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International migration and illegal costs: Evidence from Africa-to-Europe smuggling routes☆

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ABSTRACT

The 2011 Arab Spring marked the opening of the Central Mediterranean Route for irregular border crossings between Libya and Italy, which produced heterogeneous reductions of bilateral smuggling distances between country pairs in the Mediterranean region. We exploit this source of spatial and temporal variation in bilateral distance along land and sea routes to estimate the elasticity of irregular migration intentions for African and Near East countries. We estimate an elasticity of migration intentions to smuggling distances exceeding −3, mainly driven by countries with weak rule of law and high internet penetration. Our findings are consistent across irregular migration measures both at the aggregate and individual levels. We show that irregular migration elasticity is higher for youth, relatively skilled individuals and those with an informative advantage (having a social network abroad or a mobile phone).

1. Introduction

International migration is a contentious topic in both origin and destination countries. As of 2019, the UN estimated the number of international migrants to be 272 million, with Europe hosting more than 80 million, followed by the U.S. with 51 million.[1] The main south–north migration flows are between Latin America and the U.S. and from Africa to Europe. Millions of people have tried to move from Africa to Europe, many of them unsuccessfully. Despite the threats to health and life that migrants are exposed to, it

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[1] https://www.un.org/development/desa/en/news/population/international-migrant-stock-2019.html

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is expected that migration will rise with growing economic differences between developed and developing countries, demographic pressure, and global climate change (Hanson and McIntosh, 2016).

Legal migration channels are becoming scarce and congested while European destination countries are increasingly investing in administrative and physical barriers. Building up these barriers, though, has done little to decrease people's willingness to move across international borders (Docquier et al., 2014; Allen et al., 2018). Instead, a multi-billion USD human smuggling industry has emerged whose clandestine services are often unavoidable for migrants despite the inhumane conditions migrants are subjected to. Indeed, recent waves of IOM's Flow Monitoring Survey indicate that 94% of interviewed migrants used smuggling services.[2]

Much work has been done on individual and aggregate push and pull factors of legal migration, but little is known about how unauthorized migration responds to changes in the effective cost of migration.[3] Some progress has been made by incorporating the smuggling market into the theory on international migration (Friebel and Guriev, 2006, 2015; Tamura, 2010; Auriol and Mesnard, 2016), but despite their omnipresence in many developing economies, data on the specificities of smuggling services are hard to come by, similarly to many other clandestine or criminal industries. Understanding and quantifying these determinants is crucial, though, to design policies in origin and destination countries alike.

We investigate – with new geocoded data – how transportation costs over land and sea smuggling routes between Africa, Near-East and Europe affect migration intentions when legal migration channels are scarce or missing altogether. Our main contribution is to reliably estimate distance elasticities that are usually estimated with no (exogenous) cost variation over time. In addition, we investigate heterogeneous effects along individual and aggregate dimensions, such as age, gender, education, networks and information access.[4] We complement our analysis with empirical evidence of the correlation between migration distances and irregular fees migrants pay to carry out the journey, using a unique survey dataset. Finally, we employ high frequency data on observed irregular migration flows across the Mediterranean sea to show the absence of a significant pre-trend in the migration elasticity to smuggling distance.

To learn – in a causally interpretable way – about the elasticity of unauthorized international migration to the distance between the sending and the receiving countries, we leverage the impact of a large shock that reduced the length of land and sea migration routes between many African origin and European destination countries, while controlling for any other determinants of migration. The shock we exploit occurred in 2011, when Muammar Gaddafi, Libya's dictator, was overthrown after NATO airstrikes. With the demise of the Gaddafi regime (and the turmoil in the other Mediterranean countries experiencing the Arab Springs, in particular Tunisia), the so-called Central Mediterranean Route (CMR) re-opened. CMR had been closed from early year 2009 as part of the previous year's "Friendship Treaty" in which, in exchange for significant payments from Italy to Libya, Libya successfully restrained irregular migration.[5] An institutional vacuum emerged, which led to the proliferation of smuggling intermediaries connecting the Libyan coast with the south of Italy and hence changing available migration routes for many people in Africa (Micallef, 2017).

To estimate the elasticities of migration intentions to the changes in migration distance as triggered by the opening of the CMR, in our analysis we combine two main data sources. The first one is the Gallup Poll that has been used in many papers, also in the migration literature. This global dataset contains individual-level questions about the intention to migrate to preferred destination countries, which is our main outcome variable of interest. We combine this with a dataset of orgin-destination distances that is obtained by georeferencing the routes used by smugglers to bring irregular migrants from Africa/Near East to Europe. Such distances changed after the re-opening of the CMR, enabling us to leverage the time-varying bilateral dimension of the data. Africa-to-Europe migration routes form a network (with hotspots as nodes) and the opening of the CMR in 2011 made many nodes in the network closer than before, thus changing land and sea distance among countries in a heterogeneous way.

The empirical analysis then interprets distance as a proxy for migration cost, following both the trade and the migration literature (see for example Disdier and Head, 2008; Lucas, 2001; Morten and Oliveira, 2023). We estimate a gravity model of migration at the turn of the year of the shock (2011), while exploiting the opening of CMR as a source of exogenous variation. Our approach is hence similar to Feyrer (2021), who uses the closure of the Suez Canal as a (heterogeneous) exogenous shock to sea distances to identify the effect of transportation costs on trade (see also Pascali, 2017). Importantly, while we use the opening of CMR as a source of variation in bilateral distance, we do not focus on the shock itself: hence, we exclude from the analysis the year in which the shock occurred (2011) as well as the countries of the region that were directly involved in the Arab Spring (Tunisia, Egypt and Libya). We thus evaluate the regional impact of an exogenous change to the cost of migrating illegally as a result of the sudden extension of the spatial smuggling network.[6]

Because there is time variation in migration distances between countries, we can include country-pair fixed effects to control for all those characteristics that are time invariant at the pair level; these include air distance, but also colonial linkages, cultural

[2] https://migration.iom.int/reports

[3] Aksoy and Poutvaara (2019) analyze self-selection of refugees and irregular migrants based on individual characteristics, predicted income, border control, and conflicts.

[4] Heterogeneous drivers of migration are important and still have been found, among others and in different settings, by Bazzi (2017) and Clemens and Mendola (2020). The former contribution dissects the different effects of income when wealth is accounted for, the latter examines self-selection of individuals preparing to migrate all over the world, and document nearly universal positive selection on both observed (e.g. education) and unobserved determinants of earnings.

[5] Actually, on February 26, 2011, the Treaty on Friendship, Partnership and Cooperation signed between Italy and Libya on August 31, 2008 was officially suspended by the Italian government. Similar bilateral cooperation treaties have been signed by Italy in the '90s and '00s with Egypt and Tunisia. During the Arab Spring such treaties obviously lack enforcement, but soon after, with exception of Libya, these countries regain control of their shores.

[6] As we focus on migration intentions, we are interested in the information set available to potential migrants not directly involved in the Arab Springs: in 2010 the CMR was not viable as a route to migrate illegally, while in 2012 it was.

proximity and long-term bilateral links across country pairs. We further control for origin- and destination-by-time fixed effects that account for all (static and dynamic) push and pull factors of international migration at country level. Thus, we can net out the drivers of migration usually used in gravity frameworks (see Beine et al., 2016 for a comprehensive review of the use of gravity models in migration studies). Consequently, the effects on migration intentions that we measure are coming entirely through changes in the costs of irregular migration as proxied by the length of the migration route of a migrant in the country of origin to the country of destination.

We find a large negative effect of the distance connecting country pairs along illegal routes on individual migration intentions. The elasticity of migration intention rates to smuggling distance is around -3, leading to about 1.2 million more individuals planning to migrate, which corresponds to 68% of the observed increase in migration intentions between 2010 and 2012. This points to other standard drivers of migration playing a minor role in changing people's mind about their possible migratory status. A similar empirical exercise on actual migrants, presented in Section 7, delivers even larger elasticities and rules out differential pre-2011 migratory trends between countries exposed, or not, to a drop in distances in 2011.

Along the line of a large body of works studying the selection into migration, we are also interested in regional (Mahmoud and Trebesch, 2010; Akee et al., 2014; Cho et al., 2014) and individual heterogeneities (Borjas, 1987; Chiquiar and Hanson, 2005; Beine et al., 2011; Arcand and Mbaye, 2013). In terms of aggregate heterogeneity, we document that the elasticity of migration intentions to distance is stronger in countries with weak rule of law, i.e. where irregular smuggling services may flourish, and with higher information access (measured with internet penetration). Turning to individual heterogeneity, we find that irregular migration elasticity is stronger across sub-groups of the population. In particular, the negative effect of distance is not statistically different by gender while it is significantly (slightly) bigger in absolute value for youth (i.e. individuals less than 35 years of age) and for individuals with more than primary education. Moreover, people better endowed with information, i.e. those with connections to people who migrated abroad and those having a mobile phone, are more sensitive to distance reductions and have higher irregular migration elasticity. This is consistent with the argument that irregular migration is a costly business in monetary, information and time-equivalent terms (e.g. collecting information on how to reach and bargain with smugglers).

An influential literature (Hanson, 2006; Gathmann, 2008; Hatton, 2020) investigates how irregular migration from Mexico to the U.S. is affected by a number of push and pull factors, and most relevant for our work, by border enforcement. These papers find moderate effects of border enforcements on migration decisions and some evidence of shifting migration routes. Allen et al. (2018) examine the impact of the wall expansion at the Mexico-U.S. border between 2007 and 2010 on unauthorized bilateral migration flows. Using survey data on the migratory paths of irregular migrants, the authors estimate structurally the elasticity of migration to a change in distance and costs as induced by the extended fence. They find that while the decision to migrate appears to be rather inelastic to the border wall (it accounts for just 5% of the observed decline in Mexico-US migration from 2005 to 2015), the migrants' choices of route and destination within the United States are quite responsive. Structural simulations suggest that a counterfactual completed border wall would have similarly modest effects. Our finding of rather high elasticity of migration intentions to reductions in distances could be seen as evidence that border enforcement in Libya was quite effective in reducing migration.[7]

The results from Mexico to the U.S. and ours for Africa to Europe are not at odds with each other, because the two situations differ to a comparable extent. First, while we do use the fall of border protection in Libya as an exogenous shock to travel distance, for reasons of clean identification, we exclude those countries that are directly affected by it from the regressions. Moreover, the geo-political setting is rather different. Migrants from Mexico typically use the services of smugglers (coyotes) mostly to pass the last stage to the U.S, i.e., the very border crossing. Prices are relatively low (in the realm of a few hundred dollars), and many try the passage more than once. Migrants from Africa, instead, typically have much longer distances to cover and they need to use smugglers not only to cross the sea but also for parts of their journey in Africa and in Europe. Prices are higher by one order of magnitude on average. It hence seems conceivable that the decision, or in our case, the intention to migrate, is more significantly affected by a reduction to travel distance than a potential reduction (or increase) in the cost of border crossing only. Finally, Allen et al. (2018) study the shut down of (part of) a smuggling route, while we study the reverse in a high migration pressure environment. Whether one should expect the opening and closing of irregular routes to produce symmetrical effects is an open question.

