Policy Research Working Paper 9110

# Migration in Libya

## A Spatial Network Analysis

*Michele Di Maio*
*Valerio Leone Sciabolazza*
*Vasco Molini*

WORLD BANK GROUP
Poverty and Equity Global Practice
January 2020

Policy Research Working Paper 9110


## Abstract

This paper provides the first systematic analysis of migration to, within, and from Libya. The data used in the analysis are from the Displacement Tracking Matrix data set of the International Organization for Migration. The analysis uses this unique source of data, combining several techniques to analyze various dimensions of migration in Libya. First, the paper provides a detailed description of the demographic characteristics and national composition of the migrant populations in Libya. Next, it discusses the determinants of migration flow within Libya. The findings show that migration in Libya can be characterized as forced migration, because conflict intensity is the main determinant of the decision to relocate across provinces. Finally, the paper describes the direction, composition, and evolution of international migration flows passing through Libya and identifies the mechanisms of location selection by migrants within Libya by identifying hotspots and cluster provinces.


This paper is a product of the Poverty and Equity Global Practice. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at vmolini@worldbank.org.

# Migration in Libya: A Spatial Network Analysis

Michele Di Maio
Sapienza University of Rome

Valerio Leone Sciabolazza
University of Naples Parthenope

Vasco Molini*
The World Bank (Rabat, Morocco)

**JEL classification:** F22; D61; O12; N47

**Keywords:** migration, forced migration, conflicts, Libya

---

* Corresponding author, mail: vmolini@worldbank.org. The authors acknowledge financial support from the World Bank. We thank colleagues from the International Organization for Migration (IOM) for making available their datasets. We also thank Francesca Recanatini, Nandini Krishnan and Maria Davalos for their comments and suggestions on an earlier version of the manuscript. The authors are solely responsible for any errors this paper may contain.

# 1. Introduction

Libya is among the African countries with the highest proportion of migrants – around 12% – with respect to the total population. At the same time, Libya is a major gateway to Europe, with up to 90% of people crossing the Mediterranean Sea departing from its borders (IOM 2017a).

This paper provides the first overall assessment of migration patterns to, within, and from Libya during 2017 and 2018. Despite the humanitarian, political, and economic relevance of migration, lack of data has prevented an in-depth analysis of migration in Libya from being conducted. Using the most detailed data available, this paper contributes to the understanding of migration in conflict-affected developing countries, documenting the characteristics, location decisions, and movements of migrants, returnees, and internally displaced persons (IDPs) in Libya.[1]

The data used in the analysis are from the Displacement Tracking Matrix (DTM) data set of the International Organization for Migration (IOM). The DTM tracks population mobility in Libya using data collected through periodic surveys and provides detailed information on international migrants, refugees, and IDPs, whether staying in or passing through the country. To the best of our knowledge, this is the first paper to use multiple waves of DTM data for a rigorous empirical analysis of international migration patterns in Libya.

Our analysis provides a number of results. First, we document the geographical distribution of international migrants in Libya and characterize them in terms of gender, age, country of origin, and preferred destination country. Then, we describe their movements to, within, and from Libya. To begin, we establish that migration in Libya can be characterized as forced migration because conflict intensity is the main determinant of the relocation decision across provinces. Next, we describe the direction, composition, and evolution of international migration flows passing through Libya. We identify the network of migration routes connecting Libyan provinces and describe the mechanisms of location selection by migrants within Libya by identifying hotspots and cluster provinces. Our results indicate that there is a dense net of connections across Libyan provinces in terms of migration movements. From 2017 to 2018, the number of hotspots increased, and the area around Tripoli continues to represent a cluster of provinces attracting migrants. At the same time, we document a reduction in the total number

[1] IOM (2016a) defines migrant as "any non-Libyan national present in the country. Migrants can include refugees and asylum seekers (fleeing war, conflict, persecution, etc.) as well as individuals who left their homes due to lack of economic perspectives in their places of origin, or who are in Libya to study." An IDP is any "person or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized state border." A returnee is "any person who was displaced internally or across an international border but has since returned to his/her place of habitual residence".

of migrants and that migrants became more evenly distributed over the various routes connecting Libyan provinces.

Examining the international network of migrants' movements to and from Libyan provinces, we identify three migrant passages running across the country: an eastern route (from Alkufra to Tobruk), a central route (from Murzuq to Tripoli), and a western route (from Ghat province to Zwara and Aljfara provinces). The evolution of the international migration network between 2017 and 2018 indicates a change in the network structure; whereas the 2017 network was very dense, the 2018 network was far sparser. The number of origin countries decreased, and the number of different routes within Libya that migrants from each country used decreased as well. At the same time, the number of destination countries decreased, and each destination country had fewer connections. In particular, some of the African countries reported as preferred destinations in 2017 disappeared from the list in 2018, namely Chad, Mali, and Nigeria. The fact that these are all conflict-affected countries suggests that migrants who initially hoped that they would be able to return have instead outmigrated to Europe. This would explain the drastic reduction in the number of connections between Libyan provinces. To the extent that these connections indicate that migrants intend to remain in Libya or return to their country of origin, we interpret this as evidence that migrants have become more likely to leave Libya and go to Europe.

Our analysis combines a set of tools taken from spatial statistics and network analysis. Methods from spatial statistics are used to analyze location choices and identify common patterns in migration movements. These methods also allow us to identify hotspots and clusters and major gateways for the international migration network passing through Libya. Social network analysis is used to map the network of migratory movements, determine the level of migratory pressure in different provinces, and identify the formation of network hubs. To the best of our knowledge, this is the first paper to use these techniques to characterize the formation and evolution of human movements across space.

Political attention is increasingly being paid to migration in developing countries, but there are still significant gaps in the understating of this complex phenomenon. Analysis of the Libyan case can help identify factors that determine international and internal migration in a context of high risk and uncertainty. By documenting the characteristics, determinants, and evolution of migration in Libya, our paper provides the first systematic, medium-term analysis of the evolution of migration flows in the country. Furthermore, it illustrates a set of methodologies that can be easily replicated to expand the analysis over time by including additional waves of the DTM. Understanding the medium-term evolution of migration in Libya is a precondition for any policy intervention that goes beyond the immediate response to emergency or short-term changes. In this sense, our analysis, by showing how to use DTM data to characterize the evolution of migration patterns to, within, and from Libya, indicates how to use available data to track migrant movements and thus identify the best responses to the challenges that migration flows create. One of the main findings of our analysis was that migration

flows are complex phenomena that must be analyzed using multiple complementary methodologies to be correctly described and understood. To the best of our knowledge, this paper provides the most accurate and detailed analysis of migration to, within, and from Libya. We intend this paper as a first step in the attempt to link migration flows in Libya to individual, household, group, and location socioeconomic characteristics. More generally, our analysis documents important stylized facts that should inform the discussion about causes and consequences of migration to and from conflict-affected countries.

The paper is organized as follows. Section 2 discusses the literature on migration, focusing on studies using spatial statistics and network analysis. Section 3 provides some background on migration in Libya since the First Civil War (2011). Section 4 describes the data we used. Section 5 present the results of the empirical analysis. Section 6 concludes.

## 2. Literature

The literature on migration has grown dramatically in recent years. One of its main objectives has been identifying the supply (push) and demand (pull) factors that affect the decision to migrate. According to theory, on the supply side, the main driver of relocation choices is income opportunities (Borjas 1994), whereas on the demand side, national policies and labor market conditions are the main determinants of migration flows (Ortega and Peri 2012). Consistently, expected lifetime benefits from migrations are heterogeneous across individuals, and they determine how migrants self-select from specific pools of the population (Borjas 1987; Beine, Docquier, and Özden 2011).

In recent decades, two main phenomena have characterized migration: legal channels for migration have been restricted (Friebel and Guriev 2013), and sending countries are often experiencing violent conflicts affecting civilians (Marshall and Elzinga-Marshall 2017). As a result, the traditional push and pull factor framework seems to not suffice anymore when analyzing modern legal and illegal migration trends, especially in developing countries (Clemens 2014). Whereas from a theoretical standpoint there are several determinants common to regular and irregular migration,[2] some factors are unique to the latter. In particular, some studies have shown that uncertainty and risky situations (e.g. conflicts) alter the conditions under which individuals form their set of preferences, suggesting that the same pull and push factors may influence regular and irregular migrants differently (Voors et al. 2012; Arcand and Mbaye 2013; Callen et al. 2014). At the same time, there is some evidence that self-selection and

[2] According IOM (see https://www.iom.int/key-migration-terms), regular migration is migration that occurs in compliance with the laws of the country of origin, transit and destination. By opposite, irregular migration is a movement of persons that takes place outside the laws, regulations, or international agreements governing the entry into or exit from the State of origin, transit or destination.

destination choices play different roles for regular and irregular migrants. For instance, relocation decisions of the latter depend more on the existence of a diaspora network at their destination and less on the traditional pull and push factors (Manchin and Orazbayev 2018; Friebel et al. 2018). Taken together, this evidence suggests that uncertainty alters the conditions under which individuals form their set of preferences and sort themselves into migrants and nonmigrants (Ceriani and Verme, 2018). At the same time, uncertain and risky contexts such as conflict and natural disasters are likely to influence the decision to migrate illegally and which route to use to reach the destination country.

A related set of studies have examined the phenomenon of forced migration and its effect on both migrants and host communities (Kondylis 2008; Ibáñez and Moya 2010; Ruiz and Vargas-Silva 2013; UNHCR 2017a; Dustmann et al. 2017; Verme and Schuettler 2019). Although availability of data is a major constraint, the number of studies examining these factors is rapidly increasing. Specifically, studies on the effect of forced migration on migrants have examined access to high incomes (Sarvimäki, Uusitalo, and Jäntti 2009; Bauer, Braun, and Kvasnicka 2013) and skilled jobs (Falck, Heblich, and Link 2012). Other studies have examined the consequences of natives' exposure to refugees and asylum-seekers. In particular, they have considered changes in the host community economic structure, especially in relation to the labor market context (Braun and Mahmoud 2014; Maystadt and Verwimp 2014; Tumen 2016) and consumer prices (Balkan and Tumen 2016); alterations in natives' political preferences that determine a shift in local attitudes toward refugees (Lergetporer, Piopiunik, and Simon 2018); and voting behaviors (Otto and Steinhardt 2014; Dustmann et al. 2016; Dustmann et al. 2017; Sekeris and Vasilakis 2016; Steinmayr 2016).

Study of the network dimension in which a migration flow is embedded is key to understanding how migrants sort themselves and provides a way to map relationships between local communities and diasporas. As such, migrant networks have long been shown to alter the context within which migration decisions are made by providing information about opportunities and facilitating cross-border activities (for a recent review, see Leone Sciabolazza 2018). One important application of these methodologies is the study of illegal migration. This branch of literature has found that networks serve as linking and resource transmission mechanisms (Donato et al., 1992; Singer and Massey 1998; Gathmann 2004) and facilitate use of illegal routes with the help of smugglers (Dolfin and Genicot 2010). Measuring, collecting, and interpreting data on irregular migration is difficult (Koser 2010), and research on determinants of illegal border crossing is still in early stages and has mainly focused on the frontier between Mexico and the United States (for a review, see Ibarraran and Lubotsky 2007). Little is known about the development of large-scale irregular migration network systems (Cvajner and Sciortino 2010), and only recently have attempts been made to document the functioning of networks operating for asylum seekers in the United Kingdom (Koser and Pinkerton 2002) and the industry of illegal migration in Brazil (Fazito and Soares 2015), Europe (Sanchez et al. 2018), and Africa (for a brief review, see

Frouws and Horwood 2017). Apart from some anecdotal evidence in qualitative studies, the geographical aspects of the network of irregular migrants and asylum seekers have been neglected in the literature. To our knowledge, while some recent reports have incorporated the spatial factor into the description of their findings (Barthel and Neumayer 2015; Cummings et al. 2015; Echevarria and Gardeazabal 2016), only three studies (Rotte, Vogler, and Zimmerman 1997; Hatton 2004; Melander and Öberg 2007) have explicitly considered this aspect in their analysis.

## 3. Migration in Libya

Libya has experienced a prolonged period of conflict and instability since the fall of the Gaddafi regime in 2011 and the beginning of the First Libyan Civil War. The uncertain political situation, characterized by lack of a government able to control the territory, has contributed to the significant number of displaced Libyans and made Libya one of the most important hubs for human smuggling and refugee routes since 2011 (Cummings et al. 2015). Smuggling has become very remunerative in the country, it is increasingly concentrated in the hands of a few well-organized criminal networks, and is dominated by armed groups that use this activity to raise money to buy weapons and consolidate their hold on their controlled areas (Global Initiative against Transnational Organized Crime 2017).

