Short Sea Shipping in Italy: Some Evidence from Sicily

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Abstract

This work studies demand and supply of maritime port services in order to analyse the relationship between investments and 'road-sea' modal balance in Sicily. Using a panel data approach, it will be tested the presence of any correlation between the relevant variables and the volume of goods traded in Sicily.
The main insight of our framework shows a strong imbalance in terms of goods loaded and unloaded in the ports of the Sicilian Region.This result sheds somelight on our research questionand highlights that an overall reorganization of the regional logistics is desiderable.

Keywords: Short Sea Shipping; Sicily; Port investment.

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1. Introduction

Transport system is an essential term, or rather the driving element, of market globalization and firms de-localization(Lee et al., 2014). Transport efficiency increases the worldwide competition in products and services markets(Cariou et al., 2014). The economics distances reduction, as a consequence of the modern economic systems, indeed, had made it possible a wide development in the mobility of goods and people(Carlucci et al., 2017b).

In this context, maritime transport plays a key role: the increasing in ship size and the containerization have made it possible, as well as cost effective, to move huge amounts of raw materials and agricultural products over long distances. During the 1990, the international maritime traffic from Far East was characterized by a powerful impetus to the development, and it was crucial in order to link some geographical areas located far away from each other, and for contributing to reduce costs with regard to alternative transports modes(Forte, 2013).

The efficiency of port infrastructure has become particularly important for Sicily due to the fact that it is an island. In this study, we try to use empirical tools in order to understand the variables which can affect the choice of using sea freight, and the impact of this choice on demand and supply of connected services(Medda and Trujillo, 2010).

The work will proceed as follow. In the first stage, we will examine the socio-economic situation of the Sicilian region, in particular the structure of different types of transport. In the second stage, it will be analysed variables which represent, according to the literature, the main determinant of the transport demand. Using a panel data approach, it will be tested the presence of any correlation between the relevant variables and the volume of goods traded in Sicily.

2. Socio-economic framework and modal split of freight transport in Sicily

Before dealing with supply and demand of goods transport in Sicily, it is useful to give an overview of the recent socio-economic context of the Sicilian region, which is the subject of the present work.

2.1 Socio-economic Framework

The Sicilian GDP, after a steady period of growth until 2007, suffered a setback with constant decreases the values of which, in the last fifteen years, were lower than those of 1995: they went from €74.853 million in 1995 to €74.762 billion in 2015 (Fig. 1).

Figure 1: Sicilian GDP by Activity (vaues refered to year 2000)

Looking at the figure 1, that shows the added value of the productive sectors, it seems clear that the GDP reduction can be mainly attributed to the reduction in the industrial sector activities and, in part, to the decrease in services. In particular, the added value of the industrial sector in the period 2005-2015 was reduced by 30%, while the ones of services lost 8% in the same period.

This decreasing trend in the economic cycle has obviously an increasingly important burden on the decline in total trade of goods in Sicily having regards of all transport modes. Nevertheless, however, it remains strongly imbalance in the use of the different transport modes.

2.2 Modal distribution of freight transport

In Italy, the breakdown of goods transportation between the three superficial modes (rail, road and sea), is very unbalanced. Consequently, transport activities has become a priority policy issue (Arbolino et al., 2017).

The rail transport seems to plays a marginal role in the handling of goods. ISTAT data (Tab.1) show that from 1995 to 2015, the rail transport system has contributed just over 2.5% on average of total cargo handling. In Italy in 2015, 87% of goods were carried by road. On the contrary, although in Sicily we found a lower percentage of total goods being transported by road (around 65%), the trend over the years showed a structural

imbalance, while maritime transport in Sicily was the dominant mode of transport. However, the trend once again showed that there was no changes in volumes that suggests a gradual modal shift over the years(Castells, Usabiaga and Martìnez, 2014).

