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Abstract

This paper builds a dataset of bilateral trade flows between provinces of a developed and a developing country. This novel dataset combines trade and freight statistics to obtain exports and imports between Spain and Morocco for the period from 2010 to 2018, split into 15 sectors and three transport modes. With the data at hand, a gravity model of trade is estimated using a new two-stage procedure, focusing on the role played by social connectedness, proxied by Facebook connections and migration flows, while controlling for singular geographical, historical, and institutional relations between the two countries. Our results are of special relevance to EU-MENA relations and provide interesting insights for other countries whose colonial ties reversed in hostilities and political differences.

JEL Codes: F14, F15; R23
Keywords: interregional trade, transportation, border effect, migration, networks, Spain, Morocco.

1. Introduction

The core models in international trade and economic geography predict that geographical proximity and high-income disparities between two economies located nearby will generate strong economic interactions in terms of trade, migration, and foreign direct investment (see Krugman et al., 1999, and Combes et al., 2009, for classical approaches; and Atking & Donaldson, 2015 and Allen & Arkolakis, 2014, for more recent contributions). However, when institutional and historical factors are considered, empirical outcomes show a different picture. For instance, even though countries sharing a border are expected to have lower trade costs than non-adjacent pairs, there are notable exceptions. Indeed, sometimes being a neighbor does not imply friendly and stable political and economic relations, but political conflicts and tensions lead to all kinds of non-geographical barriers, which can take trade costs to infinity when it leads to trade embargoes. Firsthand examples are North and South Korea and the trade embargo between Argelia and Spain that followed the recognition of Western Sahara as an autonomous region of Morocco by the Spanish government in 2022.

In Southern Europe, the Strait of Gibraltar is one of the hottest places, not only in terms of temperature but in relation to institutional and income differences between the two continents it bridges, Europe and Africa. Just 13 kilometers separate two different worlds, with very dissimilar economic performance and living conditions[1]. Not surprisingly, for centuries, the Strait has been perceived by leading empires and dominant nations as a strategic enclave. Probably, for this reason, several geographic oddities persist nowadays, such as the Gibraltar dispute between Spain and the UK, the existence of two autonomous Spanish cities (Ceuta and Melilla) within Africa, or the permanent tensions between Morocco and the Saharawi independent movement.

Being straits points of special geographical and economic interest, for many years they have remained under the radar of the literature on economic geography and development. Unfortunately, the lack of trade data at a sub-national scale has hindered the emergence of economic research with a specific focus on such critical territories. To fill this gap in the literature, the main goals of this paper are to build and analyze the interregional trade flows by different transport modes between Spain and Morocco, countries that embrace a long list of political and cultural encounters and disagreements. More specifically, the first goal is methodological, and consists of describing the approach used to produce a province-to-province (NUTS3 level in terms of Eurostat) trade flows between Spain and Morocco, considering three alternative transport modes (ship, road, air) and 15 different sectors for the period 2010-2018.

The second goal is to identify the main determinants of interregional trade by estimating a simple two-stage estimating procedure. We derive a structural gravity equation that allows for identification of the impact of province-specific characteristics on bilateral trade flows, and then we use this standard structural gravity setting to derive a simple two-stage estimating procedure, which enables us to identify the full impact of any province-specific determinant of bilateral trade flows, differentiating between geographical and economic factors, and identifying particular bilateral relationships that depend on the mode of transport used. The third goal, this paper wants to dig deeper in other more recent channels enhancing trade such as the existence of social networks, which are related to migration, the other strong driver of interconnection and tensions between the two countries (continents). Routed in the literature on the link between trade and migration (Rauch, 2001; Rauch, & Casella, 2003; Rauch & Trindade, 2002), we estimate the relationship between the interregional trade flows of goods and the interregional linkages captured by the recent *Facebook* social index (Bailey, et al., 2018; Bailey, et al., 2020) as well as the region-to-country migration flows.

