and risk sharing (Fafchamps and Lund, 2003). There is also an important body of empirical literature, not just within economics but also in other disciplines, has employed the network analysis' tools to investigate the migration patterns. Among others, Tranos et al. (2015) employ network analysis to address the question of how migration is centralized or dispersed and how this structure evolve over time buy using the data on yearly immigration between 32 OECD countries for the period 2000-2009. The authors reveal that the distribution of migrant across the OECD countries is very unequal with almost 60% of migrants from OECD countries end up in Germany, the U.S. and the U.K., and 24% of migrants originates from Mexico and Poland. The authors also suggest that the most robust community over time is the U.S. and countries tightly related with the U.S., notably Canada, Mexico, Japan, and Israel.

Network analysis is also applied in Goldade et al. (2018) to study the internal migration patterns in the US. The main finding is that population and geographic consideration are strong indicators explaining the U.S. internal migration. In another work, Charyyev and Gunes (2019) also focus on the overall structure of the U.S. migration and yearly changes between 2000 and 2015 using temporal network analysis. According to the authors, nodes at country and state level usually remain active while there are significant fluctuations on links, meaning that

migration patterns change over the time.

Using the United Nations Population Division's Global Migration Database, Peres et al. (2016) apply network analysis to investigate the community structure in the top-one destination and top-one origin of migration network. The authors find that both top 1 origin and destination networks experience communities with a clear structure, in which 80% edges persist between each decade. On the other hand, Peres et al. (2016) reveal that only few countries can have a key influence on community evolution of both top 1 origin and destination networks. Basing also on the United Nations International Migration Flows Database 1970-2013, Aleskerov et al. (2017) focus on revealing a set of critical or central elements in the migration network. In other words, the authors tend to identify the central countries or regions in the migration network. This work shows the importance of socioeconomic, geographical and political factors in shaping the structure of migration network.

Considering a larger database covering the migration flows from 206 source countries to 145 destination countries over the period 2006-2010, Porat and Benguigui (2015) focus on the differences in the migration network pattern between destination and source countries. The authors classify the destination countries into three classes: (i) global migration hubs with high connectivity and high migration rate; (ii) local migration hubs with low connectivity and high migration rate; and (iii) local migration hubs with opposite strategy of high connectivity and low migration rate. In the same light, using the Global Bilateral Migration Database from 1960 to 2000 (Özden et al., 2011), Danchev and Porter (2016) assess how migration flows at global, regional, and local scales coexist ("glocalization"), divide ("polarization"), or form an interconnected global system ("globalization"). The authors find evidence that the world migration is neither globally interconnected nor reproduces the geographic boundaries as drawn on a world map but experiences a heterogeneous interaction of global and local tendencies in different network regions.

Previous research should be seen as a first step towards a more profound understanding of the world migration patterns. Moreover, as stated above, an analysis of migration should not be separated from a study of migrants' remittances. Therefore, in the following part, we provide both migration and remittance network analysis to offer better understanding of the interplay between migration and remittances.

Our migration and remittance network analysis is based on two bilateral data sets covering a period of 6 years: 2000, 2005, 2010, 2013, 2015, and 2017. The first data sample provides the volume of bilateral migration flow from country i to destination country j at time t (denoted Mijt). This data sample is collected from the WDI bilateral migration database (2000; 2010; 2013; and 2017) and from the UN bilateral migration database (2005 and 2015). The second data set documents the number of remittances sent from transferring country j to recipient country i at time t (denoted Rijt). Differing from bilateral migration database, obtaining a large bilateral remittance database is not an easy task. Our remittance data sample combines two existing databases: one constructed by Docquier et al. (2012) (2000 and 2005) and the other one collected from the World Bank bilateral remittance database (2010, 2013, 2015, and 2017).

The present paper is also aimed at providing a net remittance and migration network analysis, in which we define net migration and net remittances to be the difference in migration and remittances, respectively exchanged by two countries i and j. The net remittance network is considered as $R = (V, E_R)$ in which the vertex V represents countries and the edges E_R are weighted according to net remittances between 2 countries i and j:

$$\begin{cases} if\ (R_{ijt} - R_{jit}) > 0 \ \rightarrow \ j\ is\ net\ recipient\ remittances\ country \\ if\ (R_{ijt} - R_{jit}) < 0 \ \rightarrow j\ is\ net\ transferring\ remittances\ country \end{cases}$$

The net migration network $M = (V, E_M)$ is defined in a similar manner. Using net bilateral remittance and migration flows' database allows clarifying the role of each country (sending or receiving) in the remittance and migration networks. Besides, this approach may also investigate the inter-country relationships and their relative

effects on the network dynamics.

4. Empirical results

This section is organized into two sub-sections. The first one provides a network analysis based on the empirical results on a set of centrality indicators. The second one detects different communities in the migration and remittance networks.

4.1. Centrality analysis

We first focus on the empirical results of different centrality measures, which are only reported for the country in the top-ten destination or origin of migration and remittances.[3] Tables 1 and 2 report the weighted in-degree and out-degree centrality indicators respectively, which allow analyzing the migration and remittance networks in terms of binary links.[4] The weighted out-degree centrality denotes the number of different destination countries for every home country, while the weighted in-degree centrality represents the number of different home countries for every target country.