Table 1 – Modal Distribution of goods in Sicily

	1995	2000	2005	2010	2015
Railway					
Sicily	2,6	2,4	3,2	2,9	2,5
Italy	2,1	2,3	2,3	2,3	3
Road					
Sicily	76,6	70,2	68,1	66,8	64,7
Italy	93,8	93,3	92,0	92,0	87,5
Sea					
Sicily	20,9	27,5	28,7	30,3	32,5
Italy	4,6	4,7	6,0	6,0	9,5

Source: AnnuarioStatistico ISTAT

Oil products transport is not included in the in our analysis since by nature it uses to have a different logistic channels and a peculiar relation to the carriage of other goods.

The objective of our work is to examine which policies could be implemented in order to rebalance the transport of goods among different modes.For this reason, we have decided to estimate and observe solely the transport of those goods which could be transported either by sea or by land.

Sicily is affected by a chronic delay in structural railway modernization, so we have decided to focus our analysis on the factors that can push towards a rebalancing between sea and road transport(Carlucci et al., 2017a).

In the following section we will define the trade of goods moved both by land and sea as “contestable traffic” in order to highlight that sea transport appears to be more competitive with road transport only over long distances. Road is the prevailing mode for short-haul transport (less than 500 kilometres), whereas the combined transport, road-sea, is the preferred way to reach Central and Northern Italian regions.

3. An econometric analysis of the demand for maritime transport in Sicily

The strand of literature ascribed to the Public Choice, has used models where the variable related to the size of freight transport appears to be an endogenous variable

explained by a combination of other macroeconomic variables. Our study aims at identifying and measure the determinants of cargo in the Sicilian ports, pointing out any possible links with the factors mentioned frequently in the economic literature(Marcucci, 2013; Santos and Soares, 2016). This will require deployment of an empirical approach based on the estimation of a reduced form equation with observations both in space and in time, in which the dependent variable is the amount of traffic in ports, while among the independent variables there were included appropriate indicators which capture the main economic determinants of the Region.

The use of a pooled analysis of data referring to both spatial and temporal observations need the use of an econometric methodology known as Panel Data (Hsiao, 1986; Klevmarken, 1989; Solon 1989). The decision to rely on this technique can be explained taking into consideration the following advantages:

1. The ability of analysing individuals for heterogeneity. The panel data, indeed, suggests that individuals, companies, states or regions are heterogeneous with each other. Furthermore, following the time series or cross-sections analysis rules it seems impossible to capture the heterogeneity mentioned before, risking to get so distorted results. The heterogeneity characterizing the considered subjects, therefore, represents a focal point analysis.

2. Panel data are able to provide more information, higher variability, lower collinearity between variables, more degrees of freedom and greater efficiency. Studies based on time series suffered multicollinearity problems. It is less likely to occur with panel includingsectional data, since space dimension (cross-section) adds a higher variability increasing data information performance. Having more data available and therefore more information,it is possible to produce more reliable estimates on parameters.

In brief, panel data are characterized by a lower impact of multicollinearity, which is a phenomenon occurring when two or more independent variables are highly correlated. In case of perfect correlation, the independent variables are linearly dependent, violating, in this case, one of the classical linear regression model assumptions. Although this is still rare, the so-called imperfect multicollinearity is much more common and it can cause substantial problems.

An estimated parameter informs us about the impact of the independent variable on the dependent variable holding the other independent variables constant. If two variables

are significantly related in a database, regardless of variation, it will become impossible to distinguish between them; it is becoming increasingly difficult to estimate the coefficient model.

4. Function estimation of traffics in Sicilian ports

The model specification is inspired from a vast body of literature on the goods transport determinants. Model variables choice is based essentially on economic theories born over recent years that were aimed at identifying the social and economic determinants of commercial traffic (see, inter alia, Stopford, 1997).

The study covers the period ranging from 2005 to 2015, dealing with 90 observations distributed over the whole Sicily. In this respect it should be noted that the attention was focused on time period beyond 1995 because of the following reasons:

i)it was tried to bypass the problem of the lack of data, resulting from the impossibility of finding data, for some variables (income, consumption and number of companies), prior to 2005;

ii) it was decided to focus on the years following the 1994 reform (Law 84/94), which founded the Port Authority, determining a new economic scenario for Sicilian ports.