Related to the later goal, several authors have analysed the impact on bilateral trade of the stock of immigrants or emigrants from/to the trading partner. As Rauch (2001) pointed out, any positive impact of immigration on trade may simply reflects immigrant preferences for goods from their countries of origin, which can be labelled as “the taste effect”. However, the literature also suggests the existence of a complementary channel, labelled as the ‘network effect’, also induced by the social linkages that immigrants maintain with their countries of origin. Such linkages may lead to important reductions in transaction cost (information) resulting in increased bilateral trade flows (Dunlevy and Hutchinson, 1999; Wagner et al., 2002; Rauch and Trindade, 2002; Combes et al., 2005; Garmendia et al., 2012; Javorcik, et al., 2011). While the former perform over the intensity of imports, the latter can mainly improve the exporting capacity. To the best of our knowledge, there is no papers in the related literature estimating and analyzing sub-national trade flows between any two countries in Europe and Africa, which are then linked to such institutional, social network relations and migration.

Due to the extensive coastline in both countries, our results indicate the great importance of the ship transport mode as well as the port connectivity, indicating that the existence of maritime ports connections identifies relevant trade linkages between specific Spanish-Moroccan provinces, partly being driven by the role played by multinationals operating in both countries (Tokatli, 2008). Moreover, when investigating the relationship between trade and different proxies of social connectedness such as *Facebook* or the bilateral migration flows, we find quite heterogeneous results by the type of flows (exports versus imports), transport mode and type of product. Noticeable, when adding all dummies controlling for singular geographical, historical, and institutional relations for Ceuta and Melilla, the Capital cities, the Canary and Balearic Islands or the Saharan provinces, we obtain very interesting and not evident results, such as obtaining strong and persistent trade relations between Spain and the most distant, but heavily historically connected, Saharan provinces.

The rest of the paper is structured as follows: section 2 contextualizes the trade relationship between Spain and Morocco and revise the literature on interregional trade within and between countries, deepening on the channels that enhance trade such as the existence of social networks or migration. Section 3 describes a conceptual framework for decomposing the interregional trade flows between the two countries, presents in detail the method used to obtain this singular dataset. Section 4 estimates a gravity model using the constructed dataset and discusses the main results of the empirical analysis. Finally, section 5 presents some conclusions and policy implications.

2. Background

In this section, we first present the historical context of the relations between Spain and Morocco that have shaped the complexity of the interactions between both countries in more recent decades in subsection 2.1. Next, in subsection 2.2, we revise the closely related literature.

2.1. The Spanish-Moroccan relations

The relationship between Spain and Morocco has historically been characterized as complex. In particular, after Morocco's independence in 1956, bilateral relations with Spain have been marked by cyclical conflicts and disputes. Some examples of the two countries' political and diplomatic disputes are the Western Sahara dispute, fishing and agricultural competence issues, migration, or Morocco's claim to the "enclaves" of Ceuta and Melilla. On the positive side, the strong links between Spain and Morocco have been consolidated in recent years by signing treaties of friendship, good neighborliness, and cooperation in 1991. In this regard, economic data speak for themselves, indicating that bilateral trade shows a very dynamic growth of trade exchanges between 2010 and 2019 as Morocco is the top destination for Spanish exports, representing around 45% of total exports to Africa (slightly increasing from 43.06% in 2016 to 45.5% in 2019). Furthermore, Spanish exports to Africa grew by 6.4% in 2019, and this shows that Morocco plays a role not only as the first customer on the continent but also as a facilitator of access for Spanish exporters to the rest of the African market (Estacom, 2019). Morocco is also the first destination of Spanish investment in Africa and receives a third of all direct Spanish investment directed to the African continent (33.87% of the stock of investment in the continent, Registry of Foreign Investments, MINECO, 2019). These growing relations should be contextualized in the wider picture of the economic relations between the European Union (EU) and the MENA region, and more specifically, with Morocco. The EU is Morocco's leading trade partner, and Morocco is the EU's largest trade partner within the region. The EU is also the biggest foreign investor in Morocco, accounting for more than half of the country's FDI stock. Such relationships have been reinforced but several trade agreements, such as the European Neighborhood Policy, launched in 2003.

2.2. Literature review

The border between Spain and Morocco is essentially a maritime border. On the one hand, it is comprised of the waters of the Strait of Gibraltar, which separate the Iberian Peninsula from the African continent; on the other, it consists of the fragment of the Moroccan Atlantic coast that lies opposite the Canary Islands. However, the boundaries between the enclaves of Ceuta and Melilla and their hinterlands form short Spanish-Moroccan land borders in the Maghreb. Apart from Ceuta (19.4 km2), Melilla (13.4 km2), the Canary Islands (7,446.6 km2), Alborán Island (7.1 km2), Peñón de Vélez de la Gomera (2.2 km2), Peñón de Alhucemas (1.4 km2), and the Chaffarine Islands (Congreso 4.5 km2, Isabel II 2 km2, Rey Francisco 0.6 km2) complement the contested and less well-known geography of the Spanish-Moroccan border (Ferrer-Gallardo, 2008).

