INSULARITY AND INTERNATIONAL TRADE: THE CASE OF SICILY[1]

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1. Introduction

Territorial development has become increasingly central to an economics debate when analysing the factors that influence the aspects of such development. There can be no development without opening a region up to interregional and international commercial activities.

Within a territorial context where commercial relationships are essential to a marginal location or an island, it has become crucial for a scientific community to question the effects on an "insularity condition" when deciding which aspects are to be developed in relation to international trade.

The issue remains crucial because various authors have already evidenced how international trade relationships are correlated with international competition and how these relationships apply statistical forces and intensities that differ depending upon territorial continuity (Martí Puertas and García, 2014).

Factors such as infrastructure development pertaining to a centralised relational context appear to be vital to international trade development and the consequent enrichment of a region.

The geographical characteristics that favour transport connections define the capability of a region to link with trade partners and are fundamental to successful commercial activities. This capability is also determined by infrastructures that reduce transport times and relative costs, that can translate to added value (Carlucci *et al*, 2018). There are many scientific contributions that address these aspects (Martinez-Zarzoso and Márquez-Ramos, 2008; Skonieczny and Torrisi 2011).

One of the crucial elements that explain international trade development within a region, however, is linked to its topography and/or other territorial characteristics that any adequate infrastructure has developed to contribute to increase trade and the

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related added economic benefits must be taken into consideration. It seems that economic theory lacks significant contributions regarding this aspect, as highlighted in the works by Márquez-Ramos and Aparisi-Caudeli (2013) and Celbis, Nijkamp and Poot (2014) where the lack of literature regarding the impact of territorial characteristics or physical aspects as factors that could explain international trade development is noted.

This is where we need to reopen the debate in order to prove that territorial characteristics and continuity represent a fundamental feature for logistics development, and that an adequate distribution of intermodal structures and a sufficient number of logistics companies are necessary to guarantee that any detachment between the related trade areas decreases, resulting in an increase in competitiveness.

At this point, given the context of an island lacking territorial continuity, what effect can infrastructures or logistics hubs produce with regard to competitiveness in international trade? This is still an open question on which the scientific community places particular emphasis when justifying policies used to simulate island territories as central hubs involved in international trade.

The paper is organized as follows. Section 2 shows the collected data and the definition of variables to the model implementation. Section 3 deals with the econometric methodology adopted and section 4 involves the main results obtained by different models modifying the fixed effects specifications. Finally in section 5 some implications of policy emerge from the above results.

2. International trade statistical sources and data

The first difficulty found with the dataset layout is linked to the completeness of data provided by official sources. Nevertheless, we were able to construct a dataset capable of dialogue between 20 Italian regions and 20 European countries involved in international trade. The dataset is characterised by various dimensions of structural and regional competitiveness that explain incoming and outgoing trading capabilities for various sectors within the international trade system.

The dataset was constructed by placing trade relations in the manufacturing sector into a 20 x 20 panel data for the period 2007-2018 and taking GDP and pro-capita GDP for the regions and countries as being representative of the territorial economic mass, together with the geographical distances, the distance-related and time-related costs of road transport between European regions at the NUTS 2 level, the efficiency of the trading partner transport and logistics systems expressed by the World Bank LPI (Logistics Performance Index), trade logistics data that indicate global transport/logistics performance. Additional global and other specific indicators were also included in order to acquire greater details concerning various network performance parameters.

A set of summarised competitiveness level indicators concerning production systems in the Italian regions was also acquired and constructed, along with infrastructure endowment levels and territorial transport/logistics network efficiency. It should be noted that these data entered the evaluated empirical specifications as explicative variables, while import and export flows function as dependent variables; given the size of the dataset, however, specifications that foresee different result variables such as GDP and/or others may be modelled.

A longitudinal type panel dataset covering the 2007-2018 time period containing 3560 observations has resulted from the variable combinations concerning multi-sector import and export flows.

Our choice to construct the dataset at the regional level NUTS-2 comes from our intention to investigate the effect on foreign trade caused by the territorial discontinuity of Sicily as a whole considering the relevance of the main regional transport and logistics hubs, especially ports, for international trade. It must be highlighted that many Italian provinces (NUTS-3) do not have any ports and the presence of zero values would have increased considering the NUTS-3 provincial units in the dataset. The sources and descriptions of the variables that have been considered to develop the Italian infrastructure endowment gravity regional models are collated in Table 1 while Table 2 contains the regions and the partner countries considered in the following models.