As reported in Table 1, the migration destination countries in the top ten can be geographically classified in 5 groups: North American (the U.S. and Canada); European countries (Germany, France, the U.K., Spain); Australia; Middle East (Saudi Arabia, United Arab Emirates); and Russia. The main migration destinations are generally high-income countries, except the case of Russia. This evidence supports the role of pull factors that cause the individuals to move from the developing world to the advanced world. Regarding migration out-flows, the migration hierarchy is quietly different. On the top of migration out-flows, emerging countries such as India, China and Russia are found along with low-income countries such as Bangladesh, Afghanistan, and Pakistan. Migration out-flows are not only phenomenon in poor countries but also observed in some developed countries, in the U.K. Migration can be, thus, characterized in developing-developed flows and developed-developed flows. In addition, Russia is the only country, which is on the top of both immigration and emigration hierarchies. This finding can be explained by twofold. Despite its large population, Russia still receives a great flow of immigrants from ex-members of Soviet Union. By contrast, different socio-economic factors, such as relatively low income and macroeconomic and politic instability, urge workers and their families to leave Russia.

Through Tables 1-2, we observe a stable structure in terms of migration destination country. For instance, the U.S. is always the first attractive destination of migrants followed by other central ones, notably Germany, Russia and Saudi Arabia. The key role of the U.S. in the immigration network implies that a change in the U.S. migration policy, such as a restriction in the visa waiver program, may destabilize the whole structure of the immigration network. Even though the immigration structure looks like stable, we observe an obvious change in the top-ten country ranking, notably the fall in Canada's weighted in-degree centrality or the new arrival of United Arab Emirates in the top-ten destination since 2013.

Regarding the structural changes in the emigration network, developed countries, notably Germany, the U.S. and Italy, get out of the top of migration origin countries while four emerging countries, notably Mexico, China, India, and Russia, have maintained their first places in the emigration network since 2005. The period 2005-2013 experienced a massive emigration from emerging markets, which is represented by the presence of significant nodes with many connections at the core of emigration network. After 2013, the global emigration flows seem to remain relatively stable.

[3] The results for the full sample will be available up on request.
[4] The figures of degree centrality will be available up on request.

Table 1. Weighted In-degree Centrality.

Migration Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
USA	3.48E+07	USA	1.91E+07	USA	4.08E+07	USA	4.62E+07	USA	4.54E+07	USA	4.55E+07
RUS	1.21E+07	DEU	6.61E+06	RUS	1.17E+07	SAU	1.45E+07	RUS	1.17E+07	DEU	1.20E+07
DEU	1.11E+07	CAN	6.07E+06	DEU	9.75E+06	RUS	1.10E+07	SAU	1.04E+07	SAU	1.18E+07
FRA	6.28E+06	GBR	5.89E+06	SAU	7.32E+06	DEU	1.06E+07	DEU	1.01E+07	RUS	1.17E+07
IND	6.24E+06	FRA	5.40E+06	CAN	7.04E+06	GBR	7.70E+06	GBR	8.37E+06	GBR	9.06E+06
CAN	5.56E+06	SAU	5.07E+06	ESP	6.90E+06	ARE	7.61E+06	FRA	7.96E+06	CAN	8.07E+06
UKR	5.21E+06	RUS	4.77E+06	GBR	6.81E+06	FRA	7.50E+06	ARE	7.76E+06	FRA	8.01E+06
SAU	5.13E+06	ESP	4.10E+06	FRA	6.61E+06	CAN	7.40E+06	CAN	7.55E+06	ARE	8.00E+06
GBR	4.89E+06	ITA	3.95E+06	AUS	5.43E+06	ESP	6.48E+06	AUS	6.69E+06	AUS	6.81E+06
AUS	4.03E+06	AUS	3.71E+06	IND	5.39E+06	AUS	6.43E+06	ESP	5.88E+06	ESP	6.11E+06
Remittances Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
PHL	1.20E+11	ROM	5.66E+09	IND	5.30E+04	IND	7.00E+04	IND	6.89E+04	IND	6.90E+04
BGD	3.10E+10	BGD	3.02E+09	CHN	5.18E+04	CHN	5.95E+04	CHN	6.39E+04	CHN	6.39E+04
THA	7.00E+09	IDN	1.03E+09	MEX	2.21E+04	PHL	2.67E+04	PHL	2.85E+04	PHL	3.28E+04
HRV	6.00E+09	YUG	8.62E+08	PHL	2.13E+04	FRA	2.33E+04	MEX	2.62E+04	MEX	3.06E+04
YUG	9.10E+08	HRV	5.08E+08	NGA	1.92E+04	MEX	2.30E+04	FRA	2.33E+04	FRA	2.54E+04
MKD	8.00E+08	MDA	2.68E+08	FRA	1.64E+04	NGA	2.09E+04	NGA	2.05E+04	NGA	2.20E+04
MAR	2.20E+08	MKD	1.20E+08	DEU	1.25E+04	EGY	1.78E+04	PAK	1.93E+04	EGY	2.00E+04
SVN	1.50E+08	MAR	1.18E+08	EGY	1.20E+04	DEU	1.58E+04	EGY	1.83E+04	PAK	1.97E+04
BLR	8.40E+07	DZA	3.28E+07	BGD	1.01E+04	PAK	1.46E+04	BGD	1.54E+04	DEU	1.68E+04
MDA	3.70E+07	BRA	3.16E+07	ESP	1.01E+04	BGD	1.39E+04	DEU	1.54E+04	VNM	1.38E+04

Table 2. Weighted Out-degree Centrality.