We see as a specific advantage of our paper to isolate the effect of changes in migration costs (as a result of the opening of the CMR) from other policy shocks by the inclusion of country-by-time fixed effects. We also rule out several general equilibrium effects such as a shift (diversion) of migration routes, since we find little evidence for it in our setting (see Online Appendix B). The only remaining (time-varying bilateral) source of bias that may be related to our policy shock is related to (time-varying bilateral) information, which we also address in the paper, by investigating heterogeneous effect across aggregate internet access and individual mobile phone ownership.

Smugglers' networks and services almost always play a role in people's ability to migrate irregularly from Africa to Europe, that is why we associate the length of the smuggling routes with the costs of migrating illegally; we also provide supporting evidence about the positive relationship between prices and distances from a new data set.[8]

Because of the complexity of the data, we need to take several steps in the paper before presenting the main results of the gravity estimation in Section 6. We organize the paper as follows to collect all the evidence available in support of our story and

[7] Another example, also discussed in Hatton (2020) would be the agreements between Turkey and the EU which seem to have reduced outmigration in the middle East.

[8] Recent waves of IOM's Flow Monitoring Survey, available at https://migration.iom.int/reports, indicate that 94% of interviewed migrants report having used smuggling services.

analysis. In Section 2, we set the stage of the paper by presenting aggregate data on how irregular migration from Africa to Europe developed around the time that we will consider in the regressions, following the exogenous shock of the demise of the Gaddafi regime. Section 3 presents our research design and addresses several issues that could jeopardize our identification strategy. Section 4 presents the individual data on migration intention and the process used to construct and measure the time-variant smuggling routes. Section 5 then reconsiders distance as proxy for migration cost and presents quantitative evidence in favor of this hypothesis. Section 6 unfolds the main analysis and results on elasticity of migration intentions, while Section 7 performs a similar analysis with observed data on unauthorized flows. Section 8 concludes.

2. Irregular migration from Africa to Europe

With rising border controls and immigration enforcement activities, economic returns to the smuggling business have been growing over recent decades and South-North migration routes have increased in coverage, de-facto substituting the now unavailable legal channels (Jandl, 2007; Gathmann, 2008). African migrants crossing borders without visas can move towards Europe through these trans-Saharan and maritime routes.[9] While migration routes tend to be shaped by old routes which were used by caravans and during transhumance through the desert, new routes have been slowly developing driven by smuggling competition but constrained by the geography of the African continent.[10] Libya is currently one of the most important hubs for people migrating towards Italy and then often further on to other European destinations. In 2010 the CMR, connecting Libya with Europe, was a closed route for irregular migration due to the crossing being patrolled by local and international police.[11] This was mainly due to the Friendship Treaty signed between Italy in Libya in 2008, which stipulated border controls to tackle irregular migration, especially via sea. Ronzitti (2009) reviews the treaty between Berlusconi and Gaddafi, which was meant to control migration via the Mediterranean. In particular, the treaty stipulated joint Italian–Libyan naval patrols to secure the Mediterranean and a satellite detection system that was jointly financed by the EU and Italy meant to control the Libyan land borders. In 2011, though, a wave of sudden protests and uprisings, known as the Arab Spring, shook up the socio-political environment of some African Mediterranean countries. Popular revolts started in Tunisia in December 2010 and in 14 months rulers in Tunisia, Egypt, Libya and Yemen had been forced from power. In particular, in 2011 a significant number of Tunisian people (and people incarcerated in Libyan jails) left the country through the central Mediterranean route while, by late 2011, the Gaddafi autocratic regime had collapsed and Libyan borders suddenly became available to undocumented migrants.

The destabilization of Libya, combined with the dry-up of legal channels and the rise in human smuggling activities, played a significant role in offsetting the decline in Africa-EU legal migration with a rise in irregular migration flows. Official Eurostat data show that the number of regular African immigrants settling legally in EU Member States dropped significantly, from 442,000 in 2008 to 270,000 in 2012, remaining stable since then (see Fig. 1). In strong contrast, irregular arrivals of Africans to Europe have increased considerably over the last decade, with asylum and humanitarian protection entry demands surging since 2012 and to date (see also Natale et al., 2018).

Zooming in on the CMR by using data collected by Frontex on detected migrants across that route, Fig. 2 shows a close-to-zero irregular migration across that route for the year 2010, a large spike in 2011 and a lower average level in 2012. In particular, the spike in 2011 comes from people who fled Tunisia and Libya (many of them were Tunisians and migrant workers from sub-Saharan Africa) as the regimes collapsed and sea routes were no longer patrolled. This is due to the collapse of the Gaddafi regime, which resulted in the dismantlement of the control system that previously kept the CMR unavailable.[12]

One may argue that the spike in crossings is short-lived since it lasted just one year (2011) and we need to wait until the summer of 2013 to see another spike in crossing. Three remarks are in order here: (i) Mediterranean crossings between 2010 and 2012 increased by a factor of three; (ii) we focus on migration intentions in 2012, which may turn into actual migration in 2013; (iii) the huge spike we observe in 2011 stems from a rise not only in migration demand, but also in smuggling service supply. In other words, the demand-driven fluctuations in border crossing occurring since 2011 have been made possible by the booming of the smuggling industry (i.e. the reopening of the CMR), which is the source of natural variation (unanticipated shock) in irregular migration costs we leverage in our analysis.

Fig. 3 shows variation in detected irregular migrants by origin country crossing the CMR before and after the collapse of the Libyan regime. For many countries in the sample, we observe large and increasing absolute numbers. Importantly, some of these countries are not close to Libya (see for example Somalia, Eritrea, Syria and Nigeria), suggesting that Libya, after 2011, regained its status as of one of the main human smuggling hubs connecting African countries to Europe.[13]

Finally, in Fig. 4 we employ Frontex data to compare the use of different smuggling routes from Africa and the Middle East, as measured by detected irregular migrants. The figure shows that migrants from this region make use of essentially three routes, i.e. the Central, Eastern and Western Mediterranean routes. While there is a significant three-fold increase in the use of the CMR after 2010, there is not much time variation in the use of the remaining migration routes over the same period.

[9] According to Europol-INTERPOL, more than 90% of the migrants coming to the EU are facilitated, mostly by members of a criminal network using both land and Mediterranean sea routes. Despite the fact that many migrants end their journey prematurely and remain in different sites in North Africa, migratory pressure remains high (almost 2 million irregular migrants are estimated to live in Libya and other countries in the Maghreb in 2014) (Hammond, 2015).

[10] see iMap website (http://www.imap-migration.org/).

[11] All the sea and land entry points to Europe are represented in Figure A1.

[12] The collapse of law and order in the aftermath of Libya's revolution and the poor economic conditions in the area created both the environment and the incentive for the liberalization in the smuggling market as well as the intensification of migrants' exploitation since then (Micallef, 2017).

[13] In Figure A5 in the Online Appendix we report detected illegal migrants by origin countries between 2009 and 2012 in order to show the high variation and lack of persistency in migrants' origin over time.

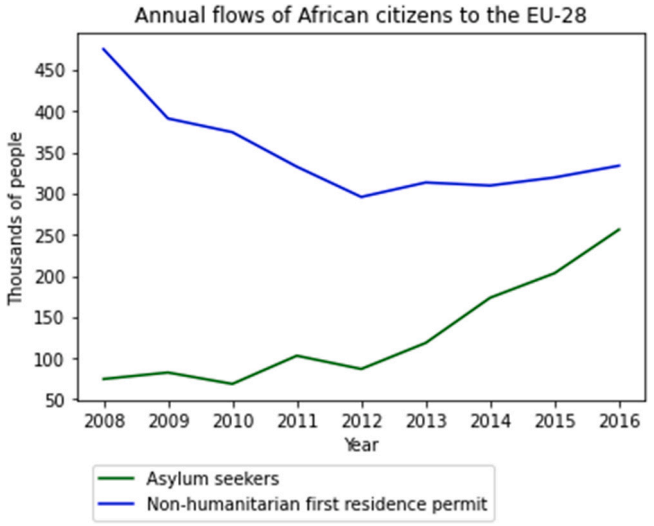

Fig. 1. Africa-EU Regular and Irregular Migration.
Notes: Annual flows of African citizens to the EU-28 based on first residence permits and asylum applications, 2008–2016, absolute numbers, in thousands.
Source: Eurostat.

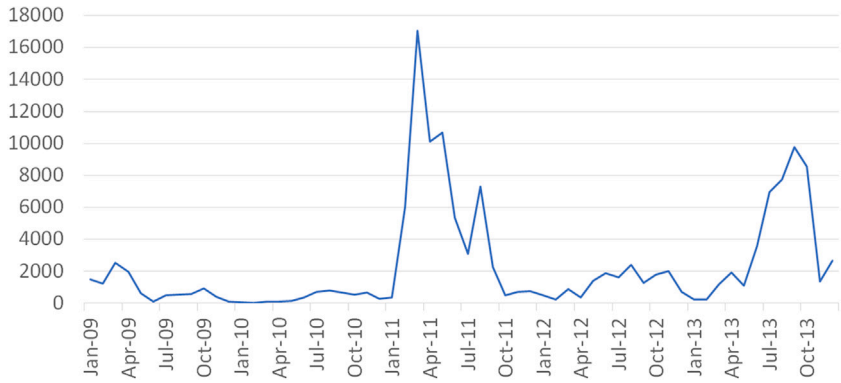

Fig. 2. Monthly pattern of irregular migration across the Central Mediterranean Route.
Notes: The figure shows the monthly number of detected undocumented migrants (i.e. detected border crossing) arriving in European territory across the Central Mediterranean Route in the period 2010–2012.
Source: Frontex.