Libya is a hub of legal and illegal migration transit (IOM 2017b). Migrants directed to Europe are going through Libya with the objective of reaching the northern coast of the country and from there the other side of the Mediterranean Sea[3] (IOM 2017b; Mixed Migration Hub 2015; IOM 2015; UNHCR 2017b). Libya is the destination of two of the most important asylum-seeker routes to Europe (figure 1). Between 2011 and 2016, approximately 630,000 people used the "Central Mediterranean route", the main route of arrival via irregular migration to Europe, to reach Italy (IOM 2016b; European Commission, 2017a). In 2016, more than 181,000 people were detected on the Central Mediterranean route, almost 90% of whom departed from Libya (European Commission 2017b).

Although Libya is primarily a migrant transit area, it is also a destination country for international migrants, including refugees. In fact, a large number of them are the economic migrants who migrate to Libya planning to stay in the country. Before the First Libyan Civil War, migrants accounted for more than 10% of the total Libyan population (World Bank 2015).[4] Since 2011, a significant number

[3] IOM (2017b) reports serious human rights violations along these smuggling routes. Migrants often experience significant violence, including extortion, exploitation, physical and sexual violence, kidnapping, and robbery, with many losing their lives as a result of being transported under inhumane conditions at sea, in the desert, and in other transit locations (Frouws and Horwood 2017). Smuggling into and outside Libya has become a very remunerative activity (UNHCR, 2018). Migrants smuggling is increasingly concentrated in the hands of criminal networks, dominated by armed groups that use this activity to raise money for buying weapons and consolidate their hold on their controlled areas (Global Initiative against Transnational Organized Crime, 2017).

[4] Historically, the Libyan economy has relied heavily on foreign workers. Prior to the 2011 conflict, nearly 50% of Libya's labor force were foreigners, between 1.2 million and 1.5 million workers. During the conflict, an estimated 1 million foreign

of migrants have left Libya, and there has been a large shift in the composition of migrants according to nationality. The percentage of migrants from the Arab Republic of Egypt, Chad, Niger, Nigeria, and Sudan has significantly increased since 2015, and the percentage from Palestine, Iraq, and Somalia has decreased significantly.

International and domestic migration flows, internal displacement, political instability, and conflict interact in complex ways in Libya. Libya has the largest number of international migrants in the subregion, at more than 770,000 (UN DESA 2016) (table 1).

Migrants headed to Europe often settle in Libya for some time before starting their second migration journey (World Bank 2018). Others—including refugees—remain stranded in Libya or other countries in the Maghreb (IOM 2015). Data from the Euro Asylum Seekers' Survey 2017 indicate that a substantial share of asylum seekers who migrate through Libya previously worked for a prolonged period in the country. For those coming from Sub-Saharan Africa, it is likely that the conflict transformed Libya from a destination into a transit country.

## 4. Data

Data used in this analysis come from the Flow Monitoring component of IOM's Displacement Tracking Matrix (DTM). The DTM tracks movements of migrants, IDPs, and refugee individuals and groups through the data collected at the Flow Monitoring Points (FMPs) (IOM 2017a). The FFMP tracking system consists of two data collection layers: 1) the Baseline Assessment Surveys identify the frequency and volume of migrants in and crossing through a specific point (FMPs), and 2) the Profile Surveys gather information about migrant profiles, including age, gender, area of origin, level of education, key transit points on their route, cost of the journey, motives, and intentions.

In our analysis, we use the data from the Baseline Assessment Surveys for the period January 2016 to April 2018.[5] Data are collected daily and quantified and reported monthly. The Baseline Assessment Survey collects information on number of migrants residing in, arriving at, and leaving from a specific FMP.[6] For those already present at the FMP, it records the nationality, planned destination, and length of stay. According to the DTM methodology (IOM 2016a), the primary method of data collection is

laborers fled Libya (World Bank, 2015). Foreign workers are employed in both high skilled and qualified jobs, for which domestic workers are in short supply, and low skilled and manual jobs, that Libyans are culturally reluctant to take (Expertise France, 2016).

[5] DTM data are considered in general to be accurate, although it is difficult to assess their absolute quality, as the DTM data are the only existing comprehensive data set on migration flows in Libya.

[6] As reported in the official DTM documentation (IOM 2016a), before the first round of DTM data collection, the team sought to identify transit. The FMPs identified in this period (November-December 2015) have been regularly updated, as new transit points have emerged or disappeared.

through key informant interviews, which are conducted in meetings with local crisis committee representatives, humanitarian and social organizations, community and tribal representatives, representatives of displaced groups, and other representatives from Baladiya[7] offices (e.g., Social Affairs, Muhalla Affairs) at a target location or a remote location. The choice of location is determined according to its accessibility and safety for interviewers and interviewees and its general security situation. When direct interviews were not possible, remote interviews were conducted. In practice, the three most common nationalities at the FMP during the week of the assessment, the three most popular destinations for the migrants at the FMP during the week of the assessment, and the percentage of migrants at the FMP within each length-of-stay category (e.g., less than two weeks, two weeks to three months) in the location during the week of the assessment are recorded. For those arriving or departing, information is collected on nationality and planned destination using the same questions.

Given how the questionnaire is constructed, the unit of observation in the data is the FMP. This allows the mapping and tracking of the FMPs' evolving characteristics in terms of the relative presence of groups of individuals of given nationalities, preferred destination countries, and the like. Yet, the structure of the data also poses some severe limits to the analysis. For instance, it is not possible to link nationalities to preferred destination countries in each FMP because information is collected as aggregates (the three most common nationalities and three most preferred destination countries).

The pool of migrants observed at the IOM FMPs in 2017 and 2018 constitutes the population under study. We use data from 95 FMPs that are constant across rounds of data collection, which allows us to track the movement of migrants in a consistent way and to compare flows across time in the same area. Seventeen additional FMPs have been included during the period of analysis to allow data collection to cover new points that more migrants were crossing through for security reasons.

The locations of the FMPs are shown in figure 2. Although there is at least one FMP in each province, distribution across provinces is not homogenous; Almargeb, Aljafara, Murzuq, Tobruk, and Tripoli each have five FMPs, and Wadi Ashishati, Ghat, and Nalut each have only one.

Our analysis is performed by aggregating data at the provincial level.[8] The map of the provinces is shown in figure 3. In what follows, unless differently stated, each metric is obtained by averaging the observations recorded in a province within a year (2017 and 2018).

[7] Second-level administrative subdivision of Libya.

[8] By aggregating FMPs data at the provincial level, we use all information available yet avoiding the problem of missing data due to the absence of an FMP in a specific round.

# 5. Results

## 5.1 Characteristics of the migrant population

### *5.1.1 Demographic characteristics and spatial distribution of migrants*

We begin our analysis by looking at the total number of migrants recorded during 2017 and 2018 in each Libyan province (Figure 4a). Almagerb, Alkufra, and Bengazi had the most migrants registered, and Al Jabalal Al Akhadar, Ghat, and Ubari had the fewest.[9] Figure 4b shows that the number of migrants has increased in almost all provinces from 2017 to 2018, with a huge increase in Almargeb. Finally, Figure 4c documents high heterogeneity in terms of number of migrants across Libyan provinces during the period under analysis. There was a slight increase in the number of migrants between rounds 5 and 16 (January 2017–February 2018). In round 17 (March-April 2018), the data indicate a massive increase in the number of migrants in almost all provinces. After that, the last three rounds of 2018 included in our data set show a reduction in the number of migrants registered at the FMPs, except in Almagerb, where the number of migrants remained very high.

DTM data also allow us to recover some information on the demographic composition of migrants. These are represented in figure 5 at the Libyan level and in figure 6 at the provincial level. The large majority (97%) of migrants are males. In 2017, females and minors were between 3% and 5% of the migrant population, respectively. The most diverse composition of the population is found in the Western regions in 2017 (Aljufra, Ghat, and Nalut). In 2018, the shares of women and minors were significantly higher.

### *5.1.2 Top origin countries and preferred destinations*

In each survey round, for each FMP, DTM data report the three most common migrant nationalities registered and the three most preferred destination countries for the migrants located at that FMP.

Table 2 shows the five nationalities most commonly registered at the FMPs in 2017 and 2018. The order of the nationalities indicates how frequently they were found.

Table 3 shows the five more preferred arrival destinations registered at the FMPs in 2017 and 2018.

[9] Baseline Assessment data are repeated estimates of net stocks of migrants at the FMP level. This implies that there is the possibility of double counting (counting the same migrant at two different FMPs during a given time period). There is a trade-off; using the monthly data would minimize the probability of double counting (it is unlikely that the same individual would move between FMPs over such a short time period), but high frequency data may be affected by a high level of variance, which would make difficult to analyze longer-time trends in the evolution of migration flow. For this reason, we decided to use the yearly average of the monthly data at the FMP level (which are themselves an average of data collected each two weeks).

The majority of the most common nationalities and preferred destinations remain the same in 2017 and 2018. Interestingly, Egypt appears as an origin and a destination country and Libya is the destination country for a large number of migrants.

### 5.2 Spatial and network analysis of migration flows

In the following sections, we use network analysis and spatial statistics to document a set of stylized facts regarding migration flows in Libya.

As the first step, we characterize the determinants of migration flows across Libyan provinces. To this end, we use a Separable Temporal Exponential Random Graph Model (STERGM), which is an extension of the Exponential Random Graph Model (ERGM). The ERGM model estimates the probability distribution from which the observed network of migration flows is likely to be drawn. Specifically, the model is used to infer which factors are most informative in explaining the process of formation of the network; for example, a migration flow is more likely to be observed between two Libyan provinces if the province of arrival has experienced fewer episodes of violence than the province of origin. The STERGM extends this analysis to the longitudinal case, i.e. observing the network at different points in time, and is used to estimate the probability of creation and of dissolution of a migration flow between two provinces.

The variables selected to be included in the model using the goodness-of-fit procedure are: i) the difference in the intensity of night lights between two provinces (to proxy for the different levels of economic activity); ii) the (log) distance between two provinces; iii) the difference in the number of conflict events taking place in two provinces[10]; iv) the difference in the number of migrants hosted in two provinces; v) the marginal propensity to create intransitive relations among provinces, which is proportional to the number of stars detected in the network: i.e., province *i* is linked to provinces *j* and *k*, which are not connected to each other; and vi) the number of links in the network (which is used in this model as a sort of intercept). Each variable is a proxy for a potential driver of migration. Variables i) and ii) are used to measure the economic and physical distance between two provinces, as in the gravity approach; variable iii) controls for potential risk factors pushing migrants to leave one province; variable iv) identifies provinces that are highly attractive for migrants; and variable v) identifies the presence of provinces that act as a bridge between unconnected provinces, having the advantage of a brokerage position (Burt, 1992) and potentially playing the role of hub in the network: i.e. provinces

[10] Data on conflict events are from the ACLED data set (Raleigh et al. (2010).

that are central to the network of migration flows and that "broker" the movement of migrants along different human corridors.

Table 4 presents the model specification that produced the best results in terms of goodness of fit (Hunter et al., 2008).[11] The results of STERGM are to be interpreted in a way similar to logit estimates: they assess the likelihood of observing the formation or dissolution of a link between two provinces with respect to a situation in which migrants move at random.[12] Results indicate that the only significant driver in the formation of a migration link between two provinces is conflict; the probability of observing a migration flow toward a province with fewer conflicts is 18% higher with respect to a situation in which migrants move at random. By contrast, the statistically significant (counter) drivers of dissolution of migration flows are the variables intransitivity and differences in economic activity. The former indicates a lower probability to observe the dissolution of hub structures in the network than by chance: i.e. over time, migrants depart from several provinces and reach different destinations, but their routes tend to overlap in some provinces that are used as a bridge in the network.[13] The latter shows that it is less likely to observe a flow to dissolve when this is directed to a wealthier province. Based on these results, we argue that migration in Libya should be characterized as forced migration because conflict intensity is the main determinant of relocation decision across provinces.

*5.2.1 Hotspot provinces and clusters of provinces in Libya*

Next, we use spatial statistics to compare the numbers of migrants in neighboring provinces. In practice, we test for the presence of spatial autocorrelation in migrant distribution across the Libyan provinces (whether the number of migrants was similar in provinces that are near each other) by identifying hotspot provinces and clusters of provinces (Anselin 1995; Barthel et al. 2015).[14]

The results of the identification of hotspots are presented in figure 7. Two provinces can be characterized as hotspots in 2017 and 2018 (Almarj and Wadi Ashshati). In 2018, we observe the emergence of four new hotspots (Ejadabia, Ghat, Murzuq, and Tobruk). The small number of migrants

[11] Goodness of fit assesses the extent to which the STERGM specification incorporates all the fundamental drivers of connectivity in the network and correctly replicates the structural features of the observed network, resulting in unbiased coefficient estimates. Specifically, as is standard in the literature, we examined the extent to which our model specification correctly replicated the distributions of degree (number of network connections of each province), the number of edgewise shared partners (number of partners that a linked dyad of provinces shares), and minimum geodesic distance (minimum number of links between two provinces).