Migration Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
RUS	1.04E+07	RUS	3.83E+06	MEX	1.22E+07	IND	1.40E+07	IND	1.59E+07	IND	1.65E+07
MEX	9.55E+06	IND	3.69E+06	IND	1.12E+07	MEX	1.33E+07	MEX	1.23E+07	MEX	1.23E+07
IND	9.52E+06	DEU	3.59E+06	RUS	1.01E+07	RUS	1.10E+07	RUS	1.04E+07	RUS	1.09E+07
UKR	5.92E+06	CHN	3.56E+06	CHN	8.18E+06	CHN	9.68E+06	CHN	9.62E+06	CHN	9.98E+06
CHN	5.81E+06	GBR	3.02E+06	UKR	5.95E+06	BGD	7.54E+06	BGD	7.25E+06	SYR	7.79E+06
POL	5.15E+06	ITA	2.74E+06	BGD	4.96E+06	PAK	6.10E+06	SYR	6.24E+06	BGD	7.76E+06
BGD	4.99E+06	IDN	2.71E+06	PAK	4.57E+06	PHL	6.00E+06	PAK	5.93E+06	PAK	6.06E+06
GBR	4.06E+06	PAK	2.65E+06	GBR	4.55E+06	AFG	5.61E+06	UKR	5.87E+06	UKR	6.02E+06
PAK	3.81E+06	MAR	2.38E+06	PHL	4.22E+06	UKR	5.54E+06	PHL	5.41E+06	PHL	5.93E+06
DEU	3.60E+06	USA	2.29E+06	TUR	4.21E+06	GBR	5.17E+06	AFG	4.79E+06	AFG	5.01E+06
Remittances Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
USA	8.06E+10	ITA	2.38E+09	USA	1.10E+05	USA	1.23E+05	USA	1.35E+05	USA	1.48E+05
SAU	2.96E+10	SAU	1.65E+09	SAU	2.14E+04	SAU	4.16E+04	SAU	4.70E+04	SAU	4.67E+04
JPN	1.62E+10	ESP	1.25E+09	CAN	2.13E+04	ARE	2.77E+04	ARE	3.24E+04	ARE	3.30E+04
KWT	5.89E+09	USA	1.17E+09	GBR	2.11E+04	GBR	2.39E+04	GBR	2.53E+04	GBR	2.68E+04
DEU	4.82E+09	DEU	1.04E+09	DEU	2.04E+04	DEU	2.27E+04	CAN	2.37E+04	DEU	2.47E+04
ITA	3.99E+09	GBR	1.03E+09	FRA	1.89E+04	CAN	2.19E+04	DEU	2.30E+04	CAN	2.46E+04
SGP	3.94E+09	MYS	3.54E+08	ESP	1.76E+04	FRA	2.05E+04	FRA	2.09E+04	FRA	2.18E+04
ARE	3.56E+09	FRA	3.47E+08	ARE	1.58E+04	RUS	1.68E+04	HKG	1.70E+04	ESP	1.79E+04
OMN	1.99E+09	KWT	3.40E+08	HKG	1.48E+04	HKG	1.58E+04	AUS	1.66E+04	ITA	1.74E+04
CHE	1.43E+09	ARE	3.35E+08	AUS	1.35E+04	ITA	1.57E+04	ESP	1.59E+04	HKG	1.71E+04

We now turn to the remittance network's structure and evolution. As expected, the main destinations of remittances are developing countries. Besides, an unexpected finding is that since 2010 along with developing countries, some advanced countries (e.g., France and Germany) have also benefited from remittance inflows. In particular, France has been on the top-five of remittance-receiving countries since 2013. The extent of remittance inflows to some European countries are mostly nurtured by compensation of employees from border, seasonal or short-term work contracts by EU residents in other countries. Regarding Tables 1-2, we also observe that there is a

significant change in the structure of remittance inflow network. Before 2005, an important part of remittances was sent to Soviet Union's ex-member countries, such as Belarus and Moldova, and Eastern European countries. After 2005, these countries lost their places on the top-ten and were replaced by emerging countries from other continents, notably China, India, and Mexico. Since 2013, as reported in Table 1-2, the major modifications have occurred only in the intensive margin of the remittance network, meaning that the architecture of remittance inflows has remained stable with the central cores belonging to three emerging Asian nations, namely India, China, and Philippines. Regarding the remittance sources, the U.S. is the most important source over the time (except in 2005) followed by Saudi Arabia. The network of out-remittances has been generally condensed and organized around high-income countries since 2010.

Comparing the degree centrality of migration network with that of remittance network, three important findings are drawn. First, we find that the immigration flows relatively correspond to the out-remittance flows: the most important destination of migrants are the most important sources of remittances, except Russia and Hong Kong. As reported in Tables 1-2, Russia figures on the top ten of both migration destination and origin but not on the top ten of remittance source. This could simply mean that migrants from former country members of Soviet Union migrate first to Russia, which is considered as an intermediary core in the migration network, and then move to other high-income countries. Different to Russia, Hong Kong is not listed on the top ten of migration destination but has become a considerable source of remittances since 2010. The fact is that Hong Kong has become an attractive destination of many multinational firms, in which the compensation of their foreign employees transferred to their origin countries are accounted in the total remittances. This result also casts a new light on the relationship between migration and remittances. On the one hand, the volume of immigration flows is not a unique factor determining the volume of remittances sent back to countries of origin. On the other hand, remittance flows also depend on the quality of migrants, meaning that a high-skill migrant may send a higher fund to his home country than a low-skill migrant. For instance, some European countries, notably France and Germany are not figured in the top-ten of migrant origins but receive such an important part of remittances. Second, the emigration flows only partially match with the in-remittance flows. Among the top-ten recipient remittance countries, since 2010, four emerging countries including China, India, Philippines, and Mexico have maintained their highest ranking. These four countries have also figured in the top-ten migration sending countries. It means that more the migrants leave their home country, more their home countries receive remittances. Remittances should be seen either as a source or because of migration. By contrast, other countries in the top-ten migration home countries are not necessarily listed in the top-ten remittance recipient countries, and vice versa. For instance, since 2010, Nigeria has ranked the 5th or the 6th in terms of receiving remittances but has not been in the top-ten migration sending countries. This finding may call into question about the validation of a positive linkage between migration and remittances. Third, concerning the network structure, the emigration and out-remittances networks are set around the U.S. Over time, this structure seems to be robust. However, the immigration and in-remittances networks seem to be more and more centralized around emerging countries, in particular India and China. Precisely, due to its large diaspora and overseas expats population, India consecutively remains the top receiver of remittances. According to the World Bank, the number of remittances transferred to India reached 2.7% of its GDP in 2017.