Having said that, although both countries share ground gateways in the Ceuta and Melilla borders (Buoli., 2014) it is critical to understand the role played by maritime ports that link the hinterland and the foreland (Franc and Van der Horst, 2010; Ducruet and Zaidi, 2012). Especially for developing countries, transport systems are among the main determinants of their growing economy (Saidi et al., 2020). As Wessel (2019) states, a good transport infrastructure offers many benefits and can enable a region to thrive economically. Indeed, the Maghreb region is a typical example of how the development of better internal transportation within each country can diffuse growth within the inner regions less connected with the maritime ports (Ducruet, Mohamed-Chérif and Cherfaoui, 2011; Atking and Donaldson, 2015; Mohamed-Chérif and Ducruet, 2016; Hlali and Hammami, 2019). As we will see in this article, the interregional relations between these two border countries are clearly conditioned by the specific economic geography of Morocco, a country with privileged access to the Atlantic, with a long coastline and a strong port capacity. Such geographical features reinforce the agglomeration of people and economic activity in the main coastal provinces, as which eases our methodological attempt to interconnect trade and freight flows by transport mode.

In addition to these geographical features, there are other factors—historical, political, social, cultural, and economic—making this Spanish-Moroccan border quite singular that has attracted some attention in the literature (Bennison, 2001; Driessen, 1992; Gold, 1999; Ribas-Mateos, 2005; and Lévy, 2008). It is worth noting that Morocco has evolved into one of the world's leading emigration countries. Cross-border mobility has been fueled by the colonial past, geographic proximity, and economic and political realities in both regions (De Haas, 2014). Further studies to be highlighted: Baldwin-Edwards (2006), studies North Africa as a region of emigration, immigration, and migratory transit. Carling (2007) examines the patters and dynamics of transit migration towards the Spanish-African borders, and of unauthorized migration across these borders. Moreover, De Haas (2007) interprets the evolution of migration within, from, and to Morocco over the twentieth century.

There is still a clear gap in analyzing the growing economic interaction between Spain and Morocco considering the background mentioned above. In most existing studies, the data used is at the country level or focuses on just one sector. To our knowledge, only Blanes and Milgram (2010) evaluated the sectoral exports of each Spanish region (NUTS2) to Morocco as a whole from 1999 to 2002 in the framework of the gravity equation. No previous analysis has been conducted with a greater spatial grid in this area, being this not an exception but rather the rule.

For example, in the case of the US-Mexico, few studies have been carried out at the regional-country level (Wall, 2003) or state-country level (Coughlin and Wall, 2003) trade data but aggregated over industries and modes. Given that there is a scarcity of information on the regional impacts of trade within Mexico, the regional analysis has been mostly relegated to the effects between the US and Mexico as a whole (Hanson, 2001; Wilson 2011; US Chamber of Commerce, 2014; Barajas et al., 2014).

Digging deeper in this direction, it is interesting to briefly mention the short list of articles where bilateral flows between countries are analyzed at the region-to-region level. For example, several analyses have been conducted for trade between Canadian provinces and the US states in the context of the border effect literature (McCallum, 1995; Anderson & van Wincoop, 2003; Feenstra, 2009). For the case of Europe, we find an interesting analysis of the case of Spanish-French flows by Lafourcade and Paluzie (2011). Similarly, Helble (2007) analyzed the border effect between Germany and France using data on regional transportation flows. His main results show that France trades about eight times more and Germany about three times more with itself than with other EU countries, respectively. In addition, Gallego and Llano (2014, 2015) analyzed the intra and interregional flows of goods between Spanish regions and the regions of the seven European countries. Other interesting analyses using interregional flows for EU countries are Nijkamp et al. (2004), Thissen et al. (2013, 2019), Chen et al. (2018), or Barbero et al. (2021).

3. Data and methods

This section describes the conceptual framework required to build a dataset on province-to province (NUTS 3) trade data by different transport modes between Spain and Morocco. We start by providing definitions and stating the assumptions needed.

