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REGIONAL LOGISTICS PRODUCTIVITY IN ITALY

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ABSTRACT

Productivity and competitiveness of the territories with reference to the logistics and transport performance are factors of increasingly importance for the economic recovery of the Italian local production systems affected by the international crisis of recent years. Different methods of parametric and nonparametric analysis are applied to deal with these sectorial specific productivity aspects. These studies fall within the field of the production functions to estimate productivity differentials between companies or industries located in different regions. This article aims to highlight the links at regional Italian level between international freight traffic by different transport modes and variables related to production factors in order to measure the degree of relative regional logistics productivity and investigate about the main factors determining the total factor productivity (TFP) of the transport and logistics sector. Using a dataset specifically built was performed a panel estimate of the regional production function of the logistics and transport services sector in the period 2007-2012 to measuring what is not explained by the mere accumulation of traditional capital and labor inputs.

Keywords: total factor productivity, logistics, transport infrastructure, panel data.

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1. Introduction

Manufacturing is no longer just about a production process in which raw materials are transformed into a physical product. Emphasis is now on making use of a wider and interconnected manufacturing value chain, including production processes which remain of central importance. The manufacturing sector is likely to continue evolving, with value created in increasingly diverse ways. Changes in business models and other areas will result in a more interconnected manufacturing system, with the international mobility of goods and production factors at its heart.

Productivity, and especially the productivity of both labour and capital inputs into the production process, i.e. total factor productivity (TFP) is widely recognised as a key driver of long-run economic growth. William Baumol similarly states that, 'without exaggeration, in the long run probably nothing is as important for economic welfare as the rate of productivity growth'.

TFP is typically defined as the increase in output that is not due to an increase in the direct inputs used to produce goods and services (i.e. more efficient use of labour and physical capital and/or the development of new products). Country and industry studies confirm the importance of TFP and its dominance in explaining differences in output growth across economies (OCSE, 2003).

The principles of neoclassical economics, especially constant returns of scale and decreasing returns of capital, do not reflect the evolution of global markets. In more recent growth economics studies these two factors have been removed and new production factors have been introduced, in particular human capital, technological and organizational efficiency.

The application of traditional production function methodology to spatial production units in order to find out the nature and strength of the explanatory variables is not new, particularly when the independent variables used are labour and capital. But beyond the conventional wisdom in production economics, territorial units unlike other manufacturing decision-making units (DMU), represent a spatial production system that cannot be fully understood simply by the quantity of labour and capital alone. There is reasonable consensus among economists that the mobility of goods, services, and labour across regions depends largely on the quality and quantity of various integrated facilities being made available, and not directly and solely on the amount of investment or capital stock (Park, De, 2004).

Agglomeration processes of different factors of production and products, and therefore externalities, increasing returns of scale and finally non-competitive markets, could thus take place. At the same time, solutions have depended on the equilibrium of economic forces both in terms of concentration and in terms of dispersion. Increasing returns to scale tend to foster the geographical concentration of production of each good. When transportation costs play a role, attractive locations for production are those which are close to markets and suppliers, all other things being equal. Finally, the concentration of production in some locations tends to attract the mobile factors of production. Once a region has a high share of production, this pattern is likely to become reinforced: a so-called second-nature advantage for the dominant region develops, that is to say, the region becomes attractive for firms because so many other firms are already producing there (rather than because of superior resource endowment).

Freight transport and logistics activities in the new economy carries out a more complex and critical function because it is not limited to a simple transfer of things from one place to another, from the producer to the consumer, but it is an integrating part of the production process and its economic organization. Moreover, the evolution of the modern economic systems has produced a new vision of the localization models through new network models where logistics integration and the strategic positioning contribute towards generating added value (Christopher, 2005).

This article is structured in the following way: the first section is the introduction, the second one deals with the model of analysis of the regional logistics productivity, the third section regards data and variables, while the results are reported in the fourth section. Finally the concluding section contains some policy indications.