[12] ERGM estimates are in log odds, so the probability of a connection is obtained as $\frac{e^{-x}}{1+e^{-x}}$, where $x$ is the estimated coefficient of a given covariate. For example, consider the coefficients associated with the variable night lights (1.77 and 1.05): the probability of observing the formation and dissolution of a link between a province with low night light intensity and one with high night light intensity is $\frac{e^{-1.77}}{1+e^{-1.77}} = 0.14$ and $\frac{e^{-1.05}}{1+e^{-1.05}} = 0.74$, respectively.

[13] To be more specific, the variable assesses the extent to which two provinces tend to have $x$ shared connections, regardless of whether the two provinces themselves are tied, controlling for marginally decreasing returns.

[14] A hotspot province is a province with significantly more migrants than in neighboring provinces. A cluster of provinces is a group of provinces hosting many (or few) migrants.

in Almarj with respect to surrounding provinces might indicate that this area acts as a buffer zone separating provinces with a high concentration of migrants from areas less involved in migrant passages. By contrast, that there are more migrants in Wadi Ashshati than in all other provinces on the Libyan western border suggests that this area was a preferred point of access for migrants arriving from the western side of the country in 2017 and 2018. Likewise, the emergence of hotspots in 2018 indicates a more concentrated presence of migrants in some provinces (Ejadabia and Murzuq) and a decrease in adjacent provinces (Ghat and Tobruk). The fact that these provinces are located at the Libyan border suggests that they are used as new entering points in Libya, which is consistent with the hypothesis of the emergence of new migrant routes.

Our analysis also reveals a cluster of provinces around Tripoli hosting a large number of migrants. The level of spatial autocorrelation in the distribution of migrants in this area increased from 2017 to 2018 and became significant at the 5% level in 2018.

*5.2.2 Migrant movements within Libya*

FMP data can be used to map the internal movements of migrants (between Libyan provinces). For each FMP, DTM data indicate which Libyan province is the most common origin for the migrants at the FMP. Using this information for all FMPs in our data set, we determine the internal movements of migrants across all Libyan provinces.

The results of the analysis for 2017 and 2018 are shown in figure 8. Capitals of provinces *i* and *j* are connected if there is movement from an FMP located in *i* to an FMP located in *j*. The size of the flow is proportional to the average number of migrants registered in the FMP.

For each year, the graphs show a dense net of connections; each province is connected to at least two other provinces, suggesting that, in general, for each province, there is not a unique migration route from or to any other province. In determining the migration route chosen, it is thus likely that individual-level characteristics play an important role.

Comparing the two graphs, we also identify a clear change in internal migration routes between 2017 and 2018. In 2017, three major corridors run through Libya (figure 8a): the eastern route, connecting Alkufra, Ejdabia, and Benghazi; the central route, from Murzuq to Tripoli; and the western corridor, from Ghat to Tripoli. The figure also shows that the second route was the most used at the time and that the eastern and central routes are less clearly recognizable in 2018 (figure 8b). This might be in part because of a general reduction in the number of migrants in the provinces, as the decrease in the width of the network linkages suggests, although it also points to a reorganization that occurred along the corridors, with migrants more evenly distributed over all paths.

*5.2.3 Clustered destinations within Libya for same-country-of-origin migrants*

To identify the possible presence within Libya of clustered destinations for migrants from the same country of origin, we analyzed the movements of same-country-of-origin migrants across Libya and over time.[15]

The results are presented in figure 9. Our analysis identifies clusters of country-of-origin migrants in five different cases. The first is Egyptians arriving in the area near Tripoli and Tobruk in January 2017.[16] The second is Ethiopians in Tobruk in July 2017. The third is migrants from Benin arriving in the area of Sebha in August 2017. The fourth, also in August 2017, is two clusters of Eritreans in Alkufra and Tobruk. The fifth is migrants from Bangladesh in the area of Tripoli in January 2018. These results support the idea that same-country-of-origin migrants, moving in the same direction, sort themselves into close routes following similar paths.

*5.2.4 International migration flows to and from Libya*

Next, we move to the analysis of the direction and composition of international migration flows to identify the backbone of migration in Libya.[17]

Figure 10 reconstructs the international migration routes passing through Libya. We create a network in which origin country *i* and destination country *j* are connected when country *i* is found as the major source of migrants at one of the FMPs of a province at least once in a year, and country *j* is registered as the preferred destination for the majority migrants in one of said FMPs at least once in a year.[18] In figure 10, the circle segments represent origin and destination countries of international migration routes through Libya. The color of a segment is uniquely associated with a country, and its size indicates the total number of incoming and outgoing migrants in that country. The direction of the flow is encoded

[15] To conduct this analysis, we followed four steps. First, we reconstructed the network of internal movements at the monthly level (similar to what was done in figure 8). Because we are interested in short-term dynamics, we used monthly data on migrants registered at the FMPs. Second, we identified significant spatial concentrations of migrants at FMPs located near each other. Specifically, we tested whether same-nationality migrant clusters occurred more frequently than would be expected if FMPs were distributed in a spatially random way. To this end, we used the join count test for k-colored factors (Cliff and Ori, 1981; Upton and Fingleton, 1985). We defined close FMPs as those located within a radius of 250 km, which is the minimum radius required to make sure that each FMP has at least one neighboring FMP, a condition that is necessary for implementation of the join count. Because only 5% of the FMPs are located more than 250 km from all the others, we dropped them from the sample. Third, for each month, *t*, we identified the nationalities for which the test indicated significant spatial concentration. Fourth, for each of these nationalities, we plotted the location of the FMPs within 250 km of each other where the majority of the arrivals corresponded to nationality *i* at time *t*.

[16] The distance between these two cities is more than 1,000 km, more than four times the radius used to detect migrant agglomerations, which means that the test evaluated the movements in these provinces separately and indicates that the two effects are independent.

[17] This exercise requires assuming that migrants found in an FMP are all moving along the same route and are all trying to reach the most-preferred country of arrival recorded at the FMP. The assumption is instrumental to identifying the migration network passing through Libya, which is discussed below in Section 5.2.5.

[18] This analysis is conducted under the assumption that migrants found at an FMP are all moving along the same route and are equally interested in reaching the top 1 preferred country of arrival recorded at that FMP.

as follows. The flow originates from country *i* if it is adjacent to the segment circle of country *i* and it has the same color as the segment; the flow ends in country *i* if it is adjacent to the segment circle of country *i* and does not have the same color as the segment.[19] Similar colors are used to identify larger geographical areas: pink for East Africa, violet for North Africa, green for West Africa, yellow for Asia, red for the Americas, and blue for Europe.

The investigation of the origins of migrant flows shows that West African countries (green) are the origin for most migrants. Outside Africa, Asia, specifically Bangladesh (yellow), plays a major role. Analysis of the destination of migrant flows reveals that Europe (blue) is the preferred destination for migrants. The second-most-preferred destination in 2017 is Western Asia (yellow: Kuwait, Israel, Saudi Arabia, Turkey), but this almost disappears in 2018.

Comparing 2017 and 2018, changes in the direction of flows originating in a specific area can be identified. For East Africa, namely Ethiopia, Eritrea, and Somalia, we observed an increase in the destinations reached, as shown by the increase in the number and width of the pink flows.

Finally, the figures allow the composition of migrants' nationality at destination to be analyzed by examining the colors of incoming flows. For all receiving countries, most migrants originated in West Africa (green), but we also observed that East Africa played an increasing role, with a significant increase in the number of pink flows reaching Italy, the Netherlands, and Sweden. Less notable, but still relevant, is the increase in the number of yellow flows, representing the Asian countries, reaching France and Germany.

*5.2.5 International migration flows through Libyan provinces*

Using data about origin and destination countries registered at the FMPs, we track migration flows connecting migrants' origin countries to Libyan provinces and Libyan provinces to migrants' preferred destinations.

Figure 11 presents the network of origin countries and Libyan provinces for 2017 and 2018. Origin country *i* is connected to Libyan province *j* if, for at least one round in a given year, the majority of migrants observed at an FMP in province *j* departed from country *i*. These graphs show two important changes that occurred between 2017 and 2018; the number of origin countries decreased,[20] and there is a notable decrease in the density of the graph, meaning that migrants from a given origin country are

[19] For ease of interpretation, we removed connections signaling migrants returning to their home country or intending to remain in Libya.

[20] The top origin countries disappearing from the graph are Benin, Cameroon, Central African Republic, Democratic Republic of Congo, Guinea, Guinea-Bissau, Kenya, Malawi, Morocco, Togo, and Tunisia. At the same time, we observe the appearance of Pakistan.

found in fewer Libyan provinces in 2018 than in 2017. These results suggest a consolidation in the set of origin countries and in the routes that the migrants departing from these countries followed.[21]

Similarly, figure 12 shows the network between Libyan provinces and preferred destination countries for migrants in each Libyan province in 2017 and 2018. Libyan province *j* is connected to destination country *i* if, for at least one round in a given year, the majority of migrants observed in an FMP located in province *j* declared that *i* is their preferred destination country. Some interesting changes appear in 2018. First, the number of destination countries decreases from 25 in 2017 to 16.[22] Second, each of the remaining destination countries has fewer connections, and the network became sparser in 2018 than in 2017. This applies to European (e.g., Germany) and African (e.g., Sudan) countries. Third, some of the African countries reported as preferred destinations in 2017 disappear from the list in 2018 (Chad, Mali, and Nigeria). Our data do not allow us to identify a precise reason for the drastic reduction in the number and the connections of network destinations. On the one hand, it may be that migrants are reconsidering the possibility of returning to their home countries or remain in Libya. On the other hand, the fact that these are all conflict-affected countries suggests that, after initially hoping to be able to return, migrants might have decided to go to Europe instead. The latter hypothesis seems the most plausible, hence we interpret this as evidence that migrants are increasingly leaving the country.

The information provided in figures 11 and 12 is combined in figure 13, which shows, for each province, the top migrant country of origin and preferred destination. The figure shows three notable facts. First, Libya is the final destination for migrants in different provinces (e.g., Sirt and Benghazi). Second, some African countries appear as origins and destinations (e.g. Egypt, Chad, Mali, Niger). These two findings complement the results shown in tables 2 and 3 (top five nationalities and top five arrival destinations registered at an FMP). They indicate that, although Egypt is the only African country among both the top five sending and top five receiving countries, other African countries are the final destinations of many migrants. Third, there is a clear change in the network structure. Whereas the 2017 network is very dense, with many countries participating as origin countries, the 2018 network is far sparser.[23]

The network represented in figure 13 can be used to identify migration patterns based on the observation that not all migration linkages are equally important for a country. To this end, using a standard

[21] Graphs reproducing the network for the top three sending countries each year (Egypt, Niger, Nigeria in 2017; Egypt, Niger, Sudan in 2018) are available upon request.
[22] The top destinations disappearing from the graph were Cyprus, Kuwait, Israel, Malaysia, Mali, Nigeria, Spain, Tunisia, Turkey, and the United States. At the same time, we observe the appearance of Belgium.
[23] There might be two reasons for this: a diversion in migrant routes, causing a contraction in the number of countries sending migrants to Libya (some countries disappear in the 2018 network because migrants from these places travel across countries other than Libya), and a stronger concentration of same-country of origin migrants along similar routes (migrants from a given sending country are found in fewer provinces in 2018 than 2017). As a consequence, the number of connections for a given sending country diminishes, and network density decreases.

approach, we begin reducing the level of complexity of the network's structure by partitioning it into communities (sets of nodes densely connected to each other and more sparsely connected to the rest of the network).[24] In other words, a community is a group (cluster) of countries with tightly interrelated migration linkages among them that are less interconnected with countries outside the group (cluster).

Figure 14 displays the communities identified based on the network of origin and destination countries of international migrants in Libyan provinces.[25] Colors are used to identify provinces belonging to the same community of the migration network (areas characterized by the same composition of migrants and the same preferences as for destination countries).

The results indicate that provinces belonging to the same community (characterized by the presence of migrants originating in similar countries and having similar preferences for the destination country) are located close to each other. This suggests the presence of specific migrant passages running across the country. For instance, figure 14a indicates the presence of at least three definite routes: the Western route (aquamarine), beginning in the province of Ghat and ending in the provinces of Zwara and Aljfara; the Eastern route (red), from Alkufra to Tobruk; and the Central route (green), from Murzuq to Tripoli. A major change occurred in 2018 (figure 14b). The Central (violet) and Eastern (green) routes remained almost unchanged, but the Western route split into two different corridors. The first connected the province of Wadi Ashshati to Misrata (light green), and the second connected the eastern province of Nalut to the central province of Sirt and the western provinces of Benghazi and Al Jabal Al Akhdar (red). This might indicate that, from 2017 to 2018, there was a shift in migrants' routes, and eastern cities became passage points to reach the other side of the country.

## 6. Conclusion

This paper has presented the first analysis of migration in Libya. To analyze this complex phenomenon, we have used DTM data of IOM and a rich toolkit that combines spatial statistical analysis and network analysis. Methods from spatial statistics were used to analyze location choices and to identify common patterns in migration movements and the presence of hotspots and clusters. Social network analysis was used to map the network of migration movements, determine the level of migratory pressure in different provinces, and identify the formation of network hubs.