Beside the degree centrality indicators, to reinforce our migration and remittance network analysis, we also consider other centrality indicators. First, the betweenness centrality is used to measure one node undertaking "mediation" role in a network. Precisely, the betweenness centrality is based on the idea that brokering position of a node between others provide the opportunity to intercept or influence the network communication. From the broker's perspective, the betweenness centrality represents the degree of control that a note has over the communication between other pairs of nodes. The betweenness centrality is defined as the total dependency of communicating pairs on a node – the broker.

Table 3. Betweenness Centrality.

Migration Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
USA	722.48	FRA	5038.46	USA	3930.83	USA	3384.09	FRA	4827.72	USA	2885.4
FRA	650.61	GBR	4391.25	FRA	2895.14	FRA	2524.17	GBR	4328.38	FRA	2152.82
AUS	610.81	USA	3411.44	GBR	2306.12	AUS	1887.97	USA	3387.15	GBR	2013.81
GBR	593.11	CAN	2830.01	DEU	1741.38	CAN	1652.08	AUS	3125.61	CHN	1640.44
CAN	554.88	AUS	2725.65	AUS	1691.39	CHN	1528.16	CAN	2727.63	AUS	1619.41
IND	530.82	ITA	1616.48	TUR	1438.4	RUS	1208.04	ITA	1643.81	CAN	1458.98
DEU	526.93	RUS	1315.37	JPN	1187.99	GBR	1044.69	RUS	1251.02	RUS	1004.26
NLD	491.41	NLD	1190.61	PRT	1174.1	EGY	962.8	NLD	1168.56	EGY	970.3
GRC	460.46	DEU	1166.74	CAN	1067.51	ITA	877.44	DEU	1104.36	TUR	760.53
ITA	449.66	GRC	1156.65	ITA	990.2	TUR	856.5	ZAF	1075.32	NLD	755.29
Remittances Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
HRV	39	ROM	11.5	CAN	5077.14	USA	2836.75	USA	2876.86	USA	2861.45
ISR	5	HRV	10	CYM	2416.44	FRA	2085.4	FRA	2093.71	FRA	2008.22
MKD	3.5	MKD	4	BHS	1359.64	AUS	1420.57	AUS	1439.65	AUS	1436.1
SVN	2.5	ISR	1.5	USA	1194.12	CHN	1359.15	CHN	1365.89	CHN	1362.44
USA	0	ITA	0	MRT	1045.13	CAN	1310.98	CAN	1333.31	CAN	1325.49
SAU	0	SAU	0	FRA	844.98	RUS	1091.56	RUS	1319.71	RUS	1307.87
JPN	0	ESP	0	CAF	831.77	GBR	914.24	GBR	920.91	GBR	918.1
KWT	0	USA	0	GBR	774.88	EGY	861.81	EGY	864.1	EGY	861.93
DEU	0	DEU	0	LIE	629.23	ITA	773.7	ITA	789.21	ITA	784.97
ITA	0	GBR	0	COG	574.59	TUR	691.25	TUR	692.78	TUR	692.8

As reported in Table 3, the most important intermediate role, which helps any two nodes without direct contract reach each other indirectly, belongs to developed countries, in particular France, the U.S. and the U.K. It means that developed countries are located at the core of the migration network. In other words, a change in the migration policies of these countries can alter even break the migration network. For instance, a restriction in the visa waiver program of one "hub" country can destabilize the whole structure of the migration network and then increase the migration pressure on other countries at the core of the network. Table 3 also reports a high level of betweenness centrality of three emerging countries, notably Russia, China and Turkey. Similar to developed countries, Russia get a hub position in the network in receiving migrants who come principally from ex-members of Soviet Union. Turkey with its transcontinental location is considered as an indispensable connection of migrants to Western Europe. Differing from Russia and Turkey, China is located at the core of the migration network in terms of migrant sending country. It implies that a change in migrant flows from China can have a significant impact on the connection of migration network. Looking at the remittance network, we observe a slight instability in terms of betweenness centrality. Until 2005, the dynamics of remittance flows is made around five countries (Israel, North Macedonia, Slovenia, Romania and Croatia), which got a significant value of betweenness centrality. Remittance flows in this period were only concentrated in a small geographic zone. This result is probably due to the lack of remittance data until 2005. Since 2010, the results on betweenness centrality have been changed due to an important improvement of remittance database. In 2010, the profiles of top-ten countries were very diverse in terms of economic development level and geography as well. After 2010, the result on remittance betweenness centrality seems to be similar to that of migration network: developed countries, such as France and the U.S., play a significant role in controlling the remittance outflows, while the crucial position in remittance inflows' network communication belongs to emerging countries, notably China, Turkey and Russia.