4.1 The dependent variable

The first issue to be dealt with in order to carry out an econometric model is the dependent variable choice.

For the present work, it has been decided to use the number of tons of cargo handled yearly in each port. The source of data for this variable is the statistical publications of Port Authority of Palermo.

For the descriptive statistics, it was decided to create three different dependent variables: the tons of goods unloaded per year, tons loaded per year, the total unloaded and loaded freight.

Subsequently, in the regression model, we have used only the total of goods loaded and unloaded.

It has been taken into account seven of the nine Sicilian provinces. The province of Enna was not included in the analysis due to the absence of a port. Likewise, the

province of Ragusa was excluded since the data pertaining to the major port (the port of Pozzallo) are available only for 2014. As a result, observations number has fallen to 70. Endogenous variables were generated by adding the traffic ports located in the same province according to the following model:

Table 2 – Sicilian Maritime Ports

PROVINCES	PORTS
Trapani	Castellammare del Golfo, Trapani, Marsala, Mazara del Vallo
Palermo	Palermo, Termini Imprese
Messina	Messina, Milazzo
Agrigento	Porto Empedocle, Licata
Caltanissetta	Gela
Catania	Catania, Riposto
Syracuse	Syracuse, Augusta

Data do not include oil products since the amount of these trades cannot be related to local needs. The trade in energy products is strictly connected to the international requirements and, for this reason, it has few links with the domestic economy of the region.

The basic equation to evaluate can be expressed in the following linear form:

$$Y_{it} = \alpha_0 + \sum_j \beta_j X_{jit} + u_{it}$$

the indices *i, t, j* refer respectively to province, year, independent variable; α is the constant and, as β, this parameter has to be evaluated and it represents the intercept value; β is the coefficients value to estimated and it represents the incidence ratio between each independent variable X*j*and the dependent variable Y_i. In geometric terms, it represents the slope of the regression line, and *u* is the error term.

4.2 The explanatory variables

Explanatory variables included in the regression model, which have been suggested by most of the literature on the determinants of goods transport, are the following:

- Population (source: ISTAT);
- Income (source Prometeia data);
- Expenditures (source: Prometeia data);
- Added value (source: Prometeia data);
- Companies (source: Movimprese)

According to economic theory, the sign of these variables is expected to be positive. There should be a positive relationship between performance of commercial traffic and the evolution of the considered variables.

As for the construction of the variables in the model, the added value has been detected separately taking into consideration the three main economic sectors (agriculture, industry, services).

The following table describes the used variable and its awaited sign.

Table 3 – Used Variables

Variables	Description	Awaited sign
Dependent Variables		
Y_AR	Loaded Goods in Tons	
Y_DP	Unloaded Goods in Tons	
Y_AP	Loaded and Unloaded Goods in Tons	
Independent Variables		
POP	Resident in the Sicilian provinces / Surface of the Sicilian provinces	+
REV	Disposable income for provinces for year / average residential population by provinces per year	+
CONS	Inhabitant expenditure by provinces / average residential population by provinces per year	+
AV_AGR	Added value in agriculture sector per year by provinces / Total added value in Sicily per year	+
AV_IND	Added value in industry sector per year by provinces / Total added value in Sicily per year	+
AV_SERV	Added value in services sector per year by provinces / Total added value in Sicily per year	+

Variables	Description	Awaited sign
N_COMP	Number of companies per year by provinces / Total number of companies in Sicily per year	+

4.3 Statistical analysis of the descriptive model

At the beginning, it has been estimated the correlations among exogenous variables and individual endogenous variables in the whole Sicilian region. It has been tried to detect the existence of links between the performance of goods traffic in the Sicilian ports and the development of each variable.