2. The regional transport and logistics productivity in the Italian context

The region's economic performance is strongly determined by the availability of immobile and polyvalent production factors. According to this approach deriving from a microeconomic view of the production function, a certain level of human and infrastructure capital can be considered as a necessary precondition for a favourable regional development (Barro and Sala-i-Martin 1991). Like the firm within the industrial organization, economic theory has tried to investigate and evaluate empirically the regional economies as entities using economic resources, applying the best technology and receiving some output through the production process. In keeping with this stylized vision of the region, it is consistent to expand and develop the assessment methods of industrial productivity and efficiency to a regional conceptual framework (Puig-Junoy, 2001).

Empirical studies demonstrate the importance of the composition of public capital: some components have more direct effects on the production process than others. The former include roads and airports, railroads and subways, ports, electrical lines and water, telecommunication i.e. 'core infrastructure', instead 'non-core infrastructure' capital components are hospitals, public buildings and others. Aschauer (1989) show a positive and significant impact of core public capital on productivity, whereas non-core infrastructure does not have this effect. Core infrastructure enhances private capital productivity and motivates private investment. Since public capital are external to individual firms, they are modelled as a shift factor in the regional productivity analysis context.

Moreover, current studies on productive infrastructure capital show that this stock raises private sector output both directly and indirectly. The direct effect arises because infrastructure capital provides intermediate services to private sector firms, that is the marginal product of infrastructure capital services in the private sector is positive. The indirect effect arises from the assumption that productive infrastructure and private capital are "complements" in production, that is, the partial derivative of the marginal product of private capital services with respect to the flow of infrastructure capital services is positive. Thus, a rise in infrastructure capital raises the marginal productivity of private capital services so that, given the rental price of such services, a larger flow of private capital services and a larger stock of private assets producing them are demanded. The rise in the marginal product of capital increases private capital formation, raising private sector output further.

The service improvements induced by transport infrastructure expands the markets for individual transport-using firms. As such market expansion links the economies of different localities and regions, there is a major consequence in terms of a shift from local and regional autarky to increasing specialization and trade and the consequent upsurge in productivity. This is as true for inter-regional trade between highly differentiated regional economies in continental regions such as the United States or the European Union as for cross-border international trade in Free Trade Areas (FTAs). The US Interstate Highway System, the Trans-European Network program and the emergence of super-efficient ocean ports all contribute to ''Smithian" growth—growth arising due to specialization and trade (Lakshmanan, 2011).

Straightforward evidence is given by investments in transport infrastructure that leads to changing location qualities and may induce changes in spatial development patterns. In the context of spatial development, the quality of transport infrastructure in terms of capacity, connectivity, travel speeds etc. determines the quality of locations relative to other locations, i.e. the competitive advantage of locations usually measured as accessibility. Although there is a certain convergence of theoretical and empirical literature on the positive effects created by investments in transport infrastructure on socio-economic growth, there are no univocal results on actual quantification of these effects. As noted by Spiekermann and Wegener (2006): "In general, regions with higher accessibility have a better economic position than regions in peripheral areas. However, there are counter-examples". So the traditional macro-economic models are not very useful for explaining and principally for predicting the effects of transport infrastructure investments and other transport policies on regional economic performance. An example of long run regional resilience with reference to the port regional systems has been studied by Wang and Ducruet (2013) with the aim of

evaluating the relationship between social-economic changes and port system evolution, such as shifts in national capital location, domestic and international trade patterns.

With reference to the Italian regional economic disparity case, in particular between the northern industrialised regions and the others one, Bonaglia et al. (2000) analyse both the link between public capital and TFP, and the difference between North and South. They find a positive relationship between TFP and public infrastructure, especially for the South and find that public infrastructure (i.e., roads, railways, etc.) is the most important (if not the only one) component of public capital affecting TFP and growth.