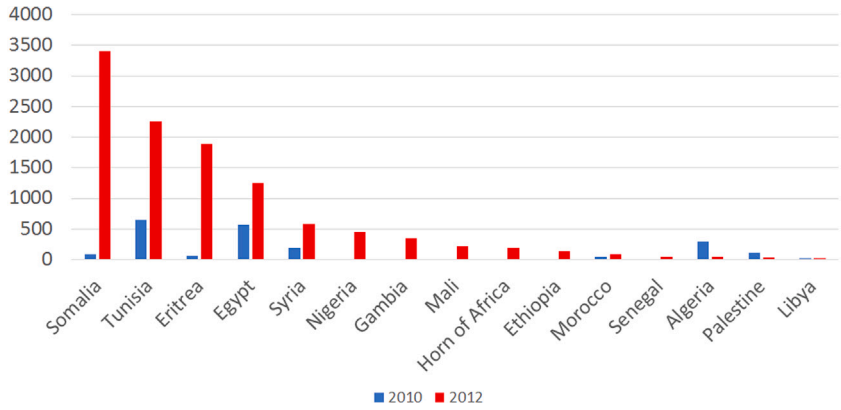

Fig. 3. Detected irregular migrants across the Central Mediterranean Route by country of origin.
Notes: The figure shows the number of detected undocumented migrants (i.e. detected border crossing) arriving in European territory across the Central Mediterranean Route from selected origin countries in years 2010 and 2012.
Source: Frontex.

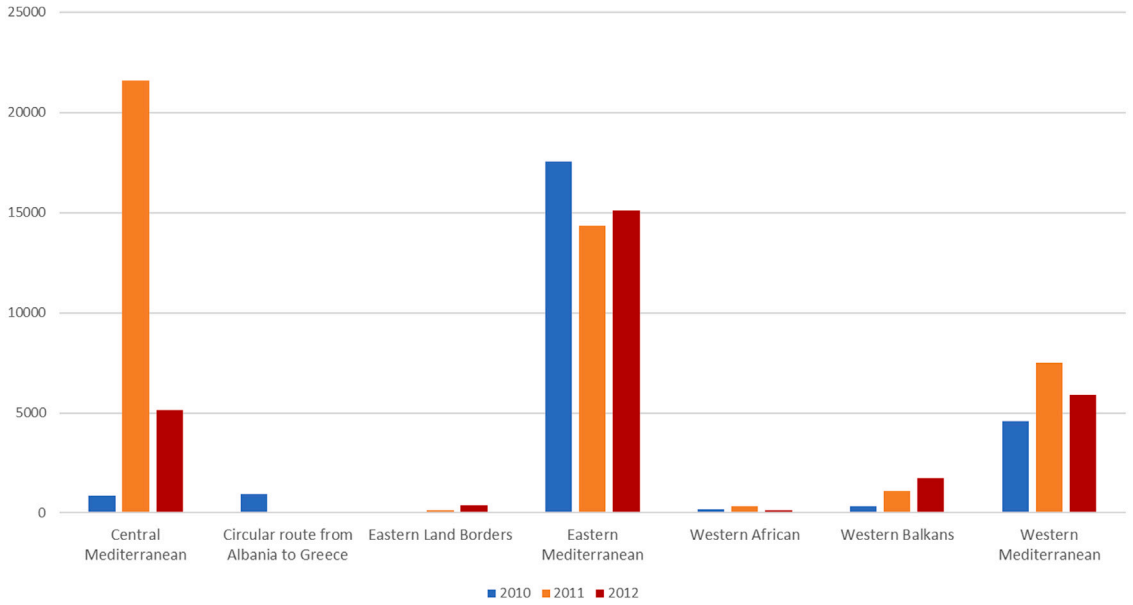

Fig. 4. Number of detected irregular migrants by migration routes.
Notes: The figure shows the number of detected undocumented migrants (i.e. detected border crossing) arriving in European territory across different migration routes in years 2010, 2011 and 2012.
Source: Frontex

Overall, the evidence reported above points to the fact that, after the Arab Spring and the associated spike in migration in 2011, the CMR re-opened while no major shocks occurred in the rest of the region. We provide more detailed evidence on this in Online Appendix B, where we present econometric analyses of Frontex data. This suggests that the kind of shock we are considering, which translated in the opening of the CMR, actually increased the possibility (i.e. reduced the cost) of migrating from (some) African to (some) European countries. The unexpected nature of such shock is crucial for our analysis, as migration opportunities changed suddenly between 2010 and 2012, while all the rest remained unchanged in that time span (including migration policies or risks at destination) and can be easily controlled for in the econometric analysis.

3. Research design

Our empirical analysis investigates the role of smuggling costs in shaping individual decisions to move from Africa to Europe irregularly. It is useful to first think of what could be deemed a perfect experiment. The outcome variable would be real migration flows, and one would look at the effects of an exogenous reduction (or increase) of migration cost that affects migration flows between different country pairs in a differential way that is systematically related to the shock.

There are however a number of obstacles to such a design. First, there is limited evidence on migration flows, owing to the clandestine nature of south-north migration. Second, prices for the smuggling services are not readily available. Finally, there are numerous push and pull factors that may confound migration elasticity along with other general equilibrium effects irregular routes may have on migration (such as access to alternate smuggling routes, migration enforcement policies and returns to unauthorized migration).

In order to overcome these obstacles, we will first measure irregular migration by using migration intentions from Gallup, and corroborate our analysis be employing actual (detected) irregular immigrants from Frontex. We further show, with a novel data set on an admittedly small and unique survey sample, that the prices smugglers charge are strongly correlated with migration distance. Key to our analysis, formal identification is achieved by leveraging a natural experiment, i.e. the turmoil in Libya (and other countries experiencing Arab Springs in 2011, i.e. Egypt and Tunisia) and the demise of Gaddafi regime, which resulted in an unanticipated and asymmetric shock in route lengths for irregular border crossing.

In what follows we discuss our strategy in more detail, highlighting how our research design allows us to disentangle several potential confounding factors.

We compile novel geo-coded data of *time-varying* bilateral distances between country pairs along land and sea routes before and after the Libya collapse. We use this source of exogenous variation in the length of smuggling routes as a proxy for the change in the cost of irregular migration. More specifically, we employ a gravity framework to estimate the impact of the change in irregular migration costs on migration intentions, netting out all possible (static and dynamic) push and pull drivers of the emigration decisions at the country of origin and destination level. Indeed, our approach allows us to use destination and origin country fixed effects interacted with time, which address eliminates a large class of potential confounders usually plaguing this type of empirical analysis.

Moreover, we further control for country-pair fixed effects, which remove time-invariant bilateral factors, as our main variable varies over time across pairs. A non-exhaustive list of confounders that are netted out by our fixed-effects' structure are origin and destination wages dynamics, flows of information on local and foreign media on migration possibilities, climatic shocks, conflict, air distance and common languages. Hence, identification is achieved through changes in distance along irregular routes, which are fully controlled by smugglers in Africa, such that the effect is coming entirely through changes in the costs of irregular border crossing. Furthermore, by using individual-level variation across demographic and socio-economic characteristics, we can provide evidence on the heterogeneity in the responsiveness of the individual demand for undocumented migration to costs.

In our gravity model, identification rests on the assumption that, before and after 2011, there are no other major bilateral changes between the country pairs we look at that are correlated with migration intentions. To address this assumption in a compelling way, we restrict our analysis to a spatial and temporal frame that minimizes the possibility that other events may interfere with or confound our identification strategy. More specifically, we exclude from the analysis the countries where the Arab Spring took place and led to a prolonged power vacuum (i.e. Egypt, Libya and Tunisia), and focus on the years 2010–2012 (and in some specifications 2013) while excluding 2011, the year when these events occurred. This allows us to focus only on the short-run impact of the exogenous change in the cost of irregular migration resulting from the unexpected reduction of bilateral smuggling routes through the opening up of the CMR. Indeed, before and after the period we consider, other bilateral and multilateral (EU) agreements or migration-policy measures were put in place systematically — also due to the same change of environment we are considering, i.e. the opening of the CMR and the booming of irregular flows (e.g. the Mare Nostrum Operation was launched at the end of 2013 and the Triton operation the following year).[14] These changes in the rescue system and border enforcement may interfere with migration decisions of border-crossing towards Europe along specific bilateral migration routes (e.g Tunisia–Italy), and this is the reason why we exclude them to have a clean 'natural laboratory' (where we can control for several simultaneous factors). The opportunity to exploit an exogenous source of variation in the cost of illegal migration, such as distance, is rare, and perhaps unique, in this region of the world (and in the migration literature in general), since migration (enforcement) policies and the middlemen industry for illegal border crossing are typically simultaneously determined.

Yet, it is still conceivable that the political earthquake of the Arab Spring gave rise to differential dynamics in emigration intentions throughout the African region even in the short-run, i.e. our identification of the demand elasticity to smuggling costs may be threatened by correlated shocks such as information spillovers or network effects. This may cast doubt on whether we are truly identifying some demand elasticity to smuggling costs, or some other underlying mechanism.

First and foremost, to address the plausibility of our assumption that smuggling distance is a proxy for the cost of irregular migration, we provide direct and unique evidence that this is the case (Section 5). Indeed, smuggling routes may be different in terms of safety and viability so that we may find that longer distance journeys turn out to be cheaper for some reasons other than transportation or time-equivalent costs. To investigate this issue, we use individual-level survey data on actual migration smuggling costs reported across different origin–destination pairs along multiple land and sea routes. We document a strong and positive correlation between bilateral distance and self-reported smuggling costs (in line with the trade literature).

Another threat to our identification strategy would be if there is important heterogeneity in availability of information regarding smuggling distance. In our specifications, any aggregate shock to information access is absorbed by origin country-time fixed effects. Moreover, any structural information and more long-run bilateral factors are absorbed in the country-pair fixed effects (for instance, the presence of long-run chain migration or media reports in the destination or host countries). The information available on the individual level, though, cannot be controlled for by the fixed effects. A large sociological and anthropological literature (references in Online Appendix D) has been looking at the determinants of migrants' information for different migration paths. While there seems to be some heterogeneity about migrants' knowledge about their conditions in the receiving country, there is much less heterogeneity about two factors that are important for our paper: first, migration risks for maritime and land transportation and, second, the knowledge about the availability of opportunities to migrate, which is mainly tantamount to having access to smuggler networks. Hamood (2006) described 15 years ago that the "overwhelming majority" of Egyptian migrants were well informed, and this is very similar to what Alpes (2017) describes in her book about migrants from Cameroon more than ten years later. Similarly, Crawley et al. (2016) reports on migration over the Mediterranean that smugglers "are embedded in the social structures and easy to find". IOM (2018) points out that smugglers cannot be expected to be trustworthy but that migrants use their social networks to increase the validity of their information. The report also points out that the diffusion of information technologies, in particular having a mobile phone and/or internet access, is crucial for migrants' information. Thus, in order to empirically investigate this issue, in our analysis we test differential distance effects across countries with low vs high baseline information access (as measured by share of people with internet at home) and across individuals with/without a mobile phone (Sections 6.1 and 6.2).[15]

Finally, in order to check the robustness of our results to potential measurement error related to intending migrants, we employ actual irregular migration data collected by Frontex, the European Border and Coast Guard Agency, which counts monthly detections of undocumented border-crossings at different European entry ports. This data source may be problematic in perfectly matching our migration intentions data, since some of the intentions may not translate into actions but, most importantly, some irregular migrants are not detected (and counted) by Frontex authorities. Nevertheless, aggregate dynamics detected by Frontex data shall mirror our findings while using the Gallup Poll. We test this in the last part of our analysis. At the same time, we take advantage of the higher frequency nature of Frontex's monthly data to check for pre-trends across smuggling routes before the outbreak of the Arab Spring (Section 7).