The second indicators used is the closeness centrality, which can be regarded as a measure of how fast a node will take to spread information to all other nodes. If a node has a great closeness centrality, this node is in a strategic position allowing it to spread quickly information and can become an important influencer in the concerned network. In other words, a node with a high closeness centrality would mean it has close relationships with many

other nodes.

Table 4. Closeness Centrality.

Migration Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
GBR	0.962	RUS	0.766	MEX	0.688	IND	0.802	IND	0.767	IND	0.818
USA	0.95	IND	0.727	IND	0.646	MEX	0.756	MEX	0.728	MEX	0.787
IND	0.935	DEU	0.727	RUS	0.645	RUS	0.754	RUS	0.723	RUS	0.767
DEU	0.935	CHN	0.711	CHN	0.642	CHN	0.735	CHN	0.708	CHN	0.754
FRA	0.935	GBR	0.691	UKR	0.642	BGD	0.733	BGD	0.695	SYR	0.746
CHN	0.92	ITA	0.685	BGD	0.642	PAK	0.718	SYR	0.685	BGD	0.733
ITA	0.92	IDN	0.679	PAK	0.606	PHL	0.71	PAK	0.68	PAK	0.725
CAN	0.909	PAK	0.646	GBR	0.605	AFG	0.683	UKR	0.65	UKR	0.696
NLD	0.878	MAR	0.64	PHL	0.601	UKR	0.681	PHL	0.642	PHL	0.687
LBN	0.875	USA	0.635	TUR	0.597	GBR	0.678	AFG	0.639	AFG	0.685
Remittances Network											
CNTY	2000	CNTY	2005	CNTY	2010	CNTY	2013	CNTY	2015	CNTY	2017
USA	1	ITA	1	USA	0.995	USA	0.989	USA	0.984	USA	0.984
SAU	1	SAU	1	SAU	0.995	SAU	0.978	SAU	0.973	SAU	0.973
JPN	1	ESP	1	CAN	0.991	ARE	0.967	ARE	0.957	ARE	0.957
KWT	1	USA	1	GBR	0.991	GBR	0.967	GBR	0.957	GBR	0.957
DEU	1	DEU	1	DEU	0.991	DEU	0.967	CAN	0.957	DEU	0.957
ITA	1	GBR	1	FRA	0.991	CAN	0.962	DEU	0.957	CAN	0.957
SGP	1	MYS	1	ESP	0.986	FRA	0.957	FRA	0.957	FRA	0.957
ARE	1	FRA	1	ARE	0.986	RUS	0.957	HKG	0.947	ESP	0.947
OMN	1	KWT	1	HKG	0.986	HKG	0.947	AUS	0.942	ITA	0.942
CHE	1	ARE	1	AUS	0.986	ITA	0.947	ESP	0.942	HKG	0.942

As reported in Table 4, before 2005, we find both developed and developing countries with high closeness centrality in the migration network. Developed countries are the most influencer in terms of receiving migrants while developing countries play a crucial role in terms of sending migrants. It means that before 2005, both receiving and sending countries in the top-ten had almost the same number of close links with the same other countries in the migration network. We may, therefore, consider that the migration network was symmetric and structured around the top-ten influential countries. However, since 2005, this structure has been changed. Developed countries (except the U.K.) have been replaced by other developing and emerging countries in the top-ten list. This structural change can be explained by the fact that since 2005 people from poor countries have moved not only to usual rich countries but also to other new destinations. This trend increases the number of close relationships of developing countries but decrease that of developed countries in the migration network. Otherwise, the world has experienced many political turmoil since 2005. This context has pushed people from poor and unstable countries to migrate. It explains the arrival of new developing countries as the most influencers in the migration network. While the closeness centrality of migration network has been changing over the period 2000-2020 with the arrival of developing countries in the influencer group, the remittance network does not experience a significant evolution concerning the closeness centrality.[5] The most important influential role in the remittance network still belongs to advanced and rich countries. Accordingly, rich countries are the main source of remittances, which are sent and distributed to the developing world. Besides, the fact that no developing country in the top ten remittance influencers argues that no developing country might play a decisive and prominent role in the remittance distribution.

4.2. Community analysis

[5] The following arguments are only based on the results on remittance closeness centrality over the period 2010-2017 due to the lack of remittance data before 2010.

We now focus on extracting the different communities in the migration and remittance network. To do so, we apply the method developed by Blondel et al. (2008) that is based on modularity optimization.6 As suggested in Yang et al. (2010), communities are the groups of nodes (countries), which are highly connected to each other than to the rest of the nodes (countries) in the same network. On the one hand, the community detection allows us to highlight the possible clusters between countries that are characterized by strong bilateral ties. On the other hand, the community analysis will be used to understand and identify the push and pull factors behind the migration and remittance networks.