[24] Community search to study networks of migration flows has been used in Davis et al. 2013; Peres et al. 2016.
[25] Several community detection algorithms have been proposed (see Fortunato 2010). The choice of one algorithm over another is usually data driven and determined by the algorithm's ability to produce a meaningful community structure, with significant within-community cohesion and between-community separation (Clauset, Newman, and Moore 2004). A standard measure used to determine algorithm fit to the data is modularity, a metric ranging between -1 and 1, with lower values reflecting poor community structure (many between-community edges and few within-community edges) and values closer to 1 indicating good community structure. In the case of the Libyan migration network, the algorithm producing the best partition is the spinglass algorithm (Reichardt and Bornholdt 2006), which returns a modularity value greater than 0.2 for 2017 and 2018.

Our results indicate that migration in Libya can be characterized as forced migration: conflict intensity is the main determinant of the decisions to relocate from one province to another. The analysis of migration flows across provinces indicates a dense network of connections; for each province, there is not a unique migration route from or to any other province, suggesting that individual-level characteristics play an important role in choice of migration route. Comparing 2017 and 2018, we identified a change in the migration pattern between Libyan provinces; whereas in 2017, the main corridors were routes connecting Alkufra, Ejdabia, and Benghazi (Eastern route); Murzuq and Tripoli (Central route), and the corridor connecting Ghat to Tripoli (Western route), in 2018, because of the reduction in number of migrants, paths became much more blurred. Our analysis also identified five clusters of provinces that were the preferred destinations of migrants from the same countries of origin. These findings show that migrants from the same country of origin, moving in the same direction, sorted themselves into contiguous routes following similar paths. As for the evolution of international migration flows into and out of Libya, from 2017 to 2018, the number of origin and destination countries decreased. In 2018, each of the origin and destination countries had fewer connections than in 2017, and the network was sparser. Finally, our analysis indicates that the location and number of refugees and IDPs across Libyan provinces did not change much between 2017 and 2018.

The present paper has provided a first general assessment of migration flows in Libya from 2017 to 2018 using a rich yet much-unexplored data set on migrant presence in the country. As a first piece of analytical work that is part of a broader research project on migration in Libya, this paper documented the spatial distribution of migrants at the most disaggregated level (i.e. provinces), identified the network of human corridors connecting Libyan provinces, and described the migration pattern between origin and destination countries. Expanding on these findings, further research will focus on the impact of foreign countries' immigration policy decisions and on the costs and effects of conflict and political instability on migration to, within, and from Libya.

## References


Anselin L. 1995. “Local Indicators of Spatial Association—LISA.” *Geographical Analysis* 27 (2): 93–115.

Arcand J.-L., and L. M. Mbaye. 2013. “Braving the Waves: The Role of Time and Risk Preferences in Illegal Migration from Senegal.” *IZA Discussion Paper* 7517.

Balkan B., and S. Tumen. 2016. “Immigration and Prices: Quasi-Experimental Evidence from Syrian Refugees in Turkey.” *Journal of Population Economics* 29 (3): 657–86.

Barthel F., and E. Neumayer. 2015. “Spatial Dependence in Asylum Migration.” *Journal of Ethnic and Migration Studies* 41 (7): 1131–51.

Bauer T. K., S. Braun, and M. Kvasnicka. 2013. “The Economic Integration of Forced Migrants: Evidence for Post-war Germany.” *The Economic Journal* 123 (571): 998–1024.

Beine M., F. Docquier, and Ç. Özden. 2011. “Diasporas.” *Journal of Development Economics* 95 (1): 30–41.

Borjas G. J. 1987. “Self-Selection and the Earnings of Immigrants.” *American Economic Review* Vol. 77 (4): 531-553

———. 1994. “Ethnicity, Neighborhoods, and Human Capital Externalities.” *American Economic Review* 85 (3): 365–90.

Braun S., and T. O. Mahmoud. 2014. “The Employment Effects of Immigration: Evidence from the Mass Arrival of German Expellees in Postwar Germany.” *The Journal of Economic History* 74 (1): 69–108.

Burt R. S. 1992. “Structural Holes.” Cambridge: MA, Harvard University Press.

Callen M., M. Isaqzadeh, J. D. Long, and C. Sprenger. 2014. “Violence and Risk Preference: Experimental Evidence from Afghanistan.” *American Economic Review* 104 (1): 123–48.

Ceriani L., and P. Verme. 2018. “Risk Preferences and the Decision to Flee Conflict.” *The World Bank Policy Research Working Paper* 8376.

Clauset A., M. E. J. Newman, and C. Moore. 2004. “Finding Community Structure in Very Large Networks,” *Physical Review E* 70: 066111.

Clemens M. A. 2014. “Does Development Reduce Migration.” in International Handbook on Migration and Economic Development, 152–85. Edward Elgar Publishing.

Cliff A. D., and J. K. Ord. 1981. Spatial Processes. London: Pion.

Cummings C., J. Pacitto, D. Lauro, and M. Foresti. 2015. “Why People Move: Understanding the Drivers and Trends of Migration to Europe.” London: Overseas Development Institute.

Cvajner M., and G. Sciortino. 2010. “A Tale of Networks and Policies: Prolegomena to an Analysis of Irregular Migration Careers and Their Developmental Paths.” *Population, Space and Place* 16 (3): 213–25.

Davis K. F., P. D’Odorico, F. Laio, and L. Ridolfi. 2013. “Global Spatio-Temporal Patterns in Human Migration: A Complex Network Perspective.” *PloS One* 8 (1): e53723.

Dolfin S., and G. Genicot. 2010. “What Do Networks Do? The Role of Networks on Migration and ‘Coyote’ Use.” *Review of Development Economics* 14 (2): 343–59.

Donato K., J. Durand, and D. Massey. 1992. “Stemming the Tide? Assessing the Deterrent Effects of the IRCA.” *Demography* 29: 139–57.

Dustmann C., F. Fasani, T. Frattini, L. Minale, and U. Schönberg. 2017. “On the Economics and Politics of Refugee Migration.” *Economic Policy* 32 (91): 497–550.

Dustmann C., K. Vasiljeva, and A. P. Damm. 2016. "Refugee Migration and Electoral Outcomes." *The Review of Economic Studies* 86 (5): 2035–91.

Echevarria J., and J. Gardeazabal. 2016. "Refugee Gravitation." *Public Choice* 169 (3–4): 269–92.

European Commission. 2017a. "Irregular Migration Via the Central Mediterranean: From Emergency Responses to Systemic Solutions." EPSC Strategic Notes, Issue 22. https://ec.europa.eu/epsc/sites/epsc/files/strategic_note_issue_22_0.pdf.

——— 2017b. "Migration on the Central Mediterranean: Managing Flows, Saving Lives." Joint Communication to the European Parliament, the European Council, 25 January. https://ec.europa.eu/home-affairs/sites/homeaffairs/files/what-we-do/policies/european-agenda-migration/proposal-implementation-package/docs/20170125_migration_on_the_central_mediterranean_route_-_managing_flows_saving_lives_en.pdf.

Expertise France (2016). Youth Motivations to Employment And Entrepreneurship. Final Report.

Falck, O., S. Heblich, and S. Link. 2012. "Forced Migration and the Effects of an Integration Policy in Post-WWII Germany?" B.E. Journal of Economic Analysis and Policy: Topics in Economic Analysis and Policy, 12(1).

Fazito, D., and W. Soares. 2015. "The Industry of Illegal Migration: Social Network Analysis of the Brazil-US Migration System." *International Migration* 53 (6): 183–204.

Fortunato S. 2010. "Community Detection in Graphs." *Physics Reports* 486 (3–5): 75–174.

Friebel G., and S. Guriev. 2013. "Human Smuggling." In *International Handbook on the Economics of Migration*, edited by A. F. Constant and K. F. Zimmermann, 121–33. Cheltenham, Edward Elgar.

Friebel G., M. Manchin, M. Mendola and G. Prarolo (2018), "International migration intentions and illegal costs: Evidence using Africa-to-Europe smuggling routes." *CEPR Discussion Paper*, 13326.

Frouws, B., and C. Horwood (2017), "Smuggled South. Danish Refugee Council and Regional Mixed Migration Secretariat (RMMS)." http://regionalmms.org/images/briefing/Smuggled_South.pdf.

Hunter D. R., Goodreau S. M., and M. S. Handcock. 2008, "Goodness of Fit of Social Net-work Models," Journal of the American Statistical Association, 103(481): 248-258

Gathmann C. 2008. "Effects of Enforcement on Illegal Markets: Evidence from Migrant Smuggling along the Southwestern Border." *Journal of Public Economics* 92 (10–11): 1926–41.

Global Initiative against Transnational Organized Crime (2017). *The Human Conveyor Belt. Assessing the Collapse of the Human-smuggling Industry in Libya and the Central Sahel.* Geneva, GITOC

Hatton, T. 2004. "Seeking Asylum in Europe." *Economic Policy* 19 (38): 5-62.

Ibáñez A. M., and Andrés Moya. 2010. "Vulnerability of Victims of Civil Conflicts: Empirical Evidence for the Displaced Population in Colombia." *World Development* 38 (4): 647–63.

Ibarraran P. and D. Lubotsky. 2007. "Mexican Immigration and Self-Selection: New Evidence from the 2000 Mexican Census." in *Mexican Immigration to the US*, edited by G. Borjas. University of Chicago Press, pp.159-192

IOM 2015. "Migration Trends Across the Mediterranean: Connecting the Dots. Prepared by Altai Consulting for IOM, MENA Regional Office." https://publications.iom.int/system/files/altai_migration_trends_accross_the_mediterranean.pdf.

IOM. 2016a. "Displacement Tracking Matrix, DTM Round 1 (database)." (accessed September 23, 2019), https://displacement.iom.int/system/tdf/reports/DTM%20Libya%20Round%201%20report-EN.pdf?file=1&type=node&id=473.

——— 2016b. "The Central Mediterranean Route: Deadlier Than Ever." Data Briefing Series Issue No. 3. IOM Berlin. https://publications.iom.int/system/files/pdf/gmdac_data_briefing_series_issue3.pdf.

——— 2017a. “World Migration Report 2018.” International Organization for Migration, Geneva.

——— 2017b. “Analysis: Flow Monitoring Surveys. The Human Trafficking and Other Exploitative Practices Prevalence Indication.” International Organization for Migration, Geneva.

Kondylis, F. 2008. “Agricultural Outputs and Conflict Displacement: Evidence from a Policy Intervention in Rwanda.” *Economic Development and Cultural Change* 57 (1): 31–66.

Koser, K. 2010. “Dimensions and Dynamics of Irregular Migration.” *Population, Space and Place* 16 (3): 181–93.

Koser, K., and Pinkerton, C. 2002. “The Social Networks of Asylum Seekers and the Dissemination of Information About Countries of Asylum.” London Home Office, Research Development and Statistics Directorate.

Leone Sciabolazza V. 2018. “A Net of Moving People: Network Analysis of International Migration Flows.” In *Networks of International Trade and Investment*, edited by A. Amighini, S. Gorgoni, and Smith M., Vernon Press, Wilmington Delaware (USA), ch.11: 249 - 296

Lergetporer P., M. Piopiunik, and L. Simon. 2018. “Do Natives’ Beliefs About Refugees’ Education Level Affect Attitudes Toward Refugees?” Evidence from a Randomized Survey Experiments.” *CESifo Working Paper Series* 6832.

Manchin M., and S. Orazbayev. 2018. “Social Networks and the Intention to Migrate.” *World Development* 109: 360–74.

Marshall, M. G., and G. Elzinga-Marshall. 2017. “Global Report 2017: Conflict, Governance, and State Fragility.” Center for Systemic Peace, Vienna, VA USA

Maystadt, J.-F., and P. Verwimp. 2014. “Winners and Losers among a Refugee-Hosting Population.” *Economic Development and Cultural Change* 62 (4): 769–809.

Melander, E., and M. Öberg. 2007. "The Threat of Violence and Forced Migration: Geographical Scope Trumps Intensity of Fighting." *Civil Wars* 9 (2): 156–73.

Mixed Migration Hub. 2015. “Detained Youth: The Fate of Young Migrants, Asylum-Seekers and Refugees in Libya Today.” Study 1, July 2015. MHUB. www.mixedmigrationhub.org/wp-content/uploads/2015/07/MHUB_2015_Detained-Youth_Exec-Summary_EN.pdf

Moran P. A. P. 1950. “Notes on Continuous Stochastic Phenomena.” *Biometrika* 37 (1): 17–23.

Ortega, F., and G. Peri. 2012. “The Role of Income and Immigration Policies in Attracting International Migrants.” *IZA Discussion Paper* 6655.

Otto A. H., and M. F. Steinhardt. 2014. “Immigration and Election Outcomes—Evidence from City Districts in Hamburg.” *Regional Science and Urban Economics* 45: 67–79.

Peres M., H. Xu, and G. Wu. 2016. “Community Evolution in International Migration Top1 Networks,” *PloS One* 11 (2): e0148615.