3.1. A theoretical decomposition of the flows

We consider two countries, Spain (*S*) and Morocco (*U*), with respective provinces, *i* and *j*, at disaggregation level NUTS 3[1] in each country. Let us now consider that for each year *t*, bilateral aggregated trade flows can be decomposed into volumes (*Q*) and unit prices (*P*) for a set of *k* tradable goods, which can travel using three alternative transport modes (M): road (R), ship (S) and airplane (A), since there are no connections by train. Therefore, the value of bilateral trade, T_{ijt}^{kM}, could be decomposed as,

$$T_{ijt}^{kM} = \left(Q_{ijt}^{kR} P_{ijt}^{kR}\right) + \left(Q_{ijt}^{kS} P_{ijt}^{kS}\right) + \left(Q_{ijt}^{kA} P_{ijt}^{kA}\right) \tag{1}$$

where Q_{ijt}^{kM} is the bilateral trade flows in volume (tons) of product variety *k*, moved from *i* to *j* by transport mode *M* (*M=R, S, A*). Similarly, each element P_{ijt}^{kM} defines the average prices (value/volume) for each dyad of provinces (geographical units at NUTS 3), transport mode, and commodity. Given that the elements of equation (1) are not observable, either using the Spanish or Moroccan statistics, we estimate these flows differentiating between exports and imports and using the existing data under several assumptions. First, we use Spanish statistics, which are

[1] The Nomenclature of Territorial Units for Statistics or NUTS is a geocode standard for the administrative divisions of countries used by Eurostat. NUTS 3 refers to small regions for specific diagnoses, NUTS 1 to major socio-economic regions and NUTS 2 to basic regions for the application of regional policies.

more disaggregated, and we assume more solid than the Moroccan ones. The methodology used combines trade and freight statistics. Hence, to estimate bilateral export flows we use the following specification:

$$\hat{X}_{ijt}^{G} = cc_t^R\left(F_{ijt}^{GR}P_{i.t}^{G}\right) + cc_t^S\left(F_{ijt}^{GS}P_{i.t}^{G}\right) + cc_t^A\left(F_{ijt}^{GA}P_{i.t}^{G}\right) \qquad (2)$$

where $\hat{X}_{ijt}^{G}$ corresponds to the estimated bilateral export flows from *i* to *j* in value (euros) of product group *G* (notice that *G* is a product group at a more aggregated level than *k* in eq. (1) above), obtained by multiplying the interregional freight flows (F_{ijt}^{GM}) in volume (tons) by a vector of provincial export prices ($P_{i.t}^{G}$) in province *i* of goods *k* belonging to group *G*.

Similarly, an equivalent equation can be specified for Spanish imports exchanging the subscript "*i.t"* by "*.jt"*[2]. The interregional flows obtained will be more aggregated in the product space than certain pieces of trade and freight statistics (see Table A.3).

The multiplication of the interregional freight flows by the trade price vector gives a raw estimate of flows that, once aggregated, do not match with the official trade statistics at the province-to-country level, so elements cc_t^R, cc_t^S, and cc_t^A are correction coefficients by mode, able to assure that the aggregation of the interregional flows of each product, mode and year perfectly matches the official trade statistics at the country-to-country and product-mode-year levels. Thus, we apply the correction:

$$cc_t^M = \left(\frac{P_t^G * F_{ijt}^{GM}}{\sum\left(P_t^G * F_{ijt}^{GM}\right)}\right) * \left(X_{i.t}^{GM}\right) \qquad (3)$$

where X in the previous equation refers to the Spanish monetary export flows to Morocco by mode. Note that the same applies for Spanish imports, disregarding the price vectors. In the following sections, we will describe how the main elements in equation (3), exports flows (X), prices (P) and freights (F) are obtained. For simplicity we will refer to export flows.

[2] A dot in the origins "i=.", denotes the total Spanish exports, that is, the summation across all Spanish provinces of origin. Likewise, a dot in the destinations, "j=.", denotes the summation across all the Moroccan importing provinces.

3.2. Trade and Freight statistics in Spain

In this section, we summarize the main information regarding the state of the art of trade and freight statistics in Spain required for estimating our province-to-province novel dataset.