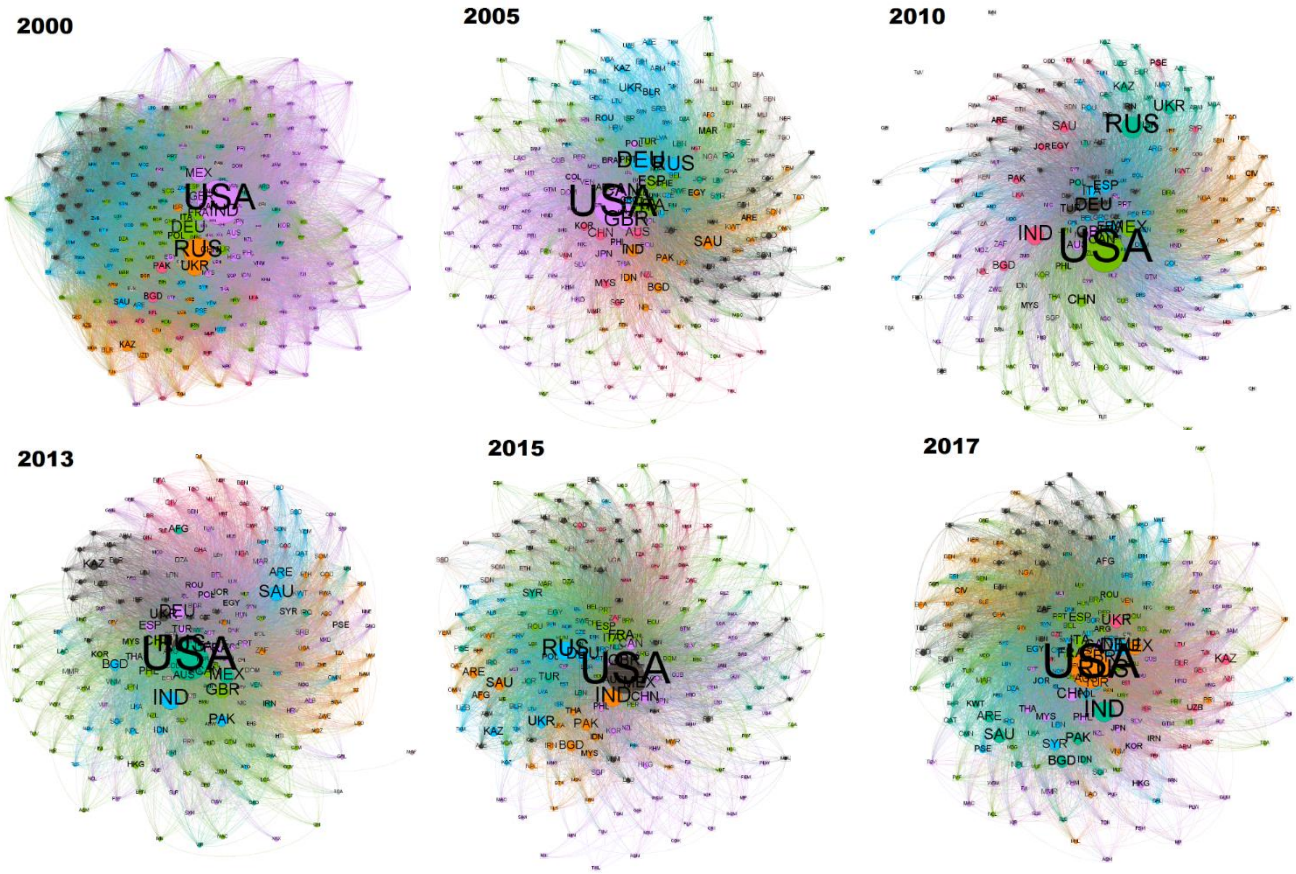

Figure 1. Migration Community.

We first describe the results of the migration community. 7 Figure 1 shows an evolution of migration community in terms of community number and community structure as well. From 2000 to 2005, the migration network includes 9 and 8 communities, respectively. After 2005, the community number increases to over 10 and then falls to 9 clusters since 2015. The modification in community number over the period 2005-2015 can be explained by the dispersion of migration flows. In fact, the migrants were tending to move to new destinations instead of just aiming for some historical and usual destinations. As suggested in Lee et al. (2014), new migration destinations have emerged as migrants venture into uncharted territory in search of better opportunities and mobility.

Regarding the community structure, we find that the largest communities are built around the top-ten countries in terms of weighted in-degree and out-degree centralities. In 2000, the largest community with 84 countries consists of the U.S., countries tightly related with the US, notably the U.K., Canada and Mexico, and most

6 See further Blondel et al. (2008) for the algorithm built for the community detection.
7 Results on the detailed composition of each migration or remittance community will be provided upon request.

countries in Asia-Pacific, including Australia, China, Japan, and Korea and so on. However, the size of this community is not robust over time. In 2015 and 2017, the US community included only 29 and 24 countries, respectively. Except some countries, which are historically and geographically linked to the US, such as Mexico, Venezuela, and Vietnam, we observe the exit of several big and advanced countries (notably Canada Asia-Pacific countries like Australia, Japan and China) from the US community. This phenomenon demonstrates a profound change in the migration network structure, which could be explained by the change either in migration policy of the U.S. or in migrants' decision. The out-coming countries from the U.S. cluster, in turn, create new migration community. Precisely, since 2013, the U.K., Canada, and the biggest Asia-Pacific countries (Australia, China and Japan) have composed the most influential migration community with 47 country members in 2017. This rising community is derived from the development of regional cooperation in Asia-Pacific. The migration network has also experienced another large community principally including European countries, their oversea territories, and some former European colonies. This community was robust with a consequent size until 2013. Since 2015, the European community has decomposed into two clusters: one dominated by Latin European countries such as France, Spain, and Italy; and the other one gathering Germanic European and Scandinavian countries. This separation concerns the difference in the socio-economic aspects between two parts of Europe. It might be seen because of the different opinions in terms of managing migration flows between European countries. Together with European countries, the mobility among Russia and ex-members of Soviet Union is intensive enough to form another robust community over time. In other words, the strong cultural, political and economic ties make these countries be clustered together.