Raleigh C., A. Linke, H. Hegre, and J. Karlsen. 2010. “Introducing ACLED: An Armed Conflict Location and Event Dataset: Special Data Feature.” *Journal of Peace Research* 47 (5): 651–60.

Reichardt J., and Bornholdt S. 2006. “Statistical Mechanics of Community Detection,” *Physical Review E* 74, 016110.

Rotte R., M. Vogler, and K. Zimmermann. 1997. “South-North Refugee Migration: Lessons for Development Cooperation.” *Review of Development Economics* 1 (1): 99–115

Ruiz I., and C. Vargas-Silva. 2013. “The Economics of Forced Migration.” *The Journal of Development Studies* 49 (6): 772–84.

Sanchez, G., R. Hoxhaj, S. Nardin, A. Geddes, L. Achilli, and S. Kalantaryan. 2018. A Study of the Communication Channels Used by Migrants and Asylum Seekers in Italy, with a Particular Focus on Online and Social Media. DG for Migration and Home Affairs (European Commission) and the Robert

Schuman Centre for Advanced Studies (European University Institute). https://ec.europa.eu/home-affairs/e-library/multimedia/publications/study-communication-channels-used-migrants-asylum-seekers-italy-particular-focus-online-social-media_en

Sarvimäki, M., R. Uusitalo, and M. Jäntti. 2009. "Long-Term Effects of Forced Migration." IZA Discussion Paper 4003, Institute of Labor Economics (IZA)

Sekeris P., and C. Vasilakis. 2016. "The Mediterranean Refugees Crisis and Extreme Right Parties: Evidence from Greece." MPRA Paper 72222, University Library of Munich, Germany.

Singer, A., and D. Massey. 1998. "The Social Process of Undocumented Border Crossing." International Migration Review, Vol. 32 (3), 561-592

Steinmayr A., 2016. "Exposure to Refugees and Voting for the Far-Right: (Unexpected) Results from Austria." IZA Discussion Paper 9790 IZA Institute of Labor Economics.

Tumen S. 2016. "The Economic Impact of Syrian Refugees on Host Countries: Quasi-Experimental Evidence from Turkey." *American Economic Review* 106 (5): 456–60.

UN DESA 2016. International Migration Report 2015. United Nations Department of Economic and Social Affairs. New York.

UN DESA 2017. International Migration Report 2017. United Nations Department of Economic and Social Affairs. New York.

UNHCR. 2017a. "Global Trends: Forced Displacement in 2016." UNHCR, Geneva. www.unhcr.org/5943e8a34

——— 2017b. "Desperate Journeys: Refugees and Migrants Entering and Crossing Europe via the Mediterranean and Western Balkan Routes." UNHCR, Geveva. www.unhcr.org/58b449f54.pdf.

——— 2018. "Global Focus." United Nations Human Rights Council, Geneva, Switzerland.

Upton G., and B. Fingleton. 1985. "Spatial Data Analysis by Example: Point Pattern and Quantitative Data." New York, Wiley.

Van der Loo M. P. J. 2014. "The Stringdist Package for Approximate String Matching," *The R Journal* 6 (1): 111–22.

Verme P. and K. Schuettler. 2019. "The Impact of Forced Displacement on Host Communities: A Review of the Empirical Literature in Economics." World Bank Policy Research Working Paper no. 8727.

Voors M. J., E. E. M. Nillesen, P. Verwimp, E. H. Bulte, R. Lensink, and D. P. Van Soest. 2012. "Violent Conflict and Behavior: A Field Experiment in Burundi." *American Economic Review* 102 (2): 941–64.

*World Bank. 2015. Labour Markets Dynamics in Libya. World Bank: Washington, D.C.*

World Bank. 2018. *Asylum Seeker in the European Union: Building Evidence for Policy Making*. Washington, DC: World Bank.

# Tables

Table 1: International Migrants in Libya (2000 and 2017)

| Number of international migrants (thousands) | | International migrants (percentage of total population) | | Women among international migrants (percentage) | | Median age of international migrants (years) | |
|---|---|---|---|---|---|---|---|
| 2000 | 2017 | 2000 | 2017 | 2000 | 2017 | 2000 | 2017 |
| 567 | 788 | 10.6 | 12.4 | 35.0 | 28.8 | 29.6 | 32.2 |

Source: UN DESA (2017).

Table 2: Five Top Nationalities Registered at Flow Monitoring Points

| **2017** | **2018** |
|---|---|
| Egypt, Arab Rep. | Egypt, Arab Rep. |
| Niger | Niger |
| Nigeria | Sudan |
| Sudan | Nigeria |
| Chad | Chad |

Source: International Organization for Migration Displacement Tracking Matrix dataset.

Note: Elaboration of the authors.

Table 3: Five Preferred Arrival Destinations Registered at Flow Monitoring Points

| **2017** | **2018** |
|---|---|
| Libya | Libya |
| Italy | Italy |
| Germany | France |
| France | Germany |
| Egypt, Arab Rep. | Egypt, Arab Rep. |

Source: International Organization for Migration Displacement Tracking Matrix dataset.

Note: Elaboration of the authors.

Table 4: Determinants of Migration Flows Across Libyan Provinces

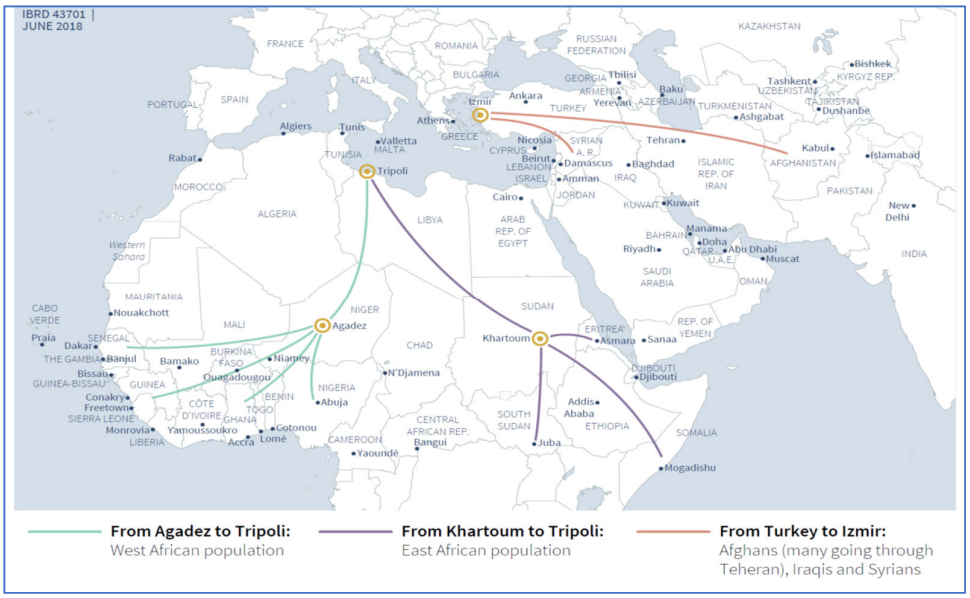
| | **Migration flows in 2018** (Binary Variable) | |
|---|---|---|
| | **STERGM Formation (1)** | **STERGM Dissolution (2)** |
| Night lights<br>(1 = moving to a province with equal or more night lights) | 1.7785<br>(1.2099) | -1.0517*<br>(0.6437) |
| Log distance | -0.3475<br>(0.7568) | - |
| Conflicts<br>(1 = moving to a province with equal or more conflicts) | -1.5842*<br>(0.9157) | -0.2631<br>(0.6216) |
| Number of migrants<br>(1 = moving to a province with equal or more migrants) | 0.4434<br>(0.9509) | 0.1486<br>(0.6029) |
| Intransitivity<br>(province *i* and *j* send migrants to province *z*, but they do not share any migrant flow with each other) | 0.2910<br>(0.2245) | -0.6251*<br>(0.2504) |
| Edges | -2.6633<br>(5.0537) | 1.5719<br>(0.4939) |
| Number of Observations | 342 | 342 |
| R2 | - | - |
| Akaike Information Criterion | 63.26 | 97.39 |

Source: International Organization for Migration Displacement Tracking Matrix.

Note: Separable Temporal Exponential Random Graph Model (STERGM) estimated coefficients and standard errors (in parentheses) are reported. *, **, *** indicate statistical significance at the 10, 5 and 1 percent level. Column (1) and (2) report respectively values for the network formation and dissolution model fitted by STERGM.

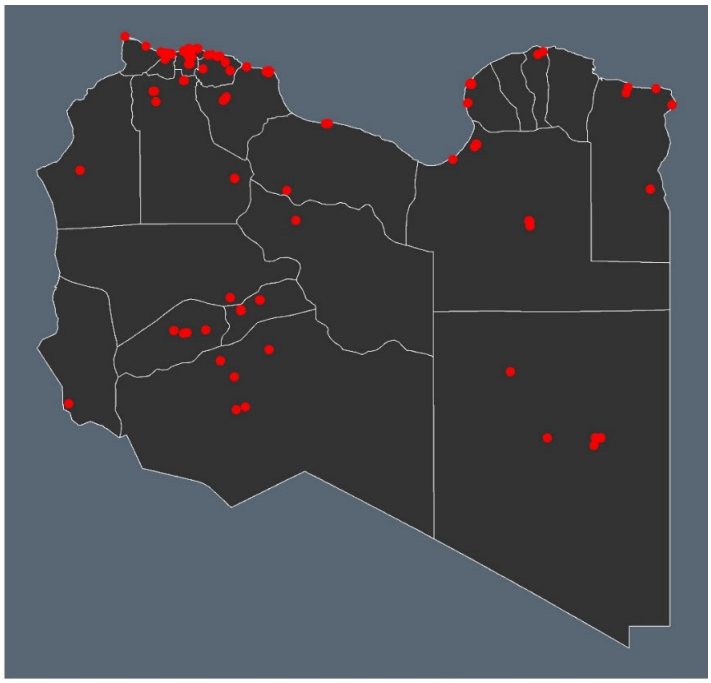
# Figures

Figure 1: Three Main Asylum-Seeker Routes to the European Union



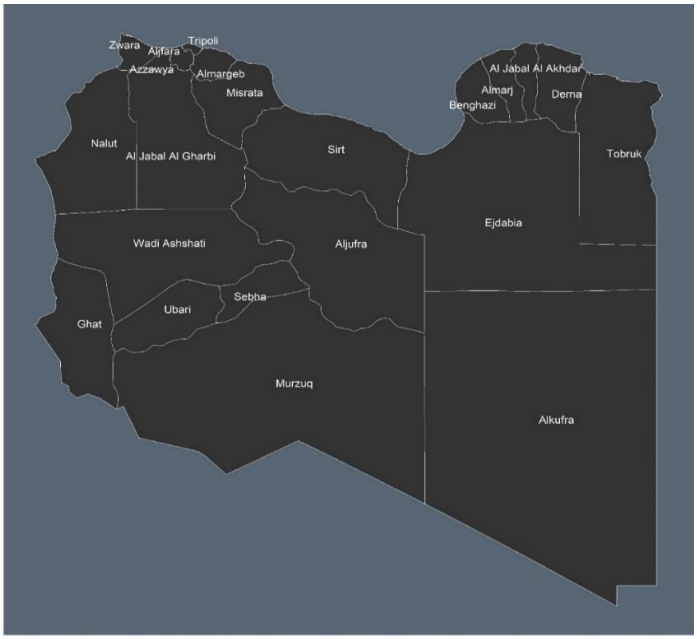

Source: World Bank (2018). Note: Data are from the Euro Asylum Seekers' Survey 2017.

Figure 2: Map of Flow Monitoring Points (FMPs) in Libya (2017-2018)



Source: International Organization for Migration Displacement Tracking Matrix.
Notes: Elaboration of the authors.

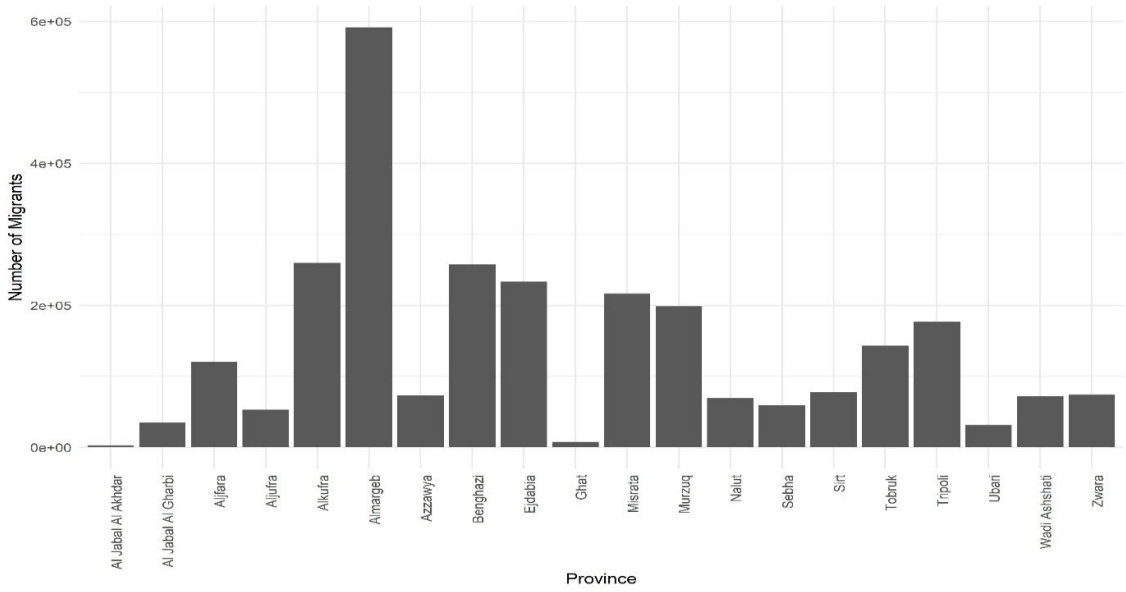
Figure 3: Map of Libyan Provinces




Source: International Organization for Migration Displacement Tracking Matrix.
Notes: Elaboration of the authors.