The table below shows which kind of correlations is possible to find in Sicily:

Table 4 – Correlation matrix

	Correlations *Y - X*						
	POP	**REV**	**CONS**	**AV_AGR**	**AV_IND**	**AV_SERV**	**N_COMP**
Y_AR	0,78	0,44	0,47	0,38	0,82	0,78	0,48
Y_DP	0,40	0,54	0,54	0,32	0,50	0,42	0,23
Y_AD	0,68	0,54	0,53	0,41	0,75	0,68	0,40

Given that the correlation takes values between -1 and 1, goods traffic in Sicily seems linked mostly to the trend of the population, and to the performance of industry and service sector. In particular, the highest correlation is obtained with the variable quantifying the level of landings (Y_ARR). As already noted, this fact can be explained considering that a negative trade balance has always affected Sicily in recent years.

Sicilian economy is characterized by the predominance of imports that has a positive effect on landings performance in the region's port.

Looking at the data it is possible to notice that the agricultural sector is poorly linked with the development of commercial traffic. However, analysing traffics breakdown, it is possible to notice a significant movement of agricultural products (representing 5% of boarding and 10% of landings, excluding oil products). As matter of fact, the available data, especially regarding the industry added value, does not allow to find any links among agricultural production and goods transport in the Sicilian ports.

The low correlation with the number of companies is probably due to the fact that this variable is not a reliable proxy of the province industrialization degree(Ambrosino *et al.*, 2016). Number of companies cannot be considered a good measure of the province industrialization. It has to be considered also type of companies, the business magnitude, the risk attitude, easier access to credit and all those variableswhich are able to show a comprehensive framework of the business situation in the province.

4.4 Results and comments

After the descriptive analysis, it was running the regression using the panel data. Compared to the previous analysis, the aim of this analysis is to define the link among traffics development and variables taking into consideration combined effects of the two.

According to the present model, indeed, transportation of goods depends on the interaction between all variables described above rather than the single independent variable behaviour. Therefore, the complete model to estimate is the following:

$$Y\_AD = \alpha + \beta_1 POP + \beta_2 INC + \beta_3 CONS + \beta_4 AV\_AGR + \beta_5 AV\_IND + \beta_6 AV\_SERV + \beta_7 N\_COMP + u$$

$$Y\_AP = \alpha + \beta_1 POP + \beta_2 REDDITO + \beta_3 CONSUMI + \beta_4 VA\_AGR + \beta_5 VA\_IND + \beta_6 VA\_SERV - \beta_7 IMPRESE + u$$

It is needed now to give attention to the variables inclusion process within the panel model. In the last twenty years, there has been a radical change of econometric theory about the criteria for inclusion of a variable in the model. Indeed, while before coefficients were estimated including explanatory variables in the model one by one, now it is used a different approach in which all the explanatory variables considered as important for the explanation of the phenomenon and then non-significant variables are removed. In some of his works, Hendry (1995) showed that errors resulting from incomplete specification of the model, can lead to improper outcomesby adding variables in different moments. The most attractive strategy turns out to be the one from the general to the 'specific model', taking out gradually the less significant variables.

Even this approach has been criticized since in a wide model, adopting a fixed probability for the first error type (5%), it is likely that some variables may mistakenly considered significant. The model was initially processed with LSDV method (fixed effects model). Characteristics of the model are shown below:

Table 5 - Summary Statistics Least Squares with Group Dummy Variables Model 1

REGRESS; Lhs=Y_AP; Rhs= ONE, POP, REV, CONS, AV_AGR, AV_IND, AV_SERV, N_COMP
Dep. var. = Y_AD Mean= 14.55937339, S.D.= 0.7490532367 Residuals: Sum of squares = 3.204629318, Std. Dev. = 0.23922
Model size: Observations = 70, Parameters = 14, Deg.Fr.= 56

Number of parameters to be evaluated is equal to 14. In order to identify which parameter will be included in the fixed effects model it is needed to take into consideration both those parameters related to exogenous variables (they amount to eight in which "ONE" is the constant variable), those parameters associated with the six (N-1) dummy variables of the model. This aspect is important since it marks the main difference between the fixed effects model and the random-effects.