Table 1 – *Variable Definitions.*

	Description	Source
Y	Total export of the manufacturing sectors - ATECO Section “C” in current Euros	ISTAT - Coeweb
X_1	Natural log of Gross Domestic Product of the Italian regions in current Euros	ISTAT - EUROSTAT
X_2	Natural log of Gross Domestic Product of the importer counties in current US Dollars	CEPII Dataset
X_3	a) Natural log of Distance-related costs of freight road transport between Italian regions and partner countries; b) Natural log of Time-related costs of freight road transport between Italian regions and partner countries	Regional Transport Costs. European Commission, Joint Research Centre (JRC), Persyn *et al*. 2020
X_4	Natural log of the road regional endowment expressed in km of the regional network per square km of regional surface	ISTAT - Territorial Indicator
X_5	Natural log of the electrified regional rail network on the total rail network	ISTAT-Territorial Indicator
X_6	Natural log of Number of berths of the regional ports per square km of regional surface	ISTAT - ASTI

Table 2 – *Territory Definition vs Foreign Countries.*

Regions	Countries
Abruzzo	Austria
Basilicata	Belgium
Calabria	Bulgaria
Campania	Croatia
Emilia-Romagna	Denmark
Friuli Venezia Giulia	France
Lazio	Germany
Liguria	Greece
Lombardy	Ireland
Marche	Netherlands
Molise	Poland
Piedmont	Portugal
Apulia	United Kingdom
Sardinia	Czech Republic
Sicily	Romania
Tuscany	Slovacchia
Trentino-Alto Adige	Slovenia
Umbria	Spain
Valle d'Aosta	Sweden
Veneto	Hungary

3. Econometric model

Empirical studies in literature highlight the application of relational models often based on OLS or GLM, or even LISREL models. The models that produce the best results regarding the measurement of trading relationship effects actually belong to the gravitational type.

The gravity model is commonly used to model international and interregional trade flows. As reviewed by Head and Mayer (2014), the gravity equation can be justified by a broad range of trade theories, such as those based on differences in factor-endowments (Deardorff, 1998), monopolistic competition (Helpman and Krugman, 1985), home-preferences (Anderson and Van Wincoop, 2003) or increasing returns to scale (Helpman and Krugman 1985; Evenett and Keller, 2002).

A basic gravity model of trade is a model of bilateral trade interactions in which size and distance effects enter multiplicatively: a gravity equation of this kind, dubbed as ‘naive’ by Head and Mayer (2014), can be represented as:

$$X_{ij} = GY_i^{\alpha}\, Y_j^{\beta} d_{ij}^{\gamma} \quad (1)$$

Where Xij represents the bilateral flow from country i to country j, G is a 'gravitational' constant, Yi and Yj are the economic mass of the trading countries such as GDP, dij is market accessibility such as distance costs between the two independent regions.

The lin-log transformation can be taken and adding a time dimension for a panel dataset estimated more easily. The basic empirical model uses an augmented gravity structure to control for the countries' unilateral and bilateral (dyadic) characteristics:

$$X_{ijt} = exp\,[\alpha_0 + \alpha_1 ln(GDP_{it}) + \alpha_2 ln\big(GDP_{jt}\big) + \alpha_3 ln(distance\ cost_{it}) + \alpha_4 ln(inf_{it}) + \rho_{it} + \gamma_{ji} + \pi_{ijt}]\eta_{ijt} \quad (2)$$

The model specification of the equation (2) includes exporter-time fixed effects (ρ_{it}) and importer-time fixed effects (γ_{ji}), pair fixed effects (π_{ijt}) are also included in order to control for all possible (observable and unobservable) trade costs at bilateral level. The pair fixed effects will absorb most of the linkages between the endogenous trade policy variables and the error term η_{ijt} in order to control for potential endogeneity of the former. In principle, the error term in gravity equations may carry some systematic information about trade costs. However, due to the structure of the fixed effects, researchers should be more confident to deal with them and interpret them (η_{ijt}) as a true measurement error (Yotov et al., 2016). Finally, it doesn't matter for the PPML estimator whether the error term in equation (2) is introduced as additive or multiplicative (Santos Silva and Tenreyro, 2006).