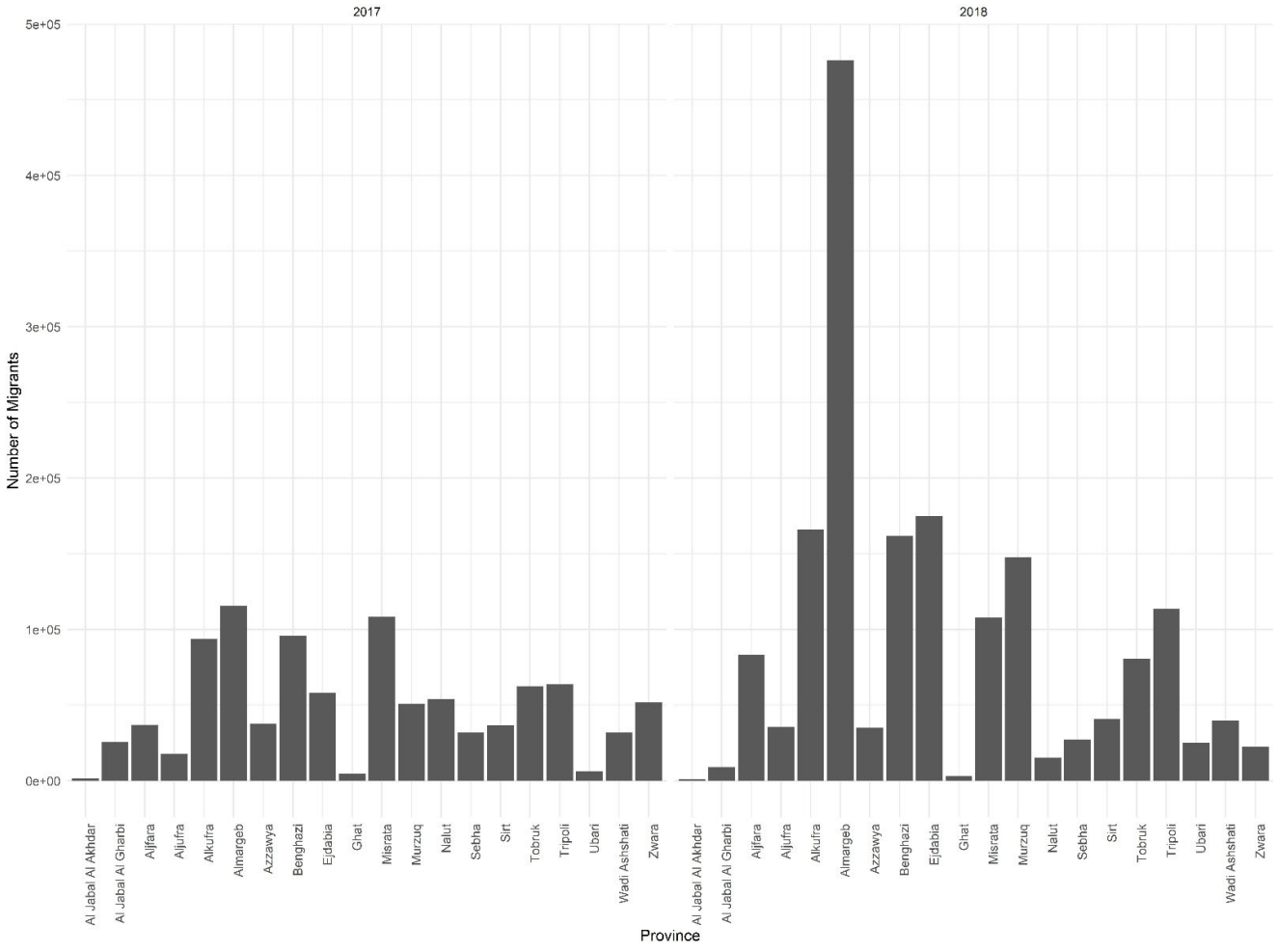
Figure 4: Number of migrants **Registered at Flow Monitoring Points: (a) All Rounds, 2017 and 2018; (b) According to Year and Province; (c) According to Round and Province**

**a**



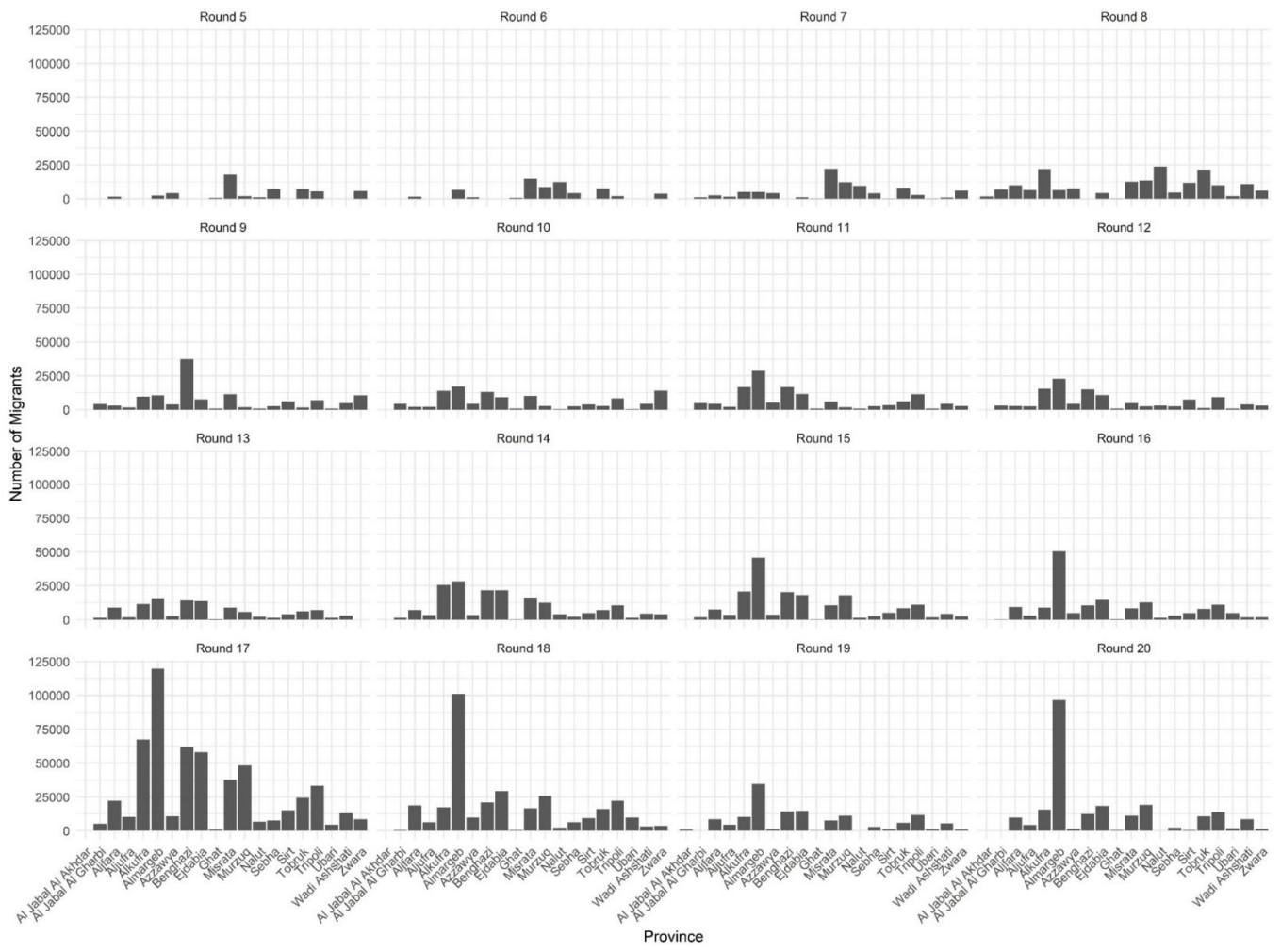

Note: Elaboration of the authors. Bars indicate number of migrants in Libyan provinces in all rounds.

**b**




Note: Elaboration of the authors. Bars indicate number of migrants in Libyan provinces in 2017 and 2018.

**c**

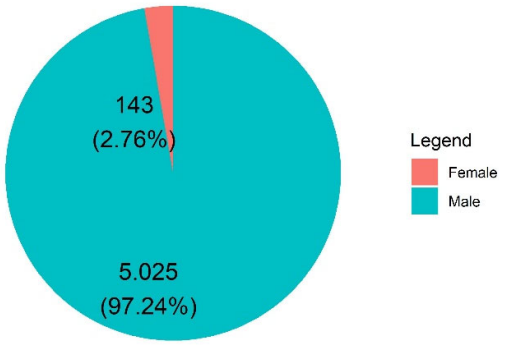



Note: Elaboration of the authors. For each round, bars indicate number of migrants in Libyan provinces.

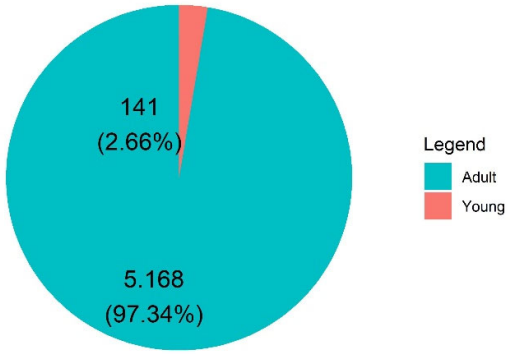
Source: International Migration Organization Displacement Tracking Matrix dataset.