Number of parameters included in the model is crucial in order to determine the degrees of freedom that, in our case, are equal to 56.

The present model is able to explain around the 89% of the variability of the dependent variable (the logarithm of tons of goods loaded or unloaded); in other words, the model is statistically correct, since the overall significance is very high (Adjusted R-squared = 0.89801).

The relevance of the model, furthermore, has been tested through the F-test, taking into consideration 13 explanatory variables (corresponding to k-1, ie 8 + 6-1) and 56 degrees of freedom. The F-test is useful in order to 'test' the explanatory power with respect of all variables included in the model. The null hypothesis for which all the coefficients of the model become simultaneously zero is rejected at the significance level of 1% since the F-test falls clearly into the rejection areas(Prob. value = 0).

Fit: R-squared = 0.917224, Adjusted R-squared = 0.89801
Model test: F[13, 56] = 47.73, Prob. value = 0.00000

To determine the extent of the exogenous variables coefficients it is needed to find the best regression model running two statistical tests: the Lagrange multiplier and the Hausman test. The first test makes a comparison between the classical model (OLS) and fixed effects models (FEM) and variable effect model (REM).

Lagrange Multiplier Test vs. Model (3) = 3.86 (1 df, prob value = .049570)
Fixed vs. Random Effects (Hausman) = 8.59 (7 df, prob value = 1.000000)

The p-value of the Lagrange multiplier is lower than 0.05, which means that the Fixed Effect and the Random Effect Models have to be preferred to the classical one. Moreover, the Hausman test shows a p-value higher than 0.05: the best model turns out to be the one with variable effects. The outcomes are the following:

Variable	Coefficients	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
POP	- .8751669629	1.3177662	-664	.5066	5.2623426
REV	- .8807890295	1.6602227	-531	.5957	9.1988488
CONS	2.564106686	1.4720102	1.742	.0815	9.1144967
AV_AGR	.1997584334	.23687595	843	.3991	8.5127110
AV_IND	1.319912016	.44489770	2.967	.0030	9.9291445
AV_SERV	.3235499055	.52270411	619	.5359	11.364149
N_COMP	- .1122336888	.27994521	-401	.6885	2.7907791
Constant	- 14.27322257	5.8716517	-2.431	.0151	

The outcomes show that the significance level is low for most of the estimated coefficients (p-value greater than 0.05).

It has been possible to obtain a final regression by eliminating progressively the less significant variables and by running a new regression with the remaining coefficient. This regression combines goods loaded and unloaded, the consumption value, and the industrial sector added value.

$$Y\_AD = \alpha + \beta_1 CONS + \beta_2 AV\_IND + u$$

$$Y\_AP = \alpha + \beta_1 CONSUMI + \beta_2 VA\_IND + u$$

The results provided by the fixed effects model (9 parameters and 61 degrees of freedom) point out that the estimated model explains the 89% of the variability of the dependent variable: the model is still statistically correct, as the overall significance is very high (Adjusted R-squared = 0.89627).Furthermore, the F-test falls into the rejection areas (Prob. value = 0).

Summary Statistics Least Squares with Group Dummy Variables Model 2
REGRESS; Lhs =Y_AD; Rhs = ONE, CONS, AV_IND; Panel Model
Dep. var. = Y_AD Mean = 14.55937339, S.D. = .7490532367
Model size: Observations = 70, Parameters = 9, Deg.Fr.= 61
| Residuals: Sum of squares = 3.550103906, Std. Dev. = .24124
Fit: R-squared = .908301, Adjusted R-squared = .89627 Model test: F[8, 61] = 75.53, Prob. value = .00000

The Hausman test shows a high p-value (greater than 0.05) for which the best model for the coefficients estimation is the variable effects model.