[14] We further include 2013 in our analysis for robustness purposes, and results hold. In the analysis run on actual monthly flows we will use the January 2010–December 2013 sample, as we do not want to have gaps in the data, specifically in the event study setting.

[15] While we are able to estimate the causal effect of distance on bilateral international migration intentions from African towards European countries, in different context the effects of distance on migration intentions might be different.

4. Data and measurement

We use information on potential migrants from two waves of the Gallup's World Poll (GWP) which is a repeated cross-section, nationally representative individual-level dataset covering more than 150 countries over several years.[16] GWP builds on yearly surveys of residents older than 15 years of age and represents more than 98 percent of the world's adult population (e.g. see Docquier et al., 2014; Dustmann and Okatenko, 2014 or Manchin and Orazbayev, 2018 for papers using the same dataset).[17] As explained in Section 3, we limit our sample to the years 2010–2013 and to the Mediterranean context, excluding Libya, Tunisia and Egypt from our estimation sample.[18]

4.1. Migration intentions

By its clandestine nature, irregular migration is not observable and it is empirically difficult to account for its size and composition. An advantage of using intentions to migrate instead of actual migration is that intentions are likely to be a primary determinant of the supply side of international migration flows. Indeed, intentions provide a measure of migration propensities also including potential illegal migrants, which are omitted from most migration statistics. On the other hand, a potential concern when using intentions is whether intentions are "mere words or true plans" (van Dalen and Henkens, 2008). Other studies show that there is a high correlation between cross-country data on the desire to migrate and actual migration flows (see for example Docquier et al., 2014). A contribution in the explanation of the desire to migrate in a gravity context is Bertoli and Ruyssen (2018), while in this paper we use a specific, stricter definition of migration intentions, i.e. whether respondents would like to move abroad and whether they plan to do so in the following year.[19]

Key to our study, the GWP survey asks, first, about the individual intention to migrate, and then about the preferred destination country. This allows us to exploit the bilateral nature of migration intentions and combine them with georeference data on origin–destination pair distance. We focus on the area across the Mediterranean Sea (i.e. Africa, Middle East and Europe) so that our final dataset consists of micro-level information from a representative sample of individuals living in 31 origin countries in Africa and the Middle East, reporting 25 European countries as their preferred destination, in the years 2010–2013. Several former studies have been using the Gallup annual surveys to better understand the different steps of the migration process (from wishes to real actions), and all of them report strong positive correlations between intentions and actual flows (see Docquier et al., 2014; Manchin and Orazbayev, 2018; Clemens and Mendola, 2020 among others). For our purpose, we employ the migration plan question, which has the advantage that the wording of the question is fully inclusive of irregular migration. Yet, we are aware that not all plans can translate into actions. This is so as the time period and the origin and destination areas under consideration are characterized by very limited free mobility of individuals as well as a high degree of uncertainty. Hence, many migrants traveling irregularly could actually end up in a country different from the originally planned one. Moreover, for legal migration, Visa application rules can take time, and in combination with the destination country mismatch pose measurement issues. Nevertheless, using both UN data and Eurostat asylum applications, in Online Appendix C we show that there is a positive correlation between bilateral migrate intentions and the subsequent number of asylum applications in our bilateral sample of country pairs.

Table 1 reports average emigration rates based on migration intentions for the GWP sample of African and Middle-Eastern countries (i.e. aggregate migration intentions as a share of total population).[20] On average, migration intentions increase from 0.71 percent of the population in 2010 to 0.88 percent in 2012. In our sample, migration intentions are mainly concentrated in the youth and male population. Indeed, the share of males in total population with migration intentions is 0.43% in 2010 (0.29% for females), increasing to 0.59% in 2012. Similar to males, the share of young people with migration intentions in total population also increases during the period. Moreover, aggregate data reveal a decrease in migration intentions among low-skilled individuals (i.e. those with no more than primary education) which represent more than half of the total population of potential migrants. Instead, migration intentions increase among those with more skills (i.e. secondary education and above) with the share of high-skilled individuals with migration intentions rising from 0.31% to 0.55%.

[16] The survey covers each country comprehensively, including rural areas. See further details on the dataset and a full list of available variables in Esipova et al. (2011) and Gallup (2012).

[17] The information is collected from randomly selected, nationally-representative samples of about one thousand individuals per country. In some countries, larger samples are collected in major cities or areas of special interest. Additionally, in some large countries, such as China and Russia, sample sizes increase to at least two thousand respondents. The survey's country samples are probability based (i.e. the weights applied in the survey are used in the empirical analysis of this paper).

[18] Ultimately, our sample of origin countries includes Benin, Burkina Faso, Botswana, Central African Republic, Cameroon, Congo, Dem. Rep., Congo, Rep., Comoros, Djibouti, Algeria, Gabon, Ghana, Guinea, Iraq, Israel, Jordan, Kenya, Lebanon, Liberia, Morocco, Mali, Mauritania, Malawi, Niger, Nigeria, Rwanda, Sudan, Senegal, Sierra Leone, Somalia, Syria, Chad, Tanzania, Uganda, Yemen, South Africa, Zambia, Zimbabwe. While destination countries are Austria, Belgium, Bulgaria, Switzerland, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, UK, Greece, Croatia, Hungary, Ireland, Italy, Luxembourg, Latvia, Montenegro, Netherlands, Norway, Poland, Romania, Serbia, Slovenia, Sweden, Turkey. Note that with the aggregate-level regressions and with the high dimension of fixed effects a number of countries are dropped due to perfectly predicted outcomes and singletons.

[19] Migration intentions are measured using the answers to the following questions: (i) "Ideally, if you had the opportunity, would you like to move permanently or temporarily to another country, or would you prefer to continue living in this country?"; (ii) "In the next 12 months, are you likely or unlikely to move away from the city or area where you live?"; (iii) "Are you planning to move permanently to another country in the next 12 months, or not?"; (iv) "To which country would you like to move?". In particular, question (iii) is asked only starting from the year 2010 and only to those who respond positively to question (ii). Hence, while we use all survey questions above as to drop inconsistent responses across them, we focus on question (iii) to identify individuals willing (i.e. planning) to migrate in the following year, out of the relevant population that is defined by respondents to question (ii). See more details on the underlying questions in Manchin and Orazbayev (2018).

[20] Some of these countries could not be included in our estimation sample as key variables might be missing.

Table 1
Emigration intention rates and composition (Gallup World Poll, 2010–2012).

	2010	2012
Emigration intention rate (as % of pop.)	0.71	0.88
Male emigration intention rate (as % of pop.)	0.43	0.59
Youth emigration intention rate (<30) (as % of pop.)	0.44	0.59
Low-skilled emigration intention rate (as % of pop.)	0.40	0.33
High-skilled emigration intention rate (as % of pop.)	0.31	0.55

Notes. Emigration intention rate is the population weighted average across our sample of country-level emigration intention rates (which are defined as the share of population with migration intentions). Low-skilled is defined as primary education, high-skilled is defined as secondary or higher education.

Table 2
Migration intention shares — Top ten origin countries (GWP, 2010 and 2012).

Rank	2010		2012	
	Origin country	Emig. intention rate	Origin country	Emig. intention rate
1	Senegal	6.58	Comoros	4.17
2	Djibouti	3.78	Senegal	3.49
3	Comoros	2.81	Sudan	2.33
4	Somalia	2.12	Ghana	2.07
5	Mali	1.98	Guinea	1.72
6	Mauritania	1.45	Algeria	1.68
7	Morocco	1.28	Mauritania	1.64
8	Sudan	1.05	Congo Rep.	1.29
9	Ghana	1.02	Morocco	1.29
10	Algeria	0.87	Nigeria	1.18

Notes. Emigration intention rate is defined as the share of population with migration intentions, calculated using sampling weights for GWP.

Table 3
Bilateral migration intention shares – Top-five origin countries with top-two destinations (Gallup World Poll, 2010–2012).

Rank	2010			2012		
	Origin	Top-2 destination	Emig. intention rate	Origin	Top-2 destination	Emig. intention rate
1	Senegal	Spain	2.36	Comoros	France	3.99
		Italy	1.86		Germany	0.177
2	Djibouti	France	2.39	Senegal	France	1.44
		UK	0.48		Spain	1.30
3	Comoros	France	2.48	Sudan	UK	1.25
		UK	0.14		France	0.58
4	Somalia	UK	1.42	Ghana	UK	1.20
		Sweden	0.25		Spain	0.60
5	Mali	France	0.82	Guinea	France	0.76
		Spain	0.60		UK	0.43

Notes. Emigration intention rate is defined as the share of population with migration intentions, calculated using sampling weights for GWP.

Table 2 reports migration intentions for the ten countries with highest emigration intention rates (all these countries are above the sample average). Table 3 provides further details on where people from the top five highest emigration countries would like to migrate, listing the two most important destinations for each country. The preferred destinations by country are only a few, with most respondents willing to go to a few selected destination countries in Europe. While this is not shown in the table, for many country-pairs for which smuggling distance shortened, migration intentions increased. The country-pairs for which distance got shorter and a more than 100% increase took place from 2010 to 2012 in migration rates are Ghana–UK, Lebanon–France, Somalia–Norway, Cameroon–UK, South-Africa–UK, Ghana–Germany, Chad–Germany, Sudan–France, and Burkina Faso–France.