Figure 5: Demographic Characteristics of Migrants

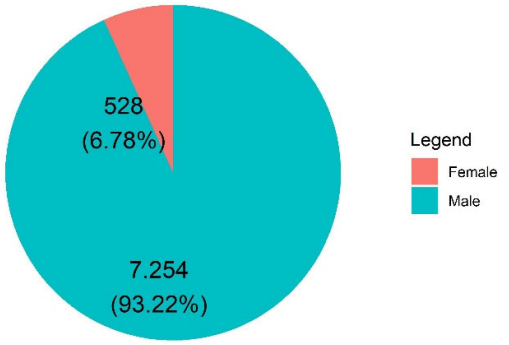
(a) 2017



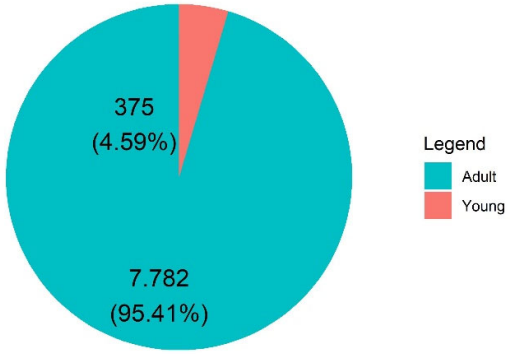

(b) 2017




(c) 2018

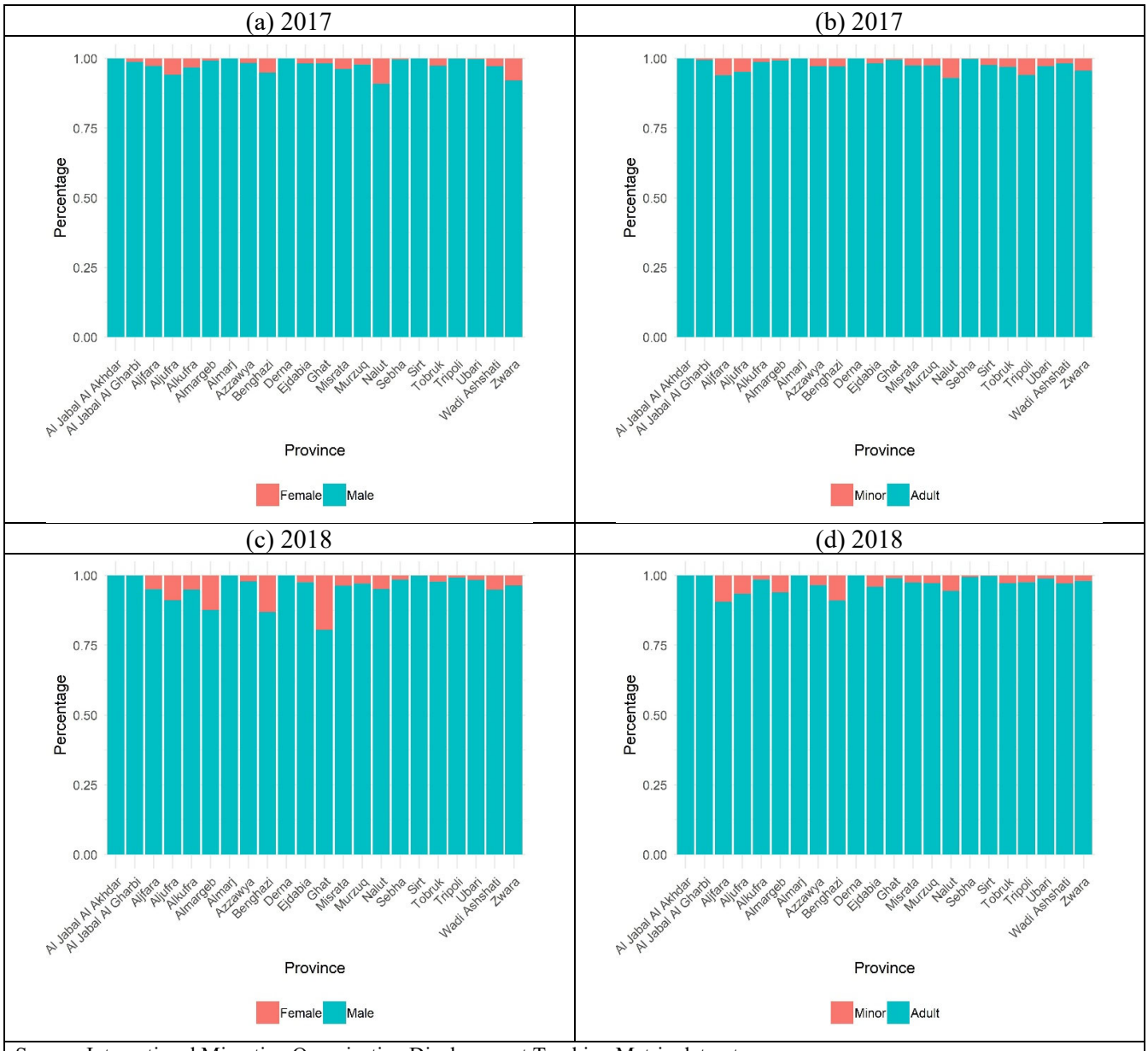



(d) 2018




Source: International Migration Organization Displacement Tracking Matrix dataset.
Note: Elaboration of the authors. Pie slices indicate percentage of men and women (panels a and c) or minors (less than 18 years old) and adults (panels b and d) in Libya, in 2017 (panels a and b) and 2018 (panels b and c). Results are yearly averages of monthly data.

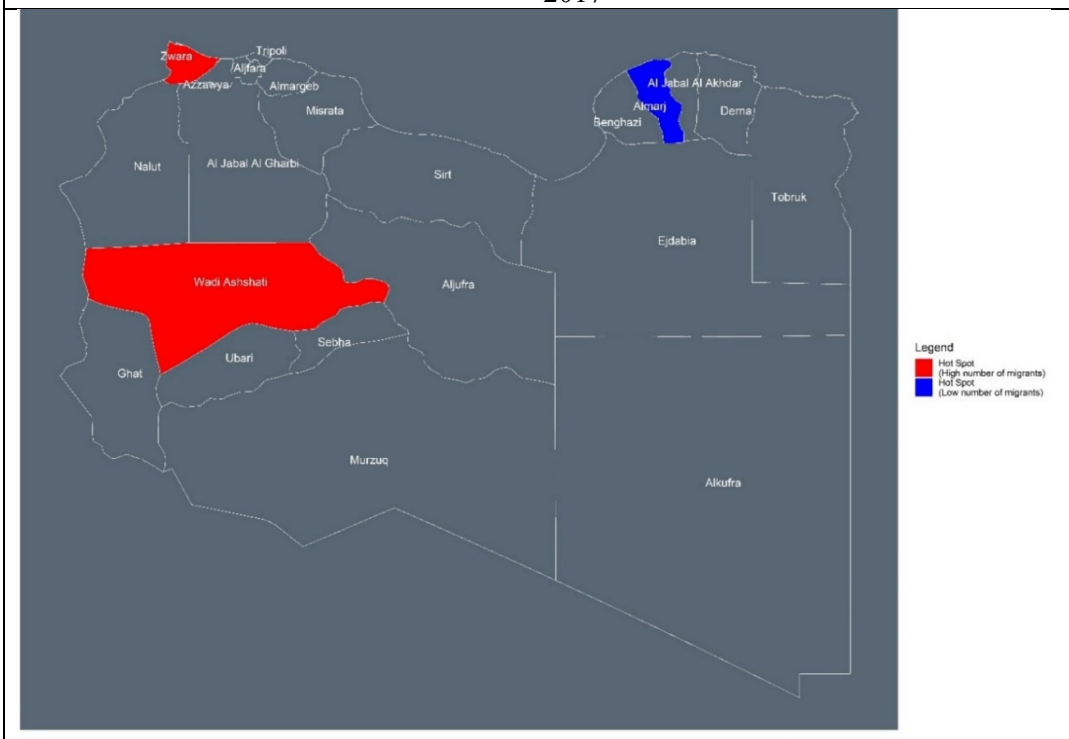
Figure 6: Demographic Composition of Migrants by Province



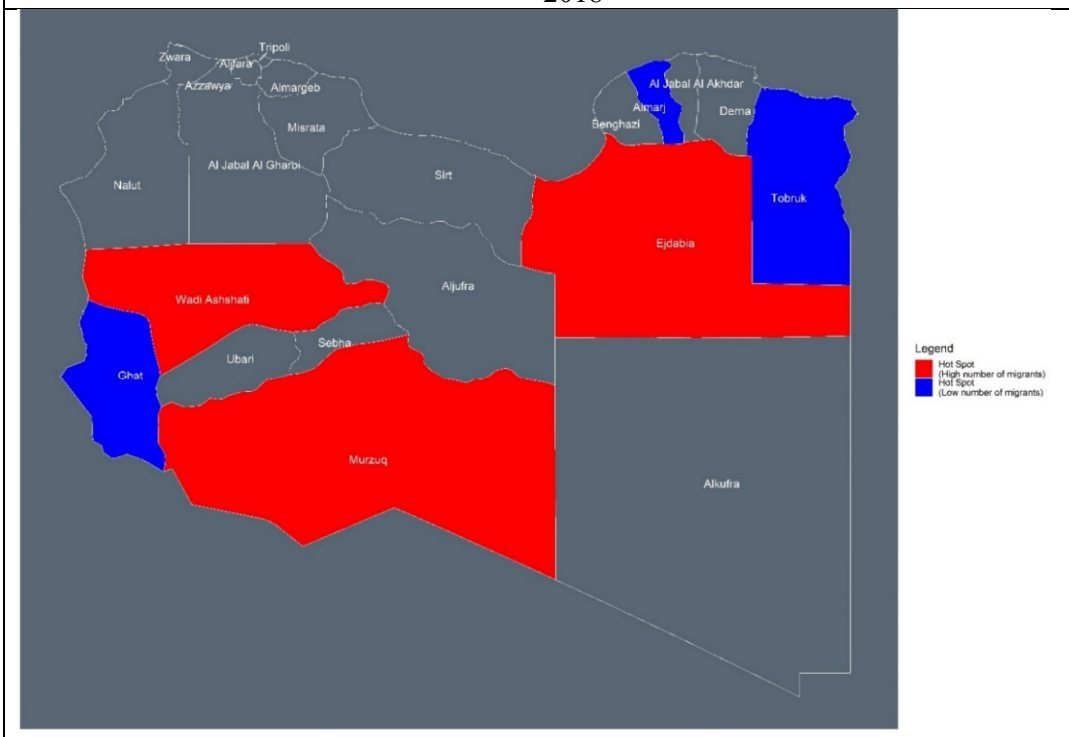

Source: International Migration Organization Displacement Tracking Matrix dataset.
Note: Elaboration of the authors. Bars indicate percentages of men and women (panels a and c) and minors and adults (panels b and d) in Libyan provinces in 2017 (panels a and b) and in 2018 (panels b and c). Results are yearly averages of monthly data.

Figure 7: Hotspot Provinces

2017

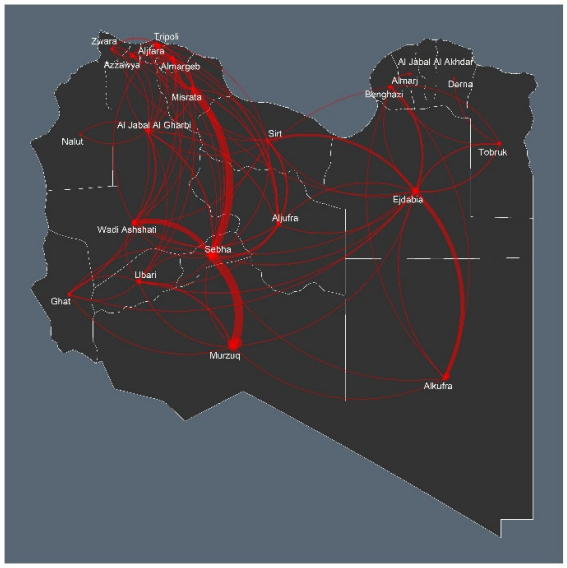
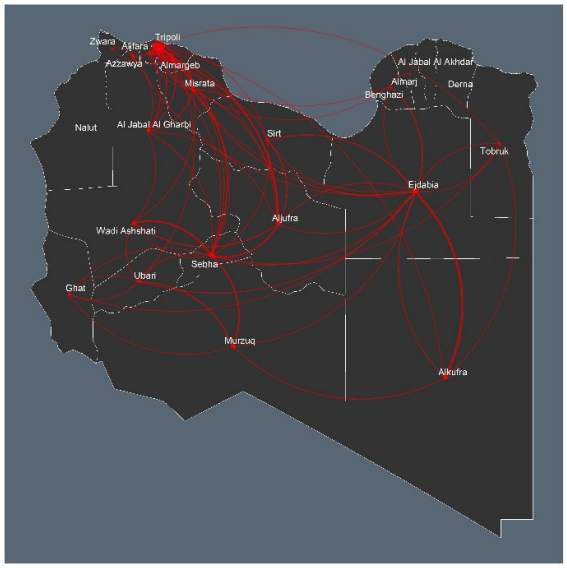



2018




Source: International Migration Organization Displacement Tracking Matrix dataset.
Note: Elaboration of the authors. Provinces with a large or small number of migrants adjacent to provinces with a small or large number of migrants are indicated in red or blue. For a precise definition of hotspot see section A.2.

Figure 8: Network of Migrants' Movements within Libya in 2017 and 2018

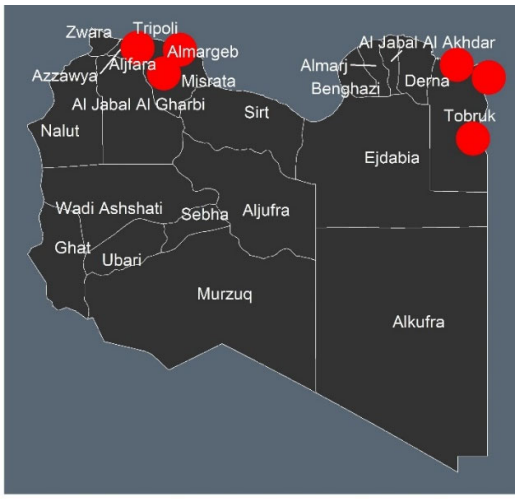
| 2017 | 2018 |
|---|---|
|  |  |



Source: International Migration Organization Displacement Tracking Matrix dataset.
Note: Elaboration of the authors. Each link indicates a movement from a flow monitoring point (FMP) located in province *i* to a FMP located in province *j*. The width of the link is proportional to the number of people who moved from one province to the other .