The potential of Poisson Pseudo-Maximum-Likelihood (PPML) estimation was recognized early in the spatial sciences by Davies and Guy (1987) who recommended using pseudo-likelihood methods instead of the more popular Poisson regression for the modelling of spatial flows. However, it was not until Santos Silva and Tenreyro (2006) that PPML took off particularly in the international trade literature. With this method, as the dependent variable enters the specification in levels and not in logarithms, it is possible to include zero trade flows in the regression.

The increasing availability of larger panel-type datasets, coupled with advances in estimation techniques for linear regression models with high-dimensional fixed effects (HDFE), has allowed researchers to control for multiple sources of heterogeneity. In this study, we apply the PPML HDFE regression implemented in Stata which pays close attention to verify the existence of a maximum likelihood solution, adapting the innovations and suggested approaches described in Correia, Guimaraes and Zylkin (2020). It also introduces some novel acceleration techniques concerning existing algorithms for HDFE nonlinear estimation that eliminate some unnecessary steps and leads to faster the computation of the parameters of interest and offer the full functionality of factorial variables to control for fixed effects.

Fixed effects can be included in the regression model in order to account for unobserved factors. Using fixed effects for both the exporting country and the importing country is common practice, and these fixed effects can account for unobserved characteristics of the exporting and importing country. Furthermore, time-dummies are always included to account for time specific fixed effects such as crises and for the deflation of nominal monetary values (Wessel, 2019). In particular we control for region/country pair and region/country-time fixed effects (for both importer and exporter regions/countries). It is general practice to use robust standards error clustered at the country-pair level (Yotov *et al.*, 2016).

The clustered panel regression confirmed by the robust Hausman test reported at the bottom of Tables 3 that a fixed effects specification should be adopted.

In the basic model we consider the Gross Domestic Product of the region of origin and of the country of destination. The bilateral trade costs are approximated by the average distance between Italian regions and the regions belonging to the importing European countries, measured in terms of road freight transport costs variable with distance for a shipment by a representative 40 tons articulated truck (Perysin *et al.*, 2020). The infrastructural variables (inf_{it}) for each export flow region of origin considered in the basic regional gravity model are: a) the natural log of the road regional endowment expressed in km of the regional network per square km of regional surface, b) the natural log of the electrified regional rail network on the total rail network, c) the natural log of the number of berths in the regional ports per square km of regional surface.

4. Results

The results are interesting with regard to the size of the effect generated in both general territorial contexts and in island contexts. Infrastructural indicators for railways and ports indicators are positive and very significant and have a positive impact on international trade relations, while the indicator for roadways is significant and negative.

In order to capture the effects on international trade relations that infrastructures can generate and to highlight the weaknesses of continuous and central nodal network connections, we have formulated the model with island fixed effects specific to Sicily (Table 4).

Table 3 – *General model results*

Variables	X_1	X_2	X_3	X_4	X_5	X_6	Constant
Y	2.744***	0.740***	-17.63***	-1.89e-08***	7.56e-09**	0.0111***	38.59***
	(0.314)	(0.0741)	(0.823)	(3.51e-09)	(3.52e-09)	(0.00418)	(9.743)
Obs	Wald chi2	r2_p	ll_0	deviance	ll		
3560	661.5	0.990	-2.250e+12	4.310e+10	-2150e+10		

Clustered Robust Hausman Test $\chi^2(5) = 35.09$ (prob=0.0000)
Country-Year Fixed Effects Yes
Importer and Exporter Fixed Effects Yes
* p<0.1, ** p<0.05, *** p<0.01. Clustered Robust Standard errors in parentheses.