4.2. Bilateral distance

We construct a matrix of bilateral distances from each country of origin (o) to each destination (d) by mapping migration routes between Africa, the Middle East and Europe, where our assumption is that distance is a good approximation of transportation costs, as pervasive in trade literature and supported in Section 5 below. Unlike air distance, land and sea migration routes change over time, hence we construct the matrix that collects such distances D_{odt}, where t is years 2010 and 2012.[21] In general, as we cover

[21] We constructed a full matrix for each African and European country pair and use it for visualization purposes in this section, but the coverage in the GWP defines the number of country pairs used in the regression analysis.

different datasets and types of analysis, we will refer to 2010 and 2012 distances as those distances that are used in the pre- and post-Arab Spring period, respectively. The assembling process follows several steps. First, the patterns of international migration routes from countries in Africa/the Middle East to Europe have been geolocalized from the maps provided by the iMap platform, which has been developed jointly by ICMPD, Europol and Frontex (a sample map of overland and oversea routes from iMap is reported in Figure A6 in the Online Appendix).[22] Each country is represented by the coordinates of its capital city, as the migration routes usually go through it and because the location of the capital city is often a good proxy for the center of mass of each country in terms of population. The structure of migration routes represent the network connecting all of the countries in our sample.[23]

In Fig. 5 the network of migration routes in 2010 is represented by the red segments connecting the (capitals of) African and European countries (note that the CMR is closed as a direct consequence of the pre-2010 agreements between European and Mediterranean African countries). The blue segments represent the sea routes which opened after the Arab spring and the fall of the Gaddafi regime, having been closed by the Italian–Libyan friendship agreement before. Hence, the CMR has been added to the 2010 network to obtain the new structure as of 2012.

The distance associated with each origin–destination pair is the minimal geodesic distance calculated using a Dijkstra algorithm along the segments of the network.[24] Hence, we can measure the effect of the opening of the CMR in 2011 on each origin–destination pair as the difference between the shortest migration route between the two countries not crossing the CMR and the shortest path between the same two countries along all of the routes, now possibly including CMR. In order to avoid too much arbitrariness, we do not impose differential transit costs depending on altitude, ruggedness or other spatially located characteristics (e.g. rivers, desert, vegetation, conflicts at play, different infrastructure maintenance, etc.), so that the cost of moving between nodes maps one to one with the distance. Moreover, we obtain almost identical results by recoding sea routes being one fifth cheaper than land routes, i.e. rescaling the length of segments across the sea by a factor of 0.2 or by doubling it.[25] The fact that these modifications have little effects on the results can be rationalized as, first, the length of the average route connecting a country pair is in the order of magnitude of thousands of kilometers and the maximum sea distance (between Libya and Italy) is less than 300 kilometers. Second, the important change between distances across the two periods is the emergence of the Central Mediterranean route, with its length playing a minor role in the overall change. It is therefore the possibility of finding shorter paths across the network (by means of additional nodes) rather than the shortening of existing segments that mostly contributes to the variation in distances across the two periods.[26]

The resulting matrix of smuggling distances is shown in Fig. 6. Here, each dot is an origin–destination country pairs and the horizontal and vertical axes report the distance along smuggling routes in 2010 and 2012, respectively. It is worth noting that, by construction, the addition of links in the network (the 2011 CMR opening) makes the minimal distance between country pairs either unchanged or shorter, particularly for those country pairs close to the new links. Note that the farther the dots are from the 45-degree line, the closer the country pairs get between 2010 and 2012. Some country pairs have been labeled as examples, such as Morocco–Spain (the closest pair, which however does not change its bilateral distance over time), Jordan–Italy (the pair experiencing the largest reduction in distance) and Yemen–Sweden (a pair made of very distant countries which experienced a sizeable reduction in distance, more than 2000 kilometers).[27] We calculated the average migration rate for 2010 and 2012 separately for the countries for which distance decreased (i.e. off the 45-degree line) and for those for which distance remained the same (i.e on the 45-degree line). We find that in our final sample the average migration rate decreased by 9% for those with no change in smuggling distance, while increased by 1.4% for those off the 45 degree line (i.e. reduced distance).

5. Evidence on smuggling costs and Africa–EU migration

Human smuggling is a global multi-billion industry. The largest markets are the south-north migrations to the USA with estimated annual revenues of around four billion USD and the one from sub-Saharan Africa to North Africa with annual revenues of more than a billion USD (UNODC, 2018). The Mediterranean routes are estimated with a revenue of half a billion USD per year. Numerous reports exist to document how the smuggling industry is organized and what prices they charge. In Online Appendix D, we list these resources. Unfortunately, the methodologies of these reports are quite different, mostly building on interviews with migrants, and the number of people interviewed per route is oftentimes insufficient to carry out quantitative analyses. What transpires though from the many reports is that (i) people are charged for different stages of their migration, so that costs build up with the distance

[22] http://www.imap-migration.org/

[23] Those off the migration routes have been connected to their closest neighboring country using the shortest straight link.

[24] The implicit assumption here is that the cost of connecting two nodes off the migration routes is infinite.

[25] In general one can think of the cost of crossing a single leg of length L over sea or land as: $TC_m(L) = r_m \cdot t_m \cdot L$, where r_m and t_m are parameters taking into account riskiness and technological factors over sea and land ($m = \{s, l\}$, respectively) specific to that leg of journey and both can be larger or smaller than 1. The main analysis assumes that $r_m \cdot t_m = 1$.

[26] Indeed life risk is also difficult to use to compute adjusted measures of distance. While sinking boats bringing immigrants across the Libyan Sea break the news, there is only scattered recording and reporting of the many casualties occurring in the thousands of kilometers of desert migrants cross before reaching the sea and land entry ports of Europe. See the Missing Migrants Project (https://missingmigrants.iom.int/) showing the scattered degree of riskiness of different routes measured by number of reported casualties.

[27] In the Online Appendix, in Figure A2 we plot how the drop in distance between 2010 and 2012 is distributed at given absolute distances (in 2010), showing that large drops are not only concentrated among those country pairs already close to each other. Figure A3 shows that there is a sizeable number of country pairs for which distance dropped between 2010 and 2012. Finally, Figure A4 shows that some countries (such as Benin, Malawi, and Zambia) did not experience any drop in distance, while others (such as Botswana, Chad and Somalia) became closer to many of the destination countries.

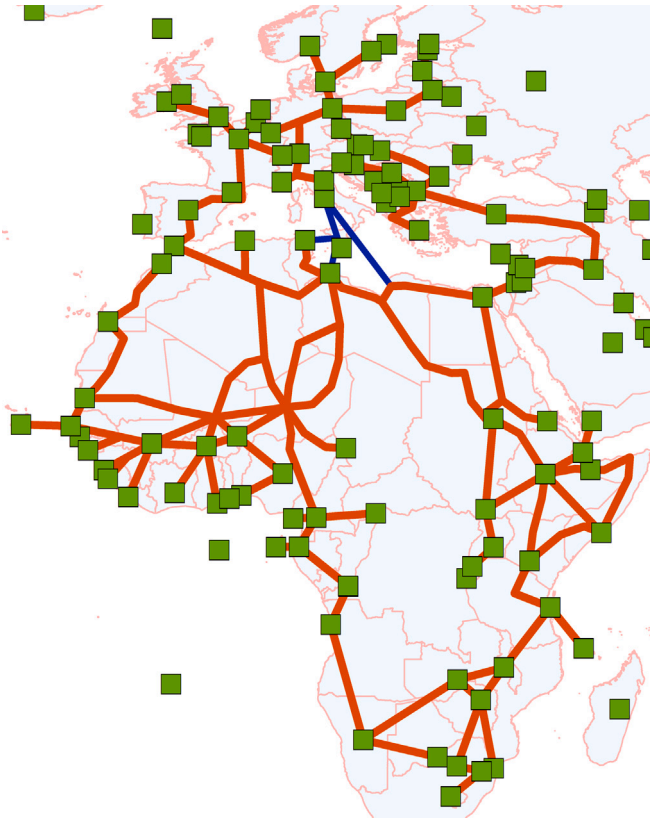

Fig. 5. Network of migration routes.
Notes: The figure shows the location of the capital cities of countries (squares) and the migration routes connecting them (lines). Countries not connected are excluded from the sample. Red migration routes relative to the year 2010 are obtained from the iMap website, while blue ones are those added to construct the network in 2012. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

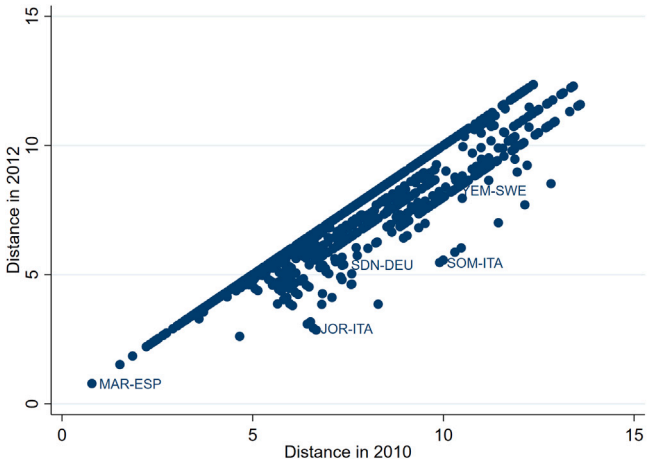

Fig. 6. Distance between pairs of countries.
Notes: The figure shows the distances, in 1000 Kilometers, between country pairs in 2010 and 2012.

traveled; (ii) there is considerable variance in the prices migrants report and this may reflect some price discrimination. In general, prices range from several hundreds to many thousands USD for different stages of the migration routes.

One exceptional dataset, and probably the only one allowing a quantitative study is a UNDP survey data collected in 2018 in 13 European countries from Africans who had migrated to Europe through irregular means from multiple African countries.