Figure 9: Clustered Movements of Same-Origin Migrants

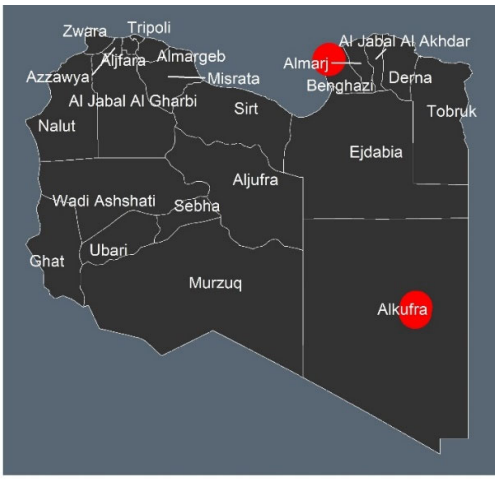
Country of origin: Egypt (January 2017)




Country of origin: Ethiopia (July 2017)


Country of origin: Benin (August 2017)

Country of origin: Eritrea (August 2017)

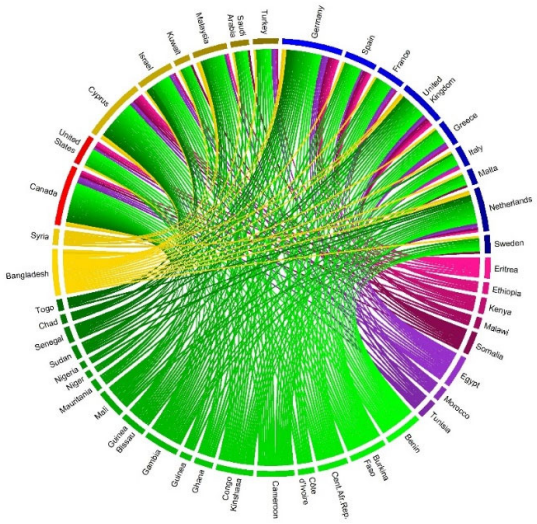



Country of origin: Bangladesh (January 2018)

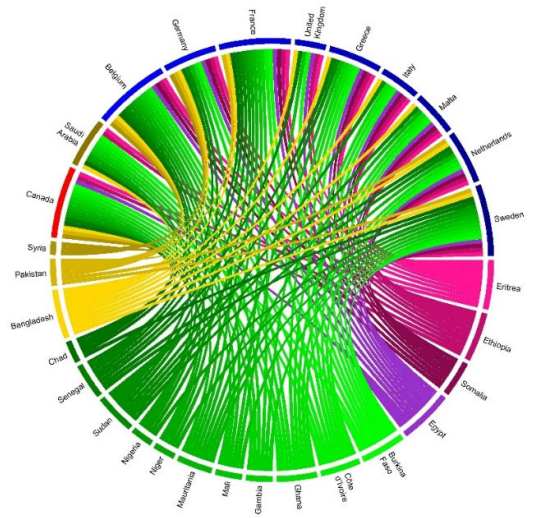

Source: International Migration Organization Displacement Tracking Matrix dataset.
Note: Elaboration of the authors.

Figure 10: Backbone of Libyan Migration Network: 2017 and 2018

2017



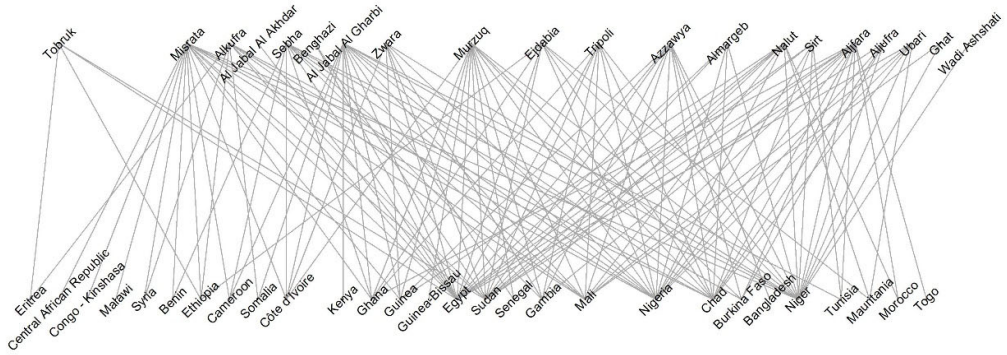

2018



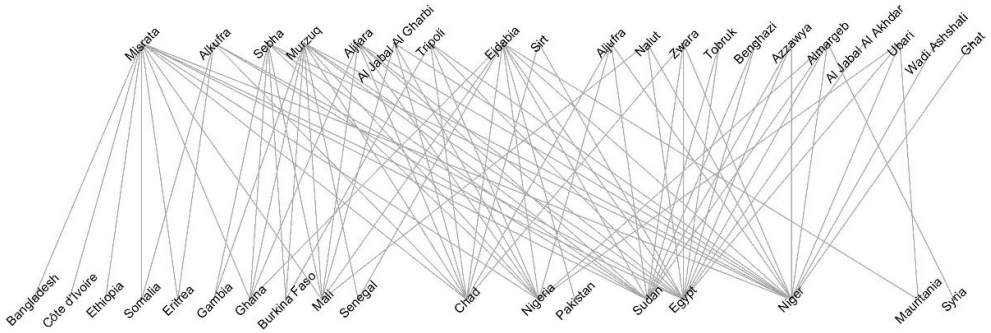

Source: International Migration Organization Displacement Tracking Matrix dataset.
Notes: Elaboration of the authors. Circles segments represent origins and destinations of migration flows. Origin color and gap between link and circle segment at destination encode direction of flow. Size of segments indicates total incoming and outgoing flows in one country. Similar hues of colors are used for countries in nearby regions (pink for east Africa, violet for north Africa, green for west Africa, yellow for Asia, red for Americas, blue for Europe, grey for Oceania).

Figure 11: Top Origin Countries: 2017 and 2018

2017



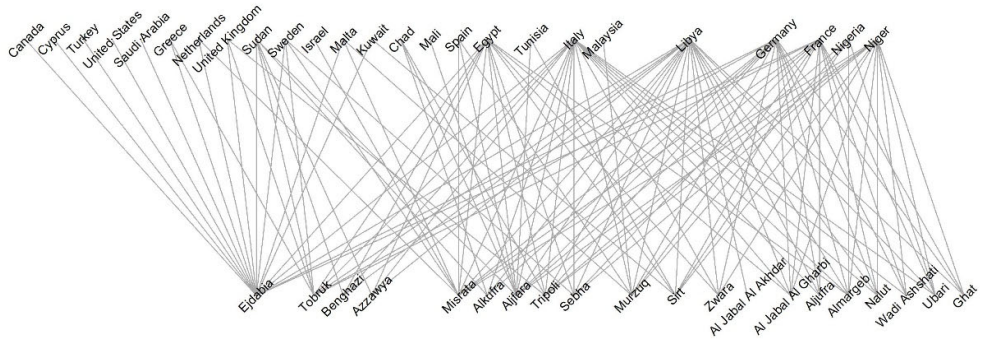

2018



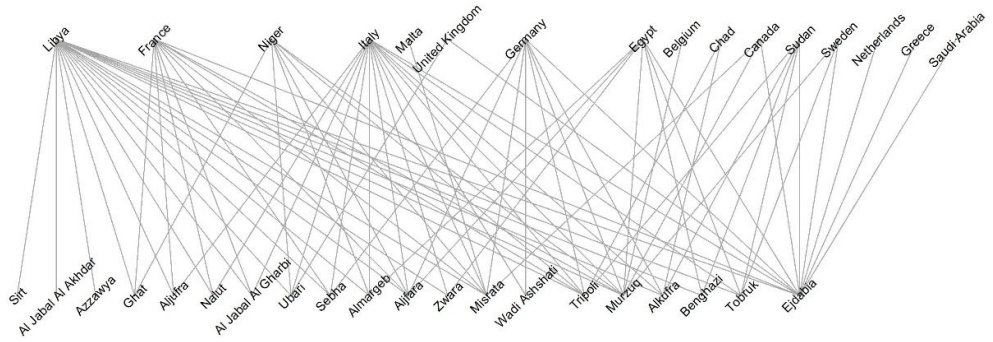

Source: International Migration Organization Displacement Tracking Matrix dataset.
Notes: Elaboration of the authors. A connection is drawn between a country and a Libyan province when migrants found at the flow monitoring points of the province are mainly from that country (connections at the bottom of the plot).

Figure 12: Top Receiving Countries: 2017 and 2018

2017



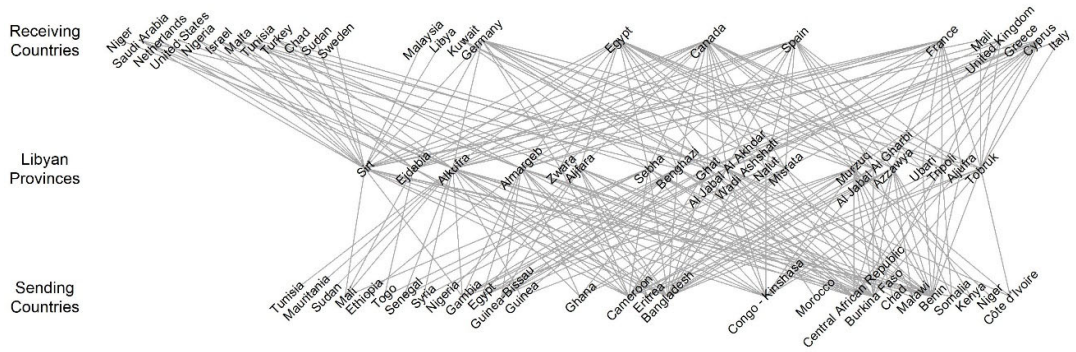

2018



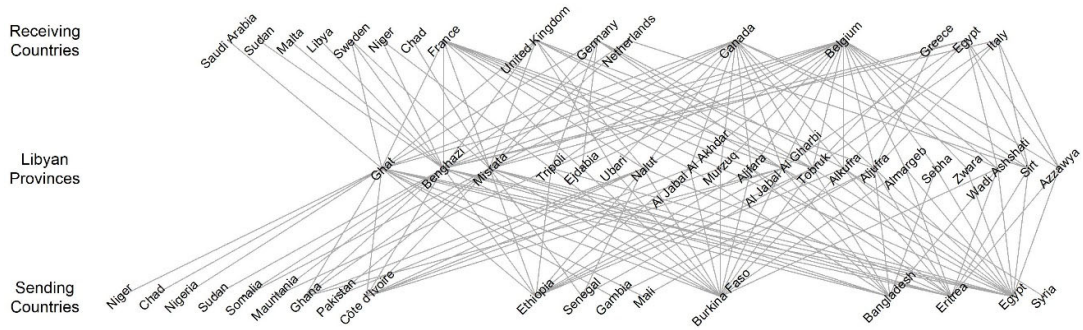

Source: International Migration Organization Displacement Tracking Matrix dataset.
Notes: Elaboration of the authors. A connection is drawn between a country and a Libyan province when migrants found at the flow monitoring points of that province have a major preference for moving toward that country.

Figure 13: Libyan Top Incoming and Outgoing Migration Flows: 2017 and 2018

2017

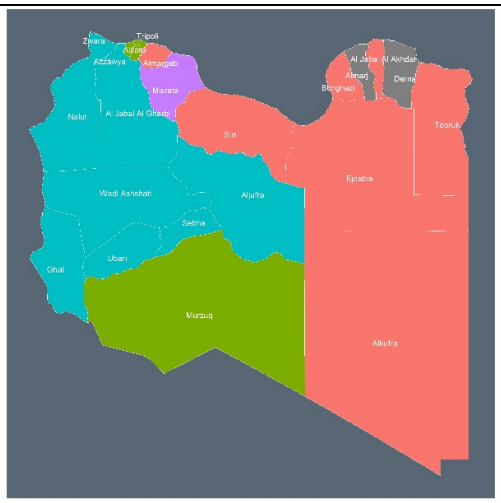
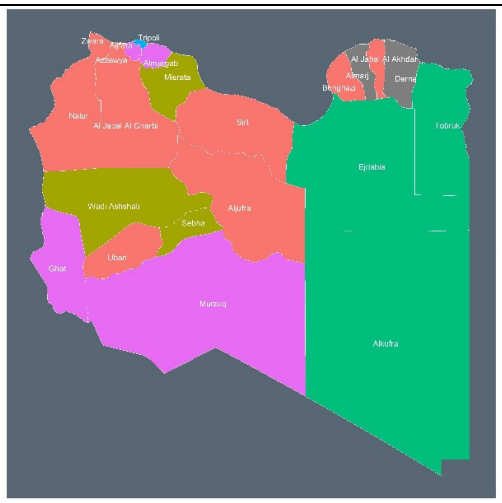



2018




Source: International Migration Organization Displacement Tracking Matrix dataset.
Notes: Elaboration of the authors. A connection is drawn between a country and a Libyan province when migrants found at the flow monitoring points of that province are mainly from that country (connections at the bottom of the plot) or they have a major preference for moving toward that country (connections at the top of the plot).

Figure 14: Spatial Distribution of Libyan Migration Network Communities – Libyan Provinces: 2017 and 2018

| 2017 | 2018 |
| --- | --- |
|  |  |

Source: International Migration Organization Displacement Tracking Matrix dataset.
Notes: Elaboration of the authors. All provinces shaded the same color belong to the same network community as defined in section 5.2.5. Grey indicates a province for which data were not available.