In Spain, there are two main sources offering information on bilateral international commodity flows between Spain and Morocco: trade and freight statistics. The latter offers the province-to-province dimension in volume (tons), while the former offers information at a province-to-country level in value (euros); for this reason, the trade statistics do not provide the detailed information needed in equation (1). At most, the information for the Spanish exports is given by,

$$X_{i.}^{kM} = X_{i.}^{kR} + X_{i.}^{kS} + X_{i.}^{kA} \quad (4)$$

where trade statistics report figures about the exports (imports) from (to) every Spanish province (NUTS 3) to (from) Morocco as a whole, with great detail for product variety *k* (17,000 products for CN[3] at eight-digit level) and split by the main transport mode used for the delivery. No information is reported about potential combinations of transport modes (i.e., multimodality between road-ship-road) and the nationality of the carrier (Spanish, Moroccan or third country's trucks). An advantage is that this source reports each flow in value and volumes.

The freight statistics, on the other hand, offer the following information depending on the transport mode. First, the road freight statistics, from the Spanish Freight Road Survey (EPTMC), provide provincial flows to (from) the Spanish provinces (NUTS 3) to Morocco as a whole, using the NSTR[4] transport classification at three-digit level for each year in volumes. Second, the ship freight statistics are from the Spanish Ports System (Spanish Ports, *Puertos del Estado*) and provide the interregional transport flow data, including the loaded-unloaded tons by each of the 52 Spanish Port Authorities delivered to each of the 31 Moroccan ports and

[3] CN (Combined Nomenclature) is the official trade classification used in the EU, which basically corresponds to the HS international classification.

[4] Standard Goods Classification for Transport Statistics, Revised.

vice versa, for each year in volumes using CN at two-digit level. Finally, the air freight statistics come from the Spanish air freight statistics (AENA[5] and Transport Ministry, *Ministerio de Transporte*) provides airport to airport aggregated flows in tons by year.

The following sub-section describes the method used to obtain monetary values using the volumes provided by freight statistics and the corresponding price vectors. As mentioned above, the final dataset contains group of products (*G*), while the original trade information is reported at a higher level of granularity *k* (see Tables A.2, A.3 and A.4 in the Appendix that report the sectoral and provincial disaggregation). The next sub-section also describes the approach used to split the flows by type of goods.

3.3. International trade prices between Spain and Morocco

The corresponding set of estimated trade prices $\hat{P}_{i.}^{SG}$ for Spanish exports to Morocco of variety *k* transported by ship, road, and air (M) are constructed taking into account the literature on export unit values and product quality (Hallak, 2006) to deal with several issues encountered when dealing with the construction of "value/volume" ratios obtained directly from the trade datasets.

More specifically, we compute for Spanish exports to Morocco the average price vectors for each province-country-product (*G*) that considers the quality composition of the internal variety-mix within each product, by computing value to volume ratios using a weighted average of the filtered variety price (*k*) included in each product group (G). Thus, using the monetary trade statistics, we obtain the corresponding province-product (*G*) flows using such price vectors.

3.4. Applied methodology by mode

Once the general framework and the data available have been defined, we describe the treatment applied to the trade and freight flows.

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[5] Aeropuertos Españoles y Navegación Aérea (Spanish Airports and Air Navigation).

3.4.1. Road mode

Road freight statistics do not report the Moroccan province of destination for the Spanish exports, but, fortunately, the actual distance traveled by truck is indicated. Such a variable will be critical in our methodology for assigning a province of destination for the Spanish exports by road.

Using the STATA command Georoute (Weber, et al., 2018) we compute the travel distance between any capital province in Spain and the destination in Morocco defined by their geographical coordinates. Next, we look for the optimal travel distance (the shortest routes by road) which are confronted with the actual distance reported by the freight statistics for each exporting provincial flow from Spain. The flows are assigned to the province for which the difference between the actual and optimal travel distance is minimum. For robustness we have compared the results obtained with Georoute with alternative distances calculated using comparable route optimization methods in ArcGIS, finding no relevant differences.

The fine spatial grid used (NUTS 3) and the special geographical features of the Spanish-Moroccan connectivity by road, where a truck must cross the Mediterranean Sea on board mainly through the Strait of Gibraltar, make this procedure more robust than for other cases. For instance, for most pair of countries that trade to each other, given the origin of the trade flow, a real distance travelled might correspond to a wider range of alternative origin-destination routes.