By administrating personal interviews, this survey collects individual-level information on socio-demographic background as well as characteristics of the migration process for about 3000 asylum seekers who arrived in Europe through irregular land and sea routes (UNDP, 2019). More specifically, we use survey data on the cost of the journey to Europe, the origin country where the respondent was living when decided to migrate to Europe, the year of arrival and the entry hub to Europe. Observations mostly refer to people that reached the European borders in recent years, but roughly 12% of the observations report arrival in Europe between 2002 (the first recorded year) and 2011. We set up a general migration cost equation (1) as a function of travel distance covered by individual migrants, netting out several confounding factors.

$$Price_{iodt} = \alpha_1 + \alpha_2 Dist_{odt} + \alpha_3 X_i + \delta_{et} + \epsilon_{iodt} \quad (1)$$

Specifically, $Price_{iodt}$ is the total amount, in PPP dollars, paid by the immigrant i to move from country o (where s/he decided to move to Europe) to the final destination d, where t is the year of first arrival to European borders.[28] $Dist_{odt}$ is the bilateral distance between the country of departure o and the European country of destination d, calculated using the algorithm presented in Section 4.2 above. X_i includes individual level controls (dummies for gender, marital status and having children, continuous variables for years of education and number of family members in the home country) while δ_{et} is a set of year-by-entry hub to Europe fixed effects, which control for any shifter occurring overtime along each route leading to different European entry hubs. The latter include budget allocated by the European countries for patrolling different areas, different organizational forms of the smuggling industry along different routes, possibly related to bottlenecks in supply or demand of smuggling services in the presence of non-competitive markets.[29]

Table 4 presents OLS results for a linear specification (prices and distances) in panel (a), and a log–log specification in panel (b). Benchmark results are reported in column 1, where the estimation sample excludes those few respondents reporting to be arrived in Europe by plane and those with missing key information, such as country of birth or origin, country of arrival in Europe and price paid for the journey. In column 2, we trim top and bottom 5% of costs and distances, while in column 3, the time dimension is limited to years 2010–2013, in order to cover the same time period used in the main analysis. Due to small sample size, we cannot exploit the within-pair over-time variation in distances, as we do in our main estimates. Comparing means is reassuring, though. While obtained with few observations, the average price paid to cross the CMR before and after 2011 remained relatively stable over time (3338 vs 3319, respectively), while along other routes it increased by 20% after 2011 (2676 vs 3211, respectively).[30] In Column 4, we keep the same estimation sample and further introduce two sets of fixed effects, i.e. country of birth and current country of residence. The coefficient of distance remains remarkably significant and stable throughout (panel (a)), even in the most demanding specification where the sample shrinks to less than 200 observations. According to our estimates, each additional 1000 km increases the cost of the trip by more than 400 US dollars. Results are barely unchanged when considering the distance form country of birth or the country where the migrant grew up, as there are little individual-level differences. Panel (b) reports the results of the log–log specification, and when excluding outliers (column 2 to 4), an elasticity equal to 1 cannot be rejected. Thus, these results are reassuring on the use of distance as a (likely linear) proxy for migration costs.

6. Estimates of the elasticity of illegal migration

In order to estimate the elasticity of migration to irregular migration costs proxied by distance, we employ a gravity model, which has been extensively used to empirically estimate trade flows since Tinbergen (1962).[31] We aggregate GWP individual migration intentions country level[32] and estimate a bilateral gravity equation of the form:

$$\log M_{odt} = \gamma_1 \log D_{odt} + v_{ot} + w_{dt} + u_{od} + e_{odt} \quad (2)$$

where the outcome variable M_{odt} is the migration rate (i.e. the share of bilateral migration intentions in total origin population) from country of origin o to country of destination d at time t.[33] The regressor of interest, $\log D_{odt}$ is the log of the time-varying smuggling distance, measuring the distance between the origin and destination country along migration land and sea routes. Estimation of Eq. (3) by means of PPML allows to interpret γ_1 as an elasticity. In addition, we include three sets of fixed effects: country-pair (u_{od}), origin-year (v_{ot}) and destination-year (w_{dt}) fixed effects.[34] The origin-time and destination-time dummies absorb any aggregate

[28] Interestingly, the survey asks whether the final destination country is the one migrants initially planned to go to. The share of negative answers is around 20%, indicating that on average migrants have a clear idea of their final destination.

[29] Including pairs, origin-by-time, and destination-by-time fixed effects is not possible in this setting, due to small sample size and the sparseness of data. For example, in the full usable sample (1,355 individuals), there would be almost 200 pair fixed effects, among which more than 100 appear at most twice in the dataset, drastically reducing the available degrees of freedom needed to obtain general results.

[30] This is obtained with very few observations, in particular only 88 have been used to calculate the mean along the CMR before 2011.

[31] See Head and Mayer (2014) and Beine et al. (2016) providing a comprehensive overview of the gravity model's application to international migration flows.

[32] Aggregate data are weighted by sampling weights, i.e. by the inverse probability of household sampling within source countries. This makes aggregate data representative in the average country.

[33] In using migration rate, we follow the theoretically derived gravity model for migration (see Beine et al., 2016).

[34] A similar empirical strategy is employed in Pascali (2017), which uses a time-varying (measure of) distance as explanatory variable in a standard gravity trade model. Country-pair fixed effects absorb all time-invariant bilateral migration costs (or benefits) such as geographical and economic proximity (including air distance for example), common language, shared tastes, social networks, colonial linkages and bilateral migration policy. The country-year fixed effects controls for all static and dynamic standard socio-economic push and pull factors. Hence, the identification comes from short-run changes – i.e. a reduction in the length of irregular migration routes, which translates into changes in illegal migration costs.

Table 4
The impact of distance on cost.

	(1)	(2)	(3)	(4)
		Panel (a)		
Dependent variable:	Prices, in PPP Dollars			
Smuggling distance	0.470***	0.424***	0.471***	0.448***
	[0.108]	[0.082]	[0.127]	[0.126]
European entry hub X year FEs	YES	YES	YES	YES
Individual controls	YES	YES	YES	YES
Birth and Destination FEs	NO	NO	NO	YES
Sample:	Full	Exclude Top/Bottom 5% of Cost and Distance	Restrict further to 2010 ≤ year ≤ 2013	Same as Column 3
Observations	1355	1130	173	162
R2	0.12	0.21	0.38	0.60
		Panel (b)		
Dependent variable:	Log (Prices)			
Log (Smuggling distance)	0.642***	0.822***	0.882***	0.927***
	[0.117]	[0.133]	[0.148]	[0.299]
Individual controls	YES	YES	YES	YES
European entry hub X year FEs	YES	YES	YES	YES
Birth and Destination FEs	NO	NO	NO	YES
Sample:	Full	Exclude Top/Bottom 5% of Cost and Distance	Restrict further to 2010 ≤ year ≤ 2013	Same as Column 3
Observations	1355	1130	173	162
R2	0.19	0.22	0.34	0.57

Notes: The dependent variable is, in panel (a), the price in PPP US dollars paid by immigrants to move from the country in which she decided to move to Europe to the final European destination country. In panel (b) the dependent variable is the log of such price. Results are estimated with OLS. All regressions include a set of individual-level controls plus year-by-entry hub fixed effects. Standard errors clustered at the level of birthplace are reported in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

time-varying push and pull factor and allow us to account for the issue of multilateral resistance (Bertoli and Fernández-Huertas Moraga 2014).[35]

Furthermore, we explore heterogeneity in the distance effect along aggregate country-level features. In particular, we test heterogeneous effects by geographical characteristics of origin location (East vs West Africa, and Northern vs Southern Africa), with priors in line with smaller migration elasticity for countries further away from the Libya shock (which is the case for Southern countries but not for Eastern or Western countries). Indeed, in the absence of the CMR, intending migrants living close to the Libyan hub would travel through longer migration routes in order to reach alternative hubs (e.g. western or eastern Mediterranean routes). In additional specifications, we test differential distance effects by country-level institutional quality (i.e. rule of law) and access to information (share of population with internet access). Indeed, countries may have high variation in their law enforcement systems and rule of law related to stemming migrant smuggling networks.[36] Likewise, not all potential migrants may be connected with these networks, perhaps not even aware about the reopening of the CMR, due to high heterogeneity in the distribution of information access.

Finally, we explore individual-level heterogeneity in the elasticity of migration intentions to irregular distance. To do so, we leverage individual survey data and run the gravity model above, while interacting our measure of the smuggling shock (time-varying migration distance) with individual socio-demographic factors. This allows us to cast light on the characteristics of individuals who respond more (or less) to the incentive for irregular border crossings. In particular, we interact our distance measure with individual level characteristics which proxy for differentials in (time-equivalent) migration costs (such as gender, age and education) and differential availability of help/information (social networks and ownership of a mobile phone). Thus, we estimate the following specification:

$$M_{iodt} = \beta_0 + \beta_1 X_{iot} + \beta_2 \log D_{odt} + \beta_3 X_{iot} * \log D_{odt} + v_{ot} + w_{dt} + u_{od} + e_{iodt} \quad (3)$$

where M_{iodt} is a binary indicator of migration intention of individual i to move from country of origin o to country of destination d at time t. Distance D_{odt} is the same measure as in Eq. (2). X_{iot} is a vector of individual covariates, which include age, gender,

[35] As the time-varying attractiveness of other destinations (i.e. multilateral resistance) is controlled for by destination-year fixed effects in our econometric analysis, the independence of irrelevant alternatives does not represent an issue in the individual migration decision problem (Grogger and Hanson, 2011; Beine, Docquier, and Ozden 2011).

[36] The rule of law index comes from the 2010 WB Worldwide Governance Indicators and captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Access to internet is measured as the (population weighted) share of individuals GWP respondents who report having internet at home.

Table 5
The impact of distance on bilateral migration intentions, country-level.

	Main specification	East vs West	SSA	Rule of Law	Internet
Distance	−3.271***	−4.037***	−3.531**	−1.391	−2.891***
	(1.117)	(0.569)	(1.101)	(1.207)	(1.115)
Distance * WestAfrica		1.672			
		(1.278)			
Distance * SSA			0.705		
			(1.131)		
Distance * Low ROL				−3.728**	
				(1.756)	
Distance * Low Internet penetration					2.359**
					(1.195)
N	431	431	431	431	431
OriginXYear FE	YES	YES	YES	YES	YES
DestinationXYear FE	YES	YES	YES	YES	YES
Pair FE	YES	YES	YES	YES	YES

Notes: The dependent variable is country-level bilateral migration intention rate. Distance is the smuggling distance with the shortest path connecting origin and destination countries obtained with the Dijkstra algorithm described in Section 4.2. Results are estimated with PPML, the sample includes years 2010, 2012, 2013. Standard errors clustered at the level of origin country and destination country are reported in brackets. *** p < 0.01, ** p < 0.05, * p < 0.1.

education, household size, wealth, urban city residence, satisfaction with local amenities.[37] The parameter of interest, β_3, identifies the differential elasticity by individual-level characteristics. Importantly, we account for country-pair, origin-by-year and destination-by-year fixed effects as above. This individual-level specification is estimated with a linear probability model and, throughout, estimates allow for arbitrary correlation across both origin and destination countries so that standard errors are two-way clustered at origin and destination.