Fixed vs. Random Effects (Hausman)=3.74(2 df, prob. value = .154105) (High(low)values of H favour FEM (REM))

Variable	Coefficient	Stand. Error	b/St.Er.	P[|Z|>z]	Mean of X
CONS	1.595146	.24785234	6.436	.0000	9.11449
AV_IND	1.246622	.22759106	5.477	.0000	9.92914
Constant	-12.3574	3.7387593	-3.305	.0009	

The β coefficients are significant and they turn out to be 1.59 for consumption and 1.24 for the industry added value. There are no specific effects relative to each port since variables included in a REM model allow to explain the observed phenomenon (in this case the goods traffic in the Sicilian ports) in its entirety without considering any specific characteristics of each unit (ports).

Correlation analysis had shown a link between goods transport and data on population. The evaluation of the regression model, instead, disaffirms those conclusions. This is established by studies carried out in recent years (among others Stopford, 1997) which highlighted the lack of connection between the data on population and the amount of goods transport.

From the outcomes above, it is possible to state that the variables sign evaluated is in line with the literature.

Moreover, the level of significance of the variables in the model is substantially unchanged from the full model which was initially analysed. Therefore, removing non-significant variables, from a statistical point of view, it is possible to confirm the validity of the estimated model in order to obtain a coefficients evaluation consistent with the predictions of the empirical model specified by the most recent literature about the determinants of goods traffic. The industrial sector added value and the level of consumption are therefore the two variables able to influence the transport of goods in the Sicilian ports.

- An analysis of the breakdown of maritime traffic (excluding oil products) reveals the presence (about 30% of the cargo handled) of coal, iron, chemicals and building materials, thus highlighting the strong link between the production of the industrial sector and the amount of traffic in the ports of Sicily.
- In the last years, incomes and consumptions follow substantially the same growth trend. Nevertheless, only the consumptions variables affect the commercial traffic. This is because the incomes variables include both consumption and savings. In recent years, Studies published by the Bank of Italy (2003) have shown an increase in the propensity to save in Sicily. However, the income level in the region is not related to the goods transport, sincesaved money is not necessary spent on the goods traffic.

5. Conclusions

The framework resulting from our analysis shows a strong imbalance in terms of goods loaded and unloaded in the ports of the Sicilian Region. Goods loaded are about 40% less than goods unloaded. The difference above leads to a significant decrease in the load factor on a ship along the shipping route and, as such, an increase in average costs per mile relating to each loaded container(Albanese *et al.*, 2013).

This phenomenon is due the Sicilian economy characteristics which are highly dependent on production of other regions. This analysis is confirmed by the study of influencing variables on the maritime transport demand which are strongly linked to the consumption level of the population and the regional companies capacity, whose proxy is given by the industry added value (AV_IND). Demand for transportation is directly

proportional to the consumption of the population since local companies are not able to afford the increase in consumption.

The positive correlation between maritime transport demand and industry added value deserves further study, although it can be state that it probably depends on local businesses need of raw materials from the rest of the world. Therefore, the increase of the added value is caused by an increase both in the local businesses activity and in the imported raw materials requirements. The analysis for each province of goods exported highlights even that in Sicily high added value goods are mainly allocated to the external market (cars and electronic components). Based upon this arguments, it is possible to state that the Sicilian market is unlikely to know some mechanism aiming at bringing a balance between loading and unloading goods since the Sicilian market of goods is structurally heavily depended on the foreign market. It becomes paramount to think about an overall reorganization of the regional logistics, including as well the trans-shipment activities along with the creation of a hub port(Marcucci, 2014). This option would make the maritime transport in Sicily more convenient and competitive, while improving the whole maritime Mediterranean transport network system (Carlucci and Cirà, 2013). Taking advantage of the unused transportation capacity on round trips from the island, while at the same time making Sicily part of a broader port network, it would be possible to create economies of density which would make the average cost of shipping more convenient(Douet and Cappuccilli, 2011).

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