3.4.2. Ship mode

The dataset provided by *Puertos del Estado* is very consistent and highly disaggregated, a clear advantage given that around 90 percent of the bilateral trade between Spain and Morocco uses ships as the main transport mode, and the information reported by this source is at the port-to-port level (the data consists of an administrative record directly registered and reported by the ports).

The information provided is according to CN at two-digit level, which clearly helps to confront the Spanish trade statistics, reported at CN at eight-digit level. Comparing these two sources at the equivalent level of disaggregation (Spanish provinces-CN2-year) leads to inconsistencies since some flows reported by the trade statistics are not equally registered at the same disaggregation (in levels or shares) by the port statistics. To solve this problem, we show below how we deal with harmonizing trade and freight statistics.

3.4.3. Air mode

The air freight statistics report trade flows at the airport-to-airport level, which allows a perfect attribution of the flows at the province-to-province level. Thus, the goods' provincial origin (destination) is assumed to be one of the airports of load (unload). However, the air freight statistics do not report detailed data for the sectoral disaggregation but just the total volume exchanged between any pair of airports. Fortunately, the trade statistics report the product level for the exports and imports by airplane, in value and volume, at the Spanish province-Morocco level. Thus, the airport-to-airport freight volumes are used to split the province-to-country trade flows by product, both in value and volume, assuming that, independently of the destination airport in Morocco, each flight with an origin in each Spanish airport has the same product mix than the province-to-country trade flow.

To distribute the official trade statistics according to freight statistics to get the province-to-province data, we apply the following shares in cascade for each transport mode which are interacted with the corresponding shares for any pair of trading provinces. This procedure is described by equations (5)-(9):

$$Share^{Mikt} = \frac{(exp^{Mikt})}{\sum_{M=1}^{M=3}(exp^{Mikt})} \text{ if } \sum_{M=1}^{M=3}(exp^{Mikt}) > 0 \quad (5)$$

$$Share^{Mikt} = \frac{(exp^{Mit})}{\sum_{M=1}^{M=3}(exp^{Mit})} \text{ if } \begin{Bmatrix} \sum_{M=1}^{M=3}(exp^{Mikt}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mit}) > 0 \end{Bmatrix} \quad (6)$$

$$Share^{Mikt} = \frac{(exp^{Mkt})}{\sum_{M=1}^{M=3}(exp^{Mkt})} \text{ if } \begin{Bmatrix} \sum_{M=1}^{M=3}(exp^{Mikt}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mit}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mkt}) > 0 \end{Bmatrix} \quad (7)$$

$$Share^{Mikt} = \frac{(exp^{Mi})}{\sum_{M=1}^{M=3}(exp^{Mi})} \text{ if } \begin{Bmatrix} \sum_{M=1}^{M=3}(exp^{Mikt}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mit}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mkt}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mi}) > 0 \end{Bmatrix} \quad (8)$$

$$Share^{Mikt} = \frac{(exp^{M})}{\sum_{M=1}^{M=3}(exp^{M})} \text{ if } \begin{Bmatrix} \sum_{M=1}^{M=3}(exp^{Mikt}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mit}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mkt}) = 0 \\ \sum_{M=1}^{M=3}(exp^{Mi}) = 0 \\ \sum_{M=1}^{M=3}(exp^{M}) > 0 \end{Bmatrix} \quad (9)$$

where $Share^{Mikt}$ is the share of the mode of delivery M (M ∈ {1,2,3=ship, road, aircraft}) in the flows that correspond to province *i*, for exports, and province *j*, for imports, year *t* and product variety *k* (by ship and aircraft at CN two-digit level, by road at NSTR three-digit level), and cero indicates that there is no flow reported in the corresponding statistics, even after the procedure to fill gaps and inconsistencies. Equation 5 represents relative information for each mode, origin, product, and year. In successive equations (6)-(9), there are missing values for some products, years, and provinces of origin. Element (exp^{Mikt}) corresponds to the total exports of province *i*, by mode *M* of product variety *k* in year *t*. Similarly, this would be done for imports, following the same procedure as above.

Once the official trade statistics have been distributed according to freight statistics, the final dataset contains group of products (*G*), while the original trade information is reported at a higher level of disaggregation *k* (see the correspondence between CN-2 and NSTR (3d) classification (*k*) to (*G*) in Table A.2).