6.1. Main results

We start by reporting aggregate-level estimates of the migration elasticity to a change in irregular distance for the period between 2010–2013, excluding 2011, as specified in Eq. (2). In addition to reporting our main specification with no interactions, we also report heterogeneous effects. Results presented in Table 5 show a negative and significant effect of the distance along illegal migration routes between country pairs on migration intentions. More specifically, a 1% increase in migration distance decreases migration intentions rates by about 3%. Results reported in the second column show that people living in West vs East Africa are not differentially affected by the distance shock. People living in Southern Africa, instead, are significantly less sensitive to the shock than people living in the Northern area (column 3).[38] Next, when looking at heterogeneity by rule of law index in column (4), the marginal effect of distance is negative and significantly different from zero only for countries of origin with relatively low rule of law (below the median), suggesting that the smuggling industry may be more widespread in contexts with poor governance and institutions. In other words, the significant effect of a change in smuggling costs on irregular migration intentions in entirely driven by countries with low (below sample median) rule of law. There could be other confounding factors correlated with rule of law, indirectly influencing the outcome. As a robustness we added a control for the country's level of development proxied by GDP per capita interacted with distance, and coefficient on distance and rule of law interaction term remain very similar.[39] Finally, in the last column we test whether the distance effect is heterogeneous according to the aggregate level of information access at the baseline (measured by the share of people with internet at home being below the sample median).[40] We find that in countries with lower access to internet individuals are less affected by the reduction in smuggling distance. Taking stock of these results, we may conclude that irregular migration elasticity is higher in (and fully driven by) countries with weak rule of low and where the smuggling market may be flourishing and the likelihood of information access also increases intentions.

We prefer a measure of cost that is based on length of distance only. Still, in a robustness check, we estimate the same specifications as above, using a weighted bilateral distance measure to account for the potentially differential risk associated with land and sea routes. We assume that crossing the legs of the journey along the sea costs twice as much as crossing legs over land. Results, reported in Table A1 in the Online Appendix, show an elasticity slightly lower and those in East Africa more likely to have migration intentions as distance drops.[41]

[37] Since recent empirical evidence shows that income considerations are not the only factor influencing migration decisions, our analysis also incorporates non-economic factors. In particular, we control for individuals' overall contentment with own living standards and local amenities such as public services, security, and governance (see for example Dustmann and Okatenko, 2014 and Manchin, 2023).

[38] In our Sub-Saharan dummy, Southern Africa includes Benin, Burkina Faso, Botswana, Central African Republic, Cameroon, Congo, Dem. Rep., Congo, Rep., Comoros, Djibouti, Gabon, Ghana, Guinea, Kenya, Liberia, Malawi, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Tanzania, Uganda, South Africa, Zambia, Zimbabwe. Northern Africa includes Algeria, Iraq, Israel, Jordan, Lebanon, Morocco, Mali, Mauritania, Niger, Sudan, Syria, Chad, Yemen.

[39] These results are available upon request.

[40] The average share of individuals with internet at home is about 12% in our country sample, with a minimum of 0.3% and a maximum of almost 45%.

[41] According to trade literature the marginal cost of moving on water is smaller than that on land, and taking this into account together with the higher risk factor at sea makes the overall relative cost of moving by sea not obviously larger than that over land. Hence, we have also run the same regression by weighting sea distance one fifth of land distance and results are again confirmed.

Some bilateral pairs may be more affected by the nature of opening of the CMR than others. Nevertheless, taking out one-by-one origin–destination pairs from our sample leaves our estimated distance coefficient broadly unchanged (see Figure A7 in Online Appendix A, where we show our coefficient by dropping all single pairs, one at a time).

By using the estimate of the elasticity of distance, we can shed light on the relative importance of smuggling costs on prospective migration. In our model, we identify the effect of relative changes in distance on relative changes in bilateral flows, hence we do not account for diversion effects towards third countries or attraction effect from third countries. While we assume the latter, the lack of diversion effect is supported by the empirical evidence we report in Online Appendix B. The number of extra individuals changing their mind about their willingness to move from Africa to Europe ($\widehat{\Delta IM}$) because of the opening of the CMR can be computed as

$$\widehat{\Delta IM} = \hat{\gamma}_1 \sum_o \sum_d \left(M_{od2010} \times Pop_{o2010} \times \left(\log Dist_{od2012} - \log Dist_{od2010} \right) \right) \tag{4}$$

where $\hat{\gamma}_1$ is the estimated coefficient reported in Table 5, column 1, M_{od2010} is the rate of migration intentions as of 2010, Pop_{o2010} is the population of the country of origin o in year 2010 and $\log Dist_{od2010}$ ($\log Dist_{od2012}$) is the distance from country o to country d calculated in year 2010 (2012). $\widehat{\Delta IM}$ amounts to roughly 1.2 million more individuals willing to migrate. The total number of people willing to migrate to Europe from the origin countries in the sample have been obtained from GWP by means of country-level aggregates based on survey weights, and are equal to 4.7 million in 2010 and 6.5 million in 2012. The opening of the CMR is therefore able to explain 68% of the increase in migration intentions between 2010 and 2012.

6.2. Heterogeneous effects across individuals

In this section, we examine the change in the composition of potential migrants due to the expansion of the smuggling network by estimating differentials in the elasticity of demand for illegal migration across heterogeneous individuals. Hence, we estimate the individual-level linear probability model (3) above and investigate interacted effects in different sub-groups of the population, while controlling for unobserved heterogeneity through country-pair and country-by-time fixed effects. Individual controls include a vector of characteristics typically shaping the migration decision including age, gender, marital status, family size (number of children), well-being indicators (income quintiles), a dummy for having a family member/friend abroad (migration network), a dummy for urban (city) areas, and satisfaction with local amenities.[42]

In Table 6, we show heterogeneity of migration elasticities across sub-groups of the population. In particular, the negative effect of distance is not statistically different between men and women while it is significantly (slightly) bigger in absolute value for youth (i.e. individuals less than 35 years of age, column 2) and more educated people (i.e. those with more than a primary education, column 3). We next exploit the micro-level channels speaking to information availability. Specifically, those having close social networks abroad (friends or relatives) are significantly more responsive to the decrease in distance along the CMR than those without networks (column 4). This is consistent with the argument that people with ties in destination countries might have a better understanding of the steps to take to move northward, so they are more likely to migrate in general and specifically along available smuggling routes. Yet, even individuals with no connections abroad increase their migration intentions when smuggling distance/cost shrinks, as the negative and significant direct effect shows. Along a similar line of argument, we consider the technological side of the information channel and in column 5 and 6 we check heterogeneous effects across individuals with internet at home and a mobile phone respectively. While the distance effect is negative but not precisely estimated among those with internet at home, the irregular migration elasticity to a change in smuggling distance is significantly amplified for those with a mobile phone. This indicates that that information available especially through mobile devices make individual more reactive to alternative ways of moving, while having internet at home is less biting and relevant at the individual level, as expected in our context. We find it reassuring that mobile phone ownership seems not to be driven by countries "getting closer" to Europe by the shock on migration routes.[43]

Overall, it should be noted that significant heterogeneity along one dimension does not rule out a potential correlation with other dimensions. In our case, it may be plausible that those who display a larger elasticity to distance – i.e. youth, higher educated, with mobile phone and networks abroad – belong to the same group.

7. Actual flows

When focusing on migrants' intentions, we are aware that the latter can change rapidly according to migrants' experience or the events that occur as part of life trajectories. Even though the empirical positive relationship between migration intentions and actual flows has been abundantly investigated during the last decade in the context of developing countries (van Dalen and Henkens 2008; Docquier et al. 2014; Laczko et al. 2017; Carling 2017; Tjaden et al. 2019), in Online Appendix C we provide further evidence that bilateral migration intentions are significantly correlated with actual flows measured by Eurostat and UN.[44]

[42] A bilateral indicator of having a network in each given destination country is available for a small subset of individuals, but for the sake of keeping the sample of constant size we use the generic, individual one.

[43] We test this by setting up a regression where, using the same sample of individuals but collapsing the multilateral dimension, the ownership of mobile phone mob_{ito} is explained by a treatment variable T_{to} equal to one for those African countries that got closer to Europe between 2010 and 2012, a set of country of origin fixed effects δ_o, a year 2012 fixed effect γ_t and individual-level controls X_{it}. Different specifications always deliver a positive (in the range 0.035–0.04) but never significantly different from zero coefficient for the treatment. Results are available upon request.

[44] Such comparison cannot be done using Frontex data as the latter only report entry port to Europe and not the destination.

Table 6
Heterogeneous distance effects across individuals (2010–2012).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Smuggling distance	−0.0055**	−0.0046**	−0.0054**	−0.0049**	−0.0050**	−0.0046**
	[0.0026]	[0.0021]	[0.0024]	[0.0022]	[0.0023]	[0.0022]
Female	−0.0080	−0.0001	−0.0001	−0.0001	−0.0001	−0.0001
	[0.0054]	[0.0001]	[0.0001]	[0.0001]	[0.0001]	[0.0001]
Age (<35)	0.0002*	0.0066*	0.0002*	0.0002*	0.0002*	0.0002*
	[0.0001]	[0.0038]	[0.0001]	[0.0001]	[0.0001]	[0.0001]
Primary Education	−0.0000	−0.0000	−0.0044*	−0.0000	−0.0000	−0.0000
	[0.0001]	[0.0001]	[0.0026]	[0.0001]	[0.0001]	[0.0001]
Network abroad	0.0004*	0.0004*	0.0004*	0.0148*	0.0004*	0.0004*
	[0.0002]	[0.0002]	[0.0002]	[0.0073]	[0.0002]	[0.0002]
internet at home	0.0000	0.0000	0.0000	0.0000	0.0040	0.0000
	[0.0002]	[0.0001]	[0.0001]	[0.0001]	[0.0039]	[0.0001]
Mobile phone ownership	0.0000	0.0000	0.0000	0.0000	0.0000	0.0071**
	[0.0002]	[0.0001]	[0.0001]	[0.0001]	[0.0001]	[0.0030]
Smuggling distance*Female	0.0009					
	[0.0006]					
Smuggling distance*Age (<35)		−0.0007*				
		[0.0004]				
Smuggling distance*Primary Edu			0.0005*			
			[0.0003]			
Smuggling distance*Network abroad				−0.0016*		
				[0.0008]		
Smuggling distance*Internet at home					−0.0004	
					[0.0004]	
Smuggling distance*Mobile phone						−0.0008**
						[0.0003]
Observations	1,176,112	1,176,112	1,176,112	1,176,112	1,176,112	1,176,112
Individual controls	YES	YES	YES	YES	YES	YES
OriginX2012 FE	YES	YES	YES	YES	YES	YES
DestinationX2012 FE	YES	YES	YES	YES	YES	YES
Pair FE	YES	YES	YES	YES	YES	YES

Notes: The dependent variable is a binary indicator for positive bilateral migration intention. Results are estimated with a linear probability model. Individual controls include gender, age, marital status, household size, wealth index, large city location, city satisfaction, internet at home and mobile phone ownership. All regressions include a set of country-pair and country-year fixed effects. Standard errors clustered at the level of origin country and destination country are reported in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In this section, we check the robustness of our main results on irregular migration elasticity by employing monthly data on actual undocumented flows collected by Frontex along the three main Mediterranean routes (Frontex classification of routes is the same as in Fig. 4).[45]

Even though Frontex collects actual irregular border-crossings, some remarks are in order while using this data source matched with our measure of bilateral distance. First, flows are calculated at the apprehension points in Europe where individual nationalities are self-reported, possibly generating other forms of measurement issues (in case, for example, asylum policies incentivize origin misreporting). Second, due to the limited bilateral structure of Frontex data, (there are mainly three entry hubs at the end of the main sea routes, i.e. Western, Central, and Eastern routes) bilateral distance is calculated between each country of origin and main European ports of entry. Yet, even if the nature of the data prevents to exploit a large variability in destinations, the monthly frequency allows us to check whether pre-trends are different across routes before the Arab Spring by means of an event study analysis.