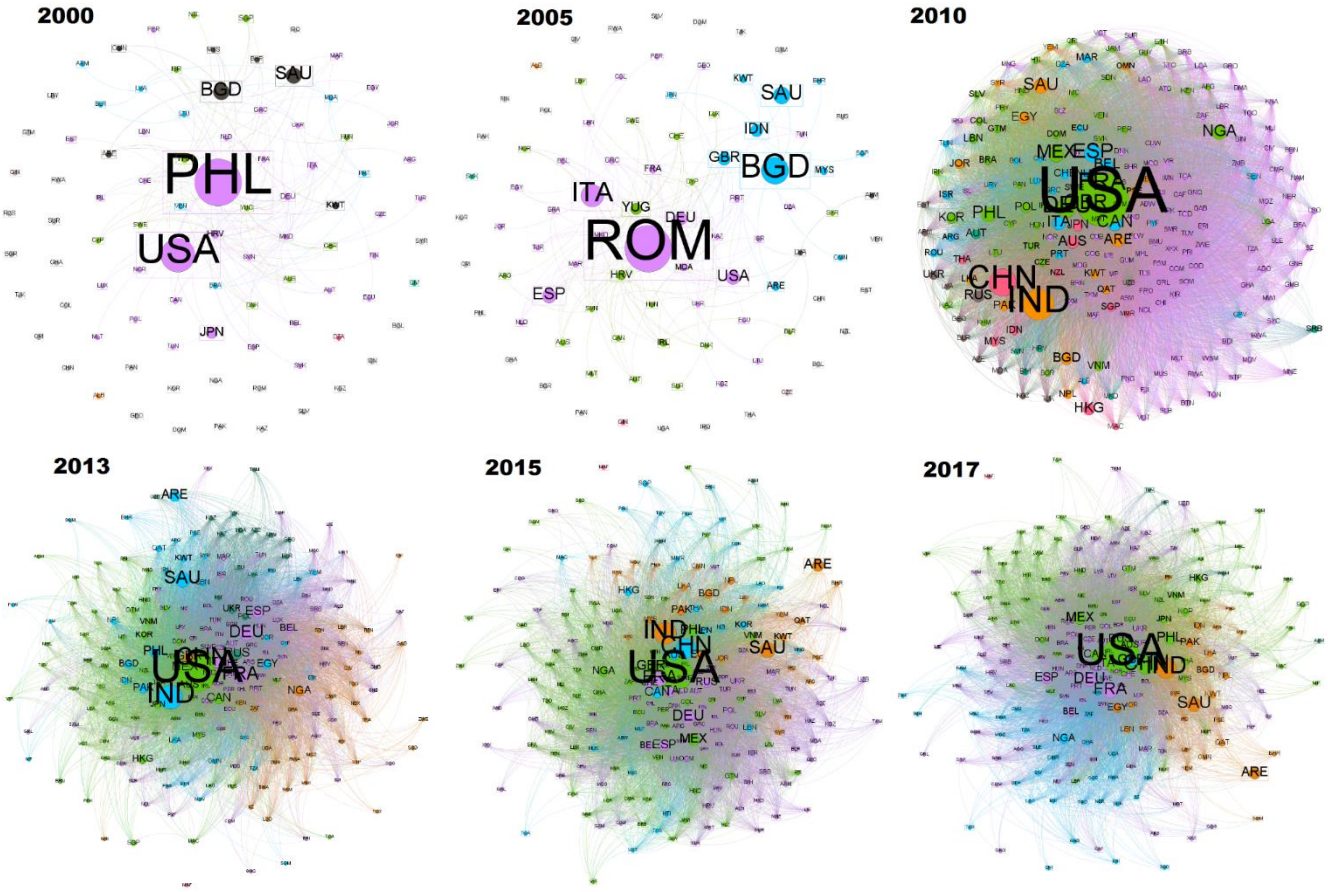

Figure 2. Remittance Community.

Figure 1 also displays a common and robust community among the Middle East and South Asia countries. The

economic prosperity of petroleum countries in the Middle East has recently attracted a large migrant flow from other Asian countries. This community is thus enlarged by the arrival of newcomers from Southeastern Asian countries including Indonesia and Thailand. Lastly, Figure 1 highlights the ease of migration inside Africa over the studied period 2000 – 2017. Intra-African migrants are classified into two communities: one covering Central and Western African countries and the other one including Eastern and Southern African countries. Despite some minor movements inside each community, the similarities in history, culture and economy among the country members make the structure of these two communities be stable over time.

We now pay our attention to the results on remittance community displayed in Figure 2. The period 2000 – 2005 observes such dispersion of remittance communities. The number of remittance communities in 2000 and 2005 is 33 and 32, respectively. This finding might be principally due to the lack of bilateral remittance data over the concerned period. Among detected communities, there are some communities with an important size. For instance, the largest community in 2000 and in 2005 includes 35 and 29 countries, respectively. While the countries in a big migration community share several similarities in culture, politics, economy and geography, this evidence is not verified in the remittance community. As showed in Figure 2, the country members of the largest remittance community are geographically, economically, and politically dispersed. This result is in line with the argument that the remittance network is not necessarily consistent with the migration network. A similar pattern of results is also obtained over the period 2010 – 2017. First, the number of remittance communities varies between 4 and 5 and is significantly lower than that of migration communities. It means that the remittance network is less polarized than the migration network. On the other hand, the composition of remittance network seems not follow that of migration network. Second, there is a significant gap in terms of size between different communities. For instance, in 2017 the largest community includes 87 countries whereas the smallest one covers only 5 countries. Third, the large communities are also established around advanced countries, such as the U.S. and European countries, or petroleum countries, notably the U.A.E and Qatar. The community structure seems robust over time even though countries in the same cluster are geographically dispersed.