4. Econometric analysis

To illustrate the potential uses of the constructed dataset, we use the gravity model of trade, the workhorse of most of the empirical analyses of bilateral trade (Anderson, 1979; Bergstrand, 1985; Baier and Bergstrand, 2007, 2009). This framework is underpinned by strong micro-foundations (Anderson, 2011; Head and Mayer, 2014), and has been proven to be helpful in modeling bilateral flows at different spatial scales, such as countries or provinces within countries (Anderson & van Wincoop, 2003; Feenstra, 2009; Gallego and Llano, 2014, 2015; Barbero et al., 2021).

Log-linear version of the gravity model could simply be estimated with Ordinary Least Squares (OLS). Nevertheless, two econometric issues bias the results. First, the existence of zero bilateral trade flows that could bias the results since these are eliminated when taking logarithms and second, the presence of heteroskedasticity that could also lead to biases in the estimates obtained from log-linear gravity models (Santos-Silva and Tenreyro, 2003, 2006).

To address these two issues, we estimate the gravity model using the Pseudo Poisson Maximum Likelihood estimator (PPML) in line with the state of the art in trade modeling using the gravity model. This estimation method has been found to produce unbiased estimates solving potential heteroskedasticity problems and accounting for zero trade flows (Santos-Silva and Tenreyro, 2003, 2006). Moreover, when fixed effects are added to the PPML, the estimation is consistent with equilibrium constraints imposed by structural approaches, like the outward and inward multilateral resistance and the equilibrium constraints (Fally, 2015).

The most recent theoretical developments lead to a simple two-stage estimating procedure proposed by Freeman et al. (2021), which could be implemented with standard econometric tools and apply to our dataset. Following Head and Mayer (2014) and Yotov et al. (2016), who summarize the most recent advances in the related empirical literature, in stage one we estimate a standard version of the structural gravity model of trade. At this first stage the outcome produces estimates of the vector of bilateral trade costs (ij) and MRT (it, jt), which are required to implement the structural specification in the second stage.

$$T_{ijtG}^{M} = exp\left[\beta_1 \ln t_{ij} + \phi_{it} + \psi_{jt} + \mu_{Gt}\right] * \varepsilon_{ijtG} \quad (11)$$

where the dependent variable T_{ijtG}^{M}, refers to export flows from Spanish province *i* to Moroccan province *j* in a year *t*, product *G* by transport mode *M*. Finally, μ_{Gt} captures product-specific factors that change over time.

By taking advantage of the additive property of PPML (Arvis and Shepherd, 2013; Fally, 2015) we are able to recover the power transformations of the MRTs from the estimates of the fixed effects in equation (11): $\hat{\psi}_{jt}$ and $\hat{\phi}_{it}$.

In stage 2 we replace the MRT estimates from above into equation (12) to obtain:

$$T_{ijtG}^{M} = exp\left[\beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnDIST_{ij} + \beta_4 LnFacebook_{ij} + \beta_5 LnMigration_{ij} + \beta_6 X_{ij} + \beta_7 \hat{O}_{it} + \beta_8 \hat{I}_{jt} + \beta_9 \gamma_i + \beta_{10} Y_t\right] * \varepsilon_{ijtG} \quad (12)$$

where $lnGDP_{it}$ and $lnGDP_{jt}$ denote the GDP of the exporter and importer province in period *t*, respectively; $lnDIST_{ij}$, is the log of bilateral distance (from provinces *i* to *j*) measured in kilometers. Considering that distance is an important factor in our analysis, the bilateral distance will be specific for each transport mode: for freight carried by ship, road and air, we use the nautical miles, the road and linear air distance, respectively. When we aggregate the modes (total flows in value), we will use the weighted distance for each pair of origin and destination provinces, which is calculated using the weight (in value) of each transport mode in our database:

$$DIST_{ij}^{W} = 0.92*DIST_{ij}^{S} + 0.07*DIST_{ij}^{R} + 0.01*DIST_{ij}^{A} \quad (13)$$

In addition, when we distribute products by ship to provinces of the Moroccan hinterland, we apply the sum of the distance from the Spanish ports to the Moroccan ports and the distance traveled to the inland province of Morocco (for exports and vice versa for imports).