Table 4 – *Sicily Model Results (with island effects X5, X7, X9 =1)*

	X_1	X_2	X_3	$X_4=0$	$X_5=1$
Y	3.012***	0.702***	-0.952**	-1.90e-08**	-4.97e-08***
	(-0.255)	(-0.0449)	(-0.487)	(-7.92E-09)	(-1.42E-09)
continue	$X_6=0$	$X_7=1$	$X_8=0$	$X_9=1$	Constant
	9.46e-09***	-1.33e-08***	0.0193***	0.00890***	-89.40***
	(-3.31E-09)	(-6.85E-10)	(-0.00494)	(-0.000932)	(-10.03)
Obs	Wald chi2	r2_p	ll_0	deviance	ll
3560	8.51e+08	0.988	2.25e+12	5.59e+10	-2.79e+10

Country-Year Fixed Effects Yes
Importer and Exporter Fixed Effects Yes
* p<0.1, ** p<0.05, *** p<0.01. Clustered Robust Standard errors in parentheses.

These preliminary results show how the infrastructure indicator that determines positive effects on Sicilian trade is that of the ports, while roadways and electrified railways indicators are significant and negative. These results are also confirmed considering the time-related costs as spatial "impedance factor" (X_3) which include travel time over the road segment, salaries in the transport sector, national speed limits, and the European transport regulations on resting times for a shipment by a representative 40 tons articulated truck (Perysin et al., 2020) (Table 5).

These results are naturally in line with Sicily's 'insularity conditions' where a large part of the exported goods is transported by sea. Investment in the maritime infrastructure could greatly increase the value of Sicilian exports.

Table 5 – *Sicily Model Results (with island effects X5, X7, X9 =1)*

	X_1	X_2	X_3	$X_4=0$	$X_5=1$
Y	3.012***	0.702***	-1.560***	-1.90e-08**	-4.97e-08***
	(0.254)	(0.0452)	(0.524)	(7.92e-09)	(1.40e-09)
continue	*X6=0*	*X7=1*	*X8=0*	*X9=1*	Constant
	9.50e-09***	-1.33e-08***	0.0193***	0.00890***	-86.53***
	(3.32e-09)	(6.91e-10)	(0.00494)	(0.000870)	-9.894
Obs	Wald chi2	r2_p	ll_0	deviance	ll
3560	4.96e+11	0.988	-2.25e+15	5.50e+15	-2.75e+13

5. Conclusion

These initial results show an interesting scenario thanks to the application of gravitational models, without which the aspects linked to particular territorial characteristics, would not have emerged.

If the variable effects under examination are analysed based on international exports in a general territorial context where territorial continuity exists, all the variables are significant and each one clearly indicates its effect on trade relations; the other major relevancy emerges when the same variables are applied to an island location with territorial discontinuity.

According to this logic, the policy indications emerging from the results are clear: where investment continues to be made for infrastructure development, such as intermodal links within an area of territorial continuity, the effects greatly benefit commercial activity, while they are less effective for island territories where infrastructure development is mainly necessary to ports and shipping. The impact generated by road or rail networks is significant but with negative signs due to the insular location and lack of territorial continuity, isolating them from the national transport network and crucial logistics hubs.

It is possible to surmise a policy scenario from these conclusions that foresees a strong relationship in terms of investment in infrastructures that guarantee territorial continuity, thus raising regional competitiveness capability indicators for international trade.

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SUMMARY

There is a broad consensus that international trade plays a role in promoting economic growth. Among the main drivers of international competitiveness, geographical factors and transport infrastructure cover a relevant role. Trivially, the distance between a region and its trading partners is, in itself, a determinant of the region's competitiveness in international markets, since a closer region would have an advantage. However, in the modern economy, logistics plays an increasingly important role in strengthening international competitiveness, as globalization has expanded the trade network by making the physical distance between regions less important. In this paper we study the case of Sicily, the largest island in the Mediterranean Sea, to see if insularity plays a role in explaining this region's total exports given its infrastructure endowment. Consistent with a broad strand of the international trade literature, this aim is achieved by means of gravity models estimated via Poisson Pseudo-Likelihood regression with multiple levels of Fixed Effects (PPML HDFE implemented in Stata). Using a novel panel dataset on the 20 Italian regions and their main international trading European partners from 2007 to 2018, we show the impact of maritime transport, roads and railways on total export of Sicily. In particular, we find a positive significant role of ports on international trade for the island. These results offer useful suggestions on what infrastructure is best to invest in to increase Sicily's total exports.

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