5. Conclusion

International migration and remittances have become meaningful facets of the world economy and modern human society. A thorough analysis of international migration and remittance dynamics is necessary to get better understanding of the tendency of these two phenomena and to give a clearer picture of the complex interactions between them. The novelty of our paper is to apply a network analysis to analyze the dynamics of both international migration and remittances for the largest database covering bilateral migration and remittances over the last two decades 2000 – 2017. Studying patterns embedded within remittance and migration networks allows us to uncover important insights regarding economic and sociological trends of migration and remittance flows as well as their implications both in regional and global settings.

Our first analysis is based on a set of traditional network measures (degree centrality, betweenness centrality and closeness centrality), which allow us to clearly characterize the patterns of migration and remittance networks. In line with previous studies, the present findings confirm the role of economic and demographic factors in the decision to migrate. On the one hand, the topmost receiving migration countries are developed or petroleum riche countries. It means that migrants are “pulled” into riche countries, which offer high wages, a much better health care and educational system. On the other hand, the topmost sending migration countries are mainly emerging countries (notably China and India) and poor and populous countries (such as Bangladesh and Pakistan). Accordingly, migrants seem to be “pushed” out of their home countries to escape from unfavorable socio-economic situations or even from the poverty. Yet, this result should be considered with caution in the case of emerging countries that experience a remarkable economic growth, emerging Asian countries. In fact, migrants from

emerging countries leave their home countries not only due to economic situations but also due to other social and political factors. In such situation, concerns have often been raised about the loss of human resources, including highly skilled workers, the so-called "brain drain", which may hinder development in emerging countries of origin. To fight against the "brain drain" phenomenon, the policy makers should institute their policies to encourage citizens to remain in the country. Such policies to lower emigration, highly skilled workers' emigration, have included strengthening educational and training institutions and boosting domestic employment opportunities in home countries.

Regarding the remittance network, we find evidence of the indisputable role of advanced and rich countries in sending remittances. Together, we observe that remittances are rising and polarizing into emerging Asia, notably China and India. In the concerned literature, remittances sent back to the home countries by migrants serve as a form of economic insurance and contribute to economic growth of migrants' home countries. So that, the polarization of remittances into Asia may extend the economic development gap between emerging Asia and the rest of the developing world. Another important finding is that the topmost remittance recipient countries also include developed countries, notably France and Germany. From these results, the immigration and out-remittance networks are formed around the riche countries. By contrast, the central role in the emigration and in-remittance networks belongs to emerging and developing countries. Among others, emerging Asia is reinforcing its dominant position both in sending migrants and in receiving remittances. This trend should be considered as both an advantage (remittances sent back by migrants become a considerable factor of Asian economic growth) and a disadvantage ("brain drain" is the most important consequence of substantial emigration and results in high net costs for the sending countries). Accordingly, developing countries should implement policies to not only encourage the return of citizens but also to stimulate links between the home countries and the overseas communities of scientists and businessmen, for example: (i) inviting scientists to teach or do temporal research in their home country or providing to them attractive research facilities and bonus payments; (ii) providing tax cuts and administrative facilities for businessmen with dual citizenship who want to invest and do business in their home countries. This paper also develops a community analysis that provides important insights regarding the interaction between countries as well as the dynamics inside the migration and remittance networks. Several important findings are drawn from this analysis. First, geographical and cultural factors play a crucial role in building migration communities. For instance, we observe two different migration communities inside Europe (Latin Europe versus Germanic Europe) as well as two distinguished ones inside Africa (Western and Central Africa versus East and Southern Africa). Second, the number of migration communities is rising, suggesting an increase in new migration destinations. On the one hand, increasing new migration destinations may be explained by the fact that migrants move to unusual and uncharted territory to look for new and better opportunities. On the other hand, stricter migration policy in advanced countries may act as a constraint in the migration decision and oblige migrants to seek new destinations. Third, there is a deepening intra-regional trend regarding the structure of migration communities. Fourth, differing from the migration communities' characteristics, the remittance network is made up of a small number of remittance communities that are however geographically dispersed. Lastly, even though the structure of migration and remittance networks is altering, the major changes have only occurred in the intensive margin of the network. The biggest sending remittance and immigration communities are still set up around advanced and riche countries, while emerging, developing and populous countries shape the largest recipient remittance and emigration communities. It indicates that economic differentials across countries still explain most of the human and capital movements. According to these findings, establishing a migration policy, which is beneficial to both sending and receiving countries, requires a strongly global cooperation not just a regional cooperation.

To conclude, compared with existing empirical studies, the most important contribution of this paper concerns the adoption of network analysis, which allows getting better understanding of the structural changes inside the

migration and remittance networks. This appropriate empirical framework should be used more widely to extend research in migration and remittances. Regardless, the network analysis' tools can allow one to explore the role of social and informational connection in the fabric of migration and remittance networks. In addition, network analysis should be an effective technique to investigate the mechanism through which migration costs due to geographical distance affect the patterns of migration and remittance networks. These two potential issues are left for future research.

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Declaration of Competing Interest

The author claims that the manuscript is completely original. The author also declares no conflict of interest.

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