We focus on the three Mediterranean routes and exploit the fact that, starting from the beginning of year 2011, distances along smuggling routes became shorter, at least for some pairs of origin country–entry gate.[46] We associate the centroids of Gibraltar, Italy and Greece for the Western, Central and Eastern Mediterranean routes, respectively, and use the (time-varying) distances as computed in Section 4.2 above.[47] This allows us to set up a bilateral dataset and employ a gravity estimation model.

[45] Frontex data can be freely accessed from https://frontex.europa.eu/we-know/migratory-map/ and are updated monthly. Thus, we use the 2010–2013 Frontex panel dataset to estimate the impact on irregular flows of the opening of the Central Mediterranean Route, induced by the Arab Spring.

[46] For each country of origin in Africa, Frontex calculates the number of monthly arrivals to Europe along each route, which can be a sea or a land one. We only focus on the three sea routes (the Eastern, Central, and Western route) because flows from African countries mainly used those routes in 2010–2013. Moreover, we can precisely locate the endpoint of such routes on the European shores, and therefore correctly attribute the associated routes.

[47] We attribute to February 2011 the month in which the CMR opened, but all of the results are robust to defining as post-Arab Spring distances measured any month between January 2011 and December 2011. Note that we are using the network provided in Fig. 5, so before February 2011 the distance from any origin country to Italy is calculated including some legs of the journey that is on European ground. Likewise, after February 2011 it is possible that some routes connecting origin countries and Gibraltar or Greece will shorten.

Table 7
Effect of distance drop on actual flows, 2010–2013.

Dependent variable:	Migrants			
	(1)	(2)	(3)	(4)
Log (Distance)	−5.977***			
	(1.348)			
Distance Drop		1.240***		
		(0.202)		
Distance Drop (20%)			3.359***	
			(0.287)	
Distance Drop (40%)				3.359***
				(0.352)
OriginXMonth FE	YES	YES	YES	YES
OriginXRoute FE	YES	YES	YES	YES
Observations	4528	4528	4528	4528
Pseudo R-squared	0.89	0.88	0.89	0.89

Notes: The dependent variable is the monthly flow of migrants arriving in Europe using the WMR, the CMR, and the EMR between January 2010 and December 2013. All PPML regressions include sets of origin-month and origin-route pair fixed effects. Explanatory variable is the log of bilateral distance (column 1) and an indicator for distance dropping by more than 0, 20%, and 40% after the Arab Spring (columns 2 to 4, respectively). Standard errors clustered at the level of country of origin are reported in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The estimation sample obtained from Frontex monthly data consists of the number of migrants from 48 origin countries in Africa apprehended at the endpoint of the 3 sea Mediterranean routes, between January 2010 to December 2013. As in our former analysis, we exclude Libya, Tunisia, and Egypt from our sample. The average number of apprehended migrants is above 23, with a standard deviation of 138. Such large standard deviation comes from almost 60% of observations being zeros, while only few observations being large numbers: only 4.5% of these range between 100 and 4098, the maximum value observed. For each origin-route pair, the distance along smuggling routes either remains constant or drop after January 2011. The latter happens for all the pairs involving the CMR, 43% of the EMR, while none along the WMR. If we consider a drop of at least 20% (40%) of the distance, such percentages change to 89% (35%) for the CMR and none (none) for the other routes.

Because of the count data nature of migration flows, together with the non negligible share of observations reporting zeros, we set up the following model and estimate it by means of PPML.

$$F_{ort} = \alpha_1 Dist_{ort} + v_{ot} + u_{or} + e_{ort} \tag{5}$$

where F_{ort} is the actual monthly number of migrant apprehensions through the three main sea routes r connecting Africa to Europe (Eastern, Central and Western routes), from origin country o at month t. The regressor of interest, $Dist_{ort}$ is the time-varying log bilateral distance between the endpoint of the smuggling route r, starting in the country of origin o in month t. In additional specifications, $Dist_{ort}$ is an indicator taking value of one if the distance between the endpoint of the smuggling route r starting in the country of origin o drops by more than a given thresholds (0, 20% or 40%) after January 2011. In addition, we control for sets of origin-month and origin-route pair fixed effects, so that we can isolate the effect of a reduction in distance on total arrivals in Europe across different routes distance changes over time.

PPML estimation results of Eq. (5) are reported in Table 7. In column 1, the coefficient on log distance is an elasticity of −6, a large magnitude compatible with the significant rise in outflows occurring during and after the Arab Spring. Columns 2 to 4 replicate the estimation using as explanatory variable the indicator for distance dropping by a positive amount, 20%, and 40%, respectively. A drop in distance (which happens for all the pairs with CMR) leads to a 245% increase in flows (see column 2). While relatively large, this is compatible with very few migrants before the Arab Springs caused by restrictive border patrol policies.

Our preferred specification is reported in column 3, where most but not all pairs including the CMR experience a 20% drop in distance, and shows a coefficient equal to 3.4, corresponding to a 27-fold increase in the number of apprehended migrants. We add leads and lags to this specification for the whole sample period around January 2011 to spot whether pre-trends are detectable. Reassuringly, as can be seen in Fig. 7, no visible differential behaviors can be detected between treated and non-treated pairs of country-route before January 2011. Robustness on these results are provided in Online Appendix E.

8. Conclusion

In a world in which income disparities between north and south diverge, and the legal opportunities for migration become increasingly scarce, a global multi-billion USD human smuggling industry has arisen. Understanding and predicting migration flows and their composition has become impossible without taking the role of the smuggling industry into account. Specifically, we focus on migration from Africa to Europe, in which migration is only possible through the use of smuggling networks.

To gauge the elasticity of aggregate migration intentions to smuggling costs, we exploit an exogenous shock that shortened the distances between many African and European country pairs in a heterogeneous way. We find large average effects of the shorter smuggling distance, i.e. an elasticity of −3.3, mainly driven by countries with weak rule of law, where it is easier for smugglers to operate through a ramification of the international illegal network, and countries more connected through access to internet.

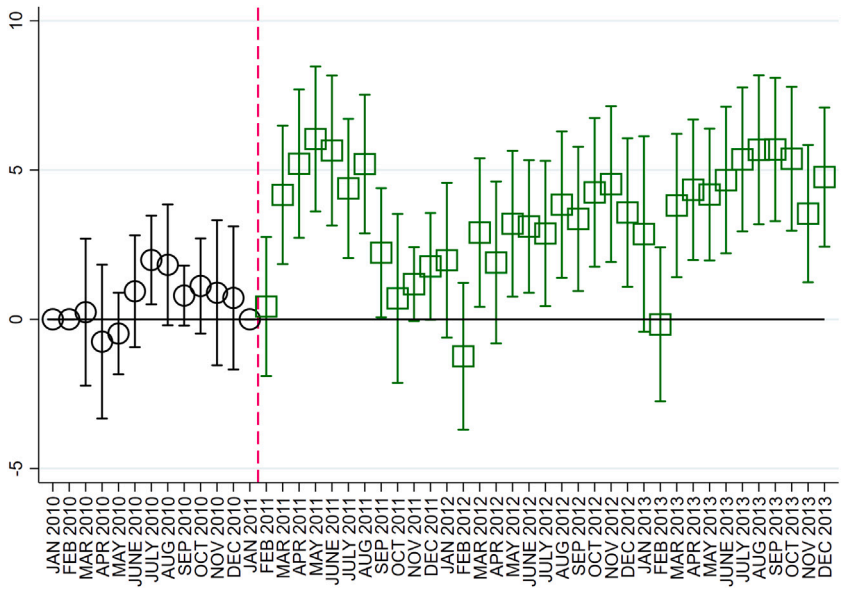

Fig. 7. Dynamic effects, years 2010–2013.
Notes: Dynamic effects of the shortening of bilateral smuggling routes by at least 20% on bilateral flows of migrants by month. Coefficients and 95% confidence intervals. Time period is January 2010–December 2013, with January 2011 as the baseline omitted month. Saturated leads-lags version of Eq. (5), which includes origin-month, route and origin-route pair fixed effects. Standard errors are clustered by country of origin.

Surprisingly, when we explore individual-level heterogeneous effects, there are no significant differences between females and males, while, less surprisingly, young people and people with relatively high education levels tend to respond more. The effects are also stronger for those with better access to information, through social networks abroad and by having a mobile phone.

It would be tempting to interpret our results as evidence in support for a strategy to tackle smuggling networks in order to reduce migration intentions and hence flows. Whether this is a feasible strategy, though, is at least questionable. The very speed with which the smuggling industry took off in Libya after the demise of the Gaddafi regime seems to indicate that the smugglers would move to other places when attacked. For this strategy to be successful would hence need a substantial amount of policy coordination.

Providing more legal channels seems to be a preferable alternative, with the caveat that those rejected or anticipating rejection could still take recourse to illegal channels unless their living conditions were to improve. Coordinating with local governments and international organizations in better screening those eligible to migrate to Europe (through quotas, for humanitarian reasons, etc.) and at the same time reinforcing and coordinating the legal apparatus aimed at blocking illegal migrants should reduce potential migrants' uncertainty on their possibility to enter Europe, therefore saving them thousands of kilometers of potentially very dangerous trips.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jinteco.2024.103878.

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