We include the variable $Facebook_{ij}$ which refers to the Social Connectedness Index which uses an anonymized snapshot of active Facebook users and their friendship networks to measure the intensity of social connectedness between locations. Users are assigned to locations based on their information and activity on *Facebook*, including the stated city on their *Facebook* profile, and device and connection information. A growing body of research has begun to emerge using data on social connectedness from online social networking services such as *Facebook* (Bailey et al., 2018; 2020). Note that $Facebook_{ij}$ is a time invariant variable; and $LnMigration_{ij}$ refers to the Moroccan immigrants in the Spanish provinces in a year t.

Furthermore, our gravity equation is enriched with element X_{ij}, which accounts for bilateral dummy variables aimed to capture special geographical features of provinces in both countries:

- Ship dummy, equal to one when products are transported by sea, zero otherwise.
- Coastal dummy, equal to one when the provinces of origin and destination are coastal provinces, zero otherwise.
- Contiguity, equal to one for provinces of origin and destination that share a common land border: Ceuta-Tangier; Melilla-Nador, zero otherwise.
- Port Connectivity, equal to one when the main Moroccan ports (Tanger-Med, Tanger, Nador, Agadir, and Casablanca ports) are linked to Spanish ports (Barcelona, Cádiz, Málaga, Granada, Almería, Las Palmas, and Santa Cruz de Tenerife), zero otherwise.

$\hat{O}_{it}$ and $\hat{I}_{jt}$ are proxies for outwards and inwards MRTs constructed using the estimates from equation (11).

Next, we consider a second specification in which the bilateral time invariant variables, that is, distance, transport mode, common border and port connectivity are replaced by bilateral fixed effects (ij). The model specification is given by,

$$T_{ijtG}^{M} = exp\left[\beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 \hat{O}_{it} + \beta_6 \hat{I}_{jt} + \beta_7 \gamma_{ij} + \beta_8 Y_t\right] * \varepsilon_{ijtG} \qquad (14)$$

where the dependent variable T_{ijtG}^{M}, refers to the export flows from Spanish province *i* to Moroccan province *j* in a year *t*, product *G* by transport mode *M*. γ_{ij} denotes bilateral dummy variables aimed to capture bilateral unobserved factors that do not change over time.

In the estimations, we approximate trade costs in two ways, with symmetric bilateral fixed effects, as in equation (14) and, as a second alternative, with the trade costs estimated from the first stage.

5. Econometric Results

[Will be completed for the conference]

The main results obtained using the novel dataset are presented in Table 1. The two panels of Table 1 are based on different approaches to proxy bilateral trade costs. Estimates in panel A are obtained with flexible bilateral trade costs, while the estimates in panel B are obtained after constraining the vector of bilateral trade costs in the second stage analysis to be the vector of corresponding estimates obtained from the first stage.

6. Conclusions

[Will be completed for the conference]

In this paper, we developed a methodology which integrates trade and freight statistics and allows us to compute province-to-province export and import trade flows between Spain and Morocco. To the best of our knowledge, it is the first dataset at this spatial grid connecting a European and African country, between which the level of integration has been increasing in the last decades, not just concerning the flows of goods but also of services, capital and migration.

We use a two-steps structural gravity approach, able to test the typical gravity variables, in addition to singular geographical relations, captured by a set of dummies variables.

The empirical analysis serves to illustrate the relevance of considering highly detailed spatial trade flows (i.e., interprovincial) to better measure the effect of contiguity in trade, which, as shown, is not always positive. Moreover, the use of transport mode specific flows (i.e., road, ship, air), and transport specific measures of connectivity also contributes to the expanding literature connecting trade, geography and transportation infrastructures, with a special focus on the less developed countries. In particular, our results show that the existence of maritime ports connections identifies relevant trade linkages between distant provinces between Spain and Morocco.

On the contrary, the Spanish enclaves that share a border with Moroccan provinces, Ceuta and Melilla, show that trade effects are not as expected in a typical situation where the contiguity effect prevails, either because of the small size of the enclaves or because of their institutional problems.

The policy implications of the results obtained here are crucial to understanding the current and future economic relations between Spain and Morocco, as well as between Europe and North Africa, being those important macro-regions that the Gibraltar Strait bridges.

This paper is expected to serve as a starting point for further investigations using this novel dataset, with the specific goal of producing causal analysis able to address the relevance of new transportation infrastructure in the performance of regions and firms. It could also serve for interconnecting different multiregional multisectoral models able to address the territorial and sectoral consequences of different policies being adopted in the field of trade integration and better control of migratory flows, both, in Europe and in Northern Africa.

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TABLES