From a New Economic Geography (NEG) perspective (Krugman, 1991), the Northern Italian industrial district growth performance before the crisis fits very well to theoretical models of NEG, explaining how low transportation costs in combination with the spatial concentration and specialisation of economic activities, referred to as agglomeration effects, increase economies of scale. In the current post-crisis period productivity-driven growth is mainly based on export-oriented new technological knowledge and innovation which is becoming a prominent factor in the Italian regional growth path.

The international trade is stimulating growing demand for advanced logistics services from Italian businesses in order to be competitive on new export markets. The organization of the "ante crisis" logistics model in many Italian regions is no longer adequate for the requirements of domestic firms, which increasingly demand integrated intermodal services and specialized operators capable of managing the entire logistics chain for higher quality products destined for export. This new logistics model calls for efficient dedicated infrastructures and highly qualified logistics operators capable of managing the whole logistics chain. Italian firms have the incentive to find new emerging markets since the international crisis has led to a contraction of traditional markets, especially European ones with advanced logistics services, and these businesses are looking for openings in new and more dynamic markets, but which have outdated logistics services, such as China, India, Russia, South Africa, Brazil, Turkey, etc. In this context logistics services available to the firms becomes of central importance and acquires greater strength than the traditional transport functions. The elements of strength to be found in regional logistics systems with high productivity can be summarized as:

a) suitability to international transport: greater adaptability to long distance and containerized or unitized traffic, of growing importance in a progressively more integrated continental and global market;

b) reduction of negative environmental externalities: air and noise pollution, climate change, urban and landscape impact;

c) higher levels of safety: reduction of road congestion, border crossings and port transit with a positive impact on accident rates;

d) energy savings: reduced consumption of energy resources;

e) optimization of the gateway function: fully exploiting Italy's geographical position as entry point for goods heading for central Europe;

f) exploiting synergies between the various modes of transport: specialization of transport according to distance and type of goods transported;

g) efficient use of resources: rationalization in the use of staff, vehicles and equipment;

h) rationalization in the use of territory: optimization in the organization of dedicated areas and reduction in land use compared with more widespread models;

i) value creation possibilities to the regional system due the presence of multinational logistics operator that adding value to the intermediate and final goods within the global value chains.

In an extended form, regional clustering logistics activities could lead to specific 'logistics clusters' where firms could locate and manage their distribution and value-added activities (Sheffi 2012). The development of this kind of cluster, however, is strictly connected to the specific predisposition of the infrastructures to ship products easily to the world market, thanks to the direct availability of a specific and efficient shipping system (freight rail terminals, ports, airports, etc.).

For example, certain critical points in the Italian logistics/transport system prevent the competitive and quantitatively coherent absorption of the flows of goods passing through ports, thereby generating a separation between origin/destination sea flows and origin/destination land flows. Indeed, very few Italian ports are equipped with an “on dock” rail terminal where containers and other cargo units can be moved directly and quickly from the docks or the storage areas to a railcar using the terminal's own equipment.

The paper aims to highlight the links between inbound and outbound international freight traffic for the different modes of transport and spatial production variables at Italian territorial NUT2 European level in order to measure the regional logistics productivity and subsequently to investigate the main factors determining itself. Econometric panel data models relating to the estimation of regional production functions in order to analyze the logistics productivity performance in Italy over the period 2007-2012 have been applied.

3. The empirical model and data

Analyzing aggregate production functions for the 20 Italian regions, NUTS2 units of the administrative divisions of countries for statistical purposes developed by the European Union. We focused on the influence on total factor productivity of the freight transport and logistics sectors including the activities that more directly have an impact on the international trade. The economic sectors here considered are comprised in the divisions: 49 - terrestrial transport, 50 - maritime transport, 52 - warehousing and support activities for transportation, of the Italian statistical four digit ATECO 2007 classification of economic activities. This classification is the national version of the European nomenclature NACE Rev. 2.

Production Y_{it} (international inbound and outbound freight multimodal traffic) can be determined by the levels of labour input and private capital, L_{it} and K_{it} the level of public capital. Public capital is decomposed into the transport infrastructural endowment indexes about transport modes: Is_{it} for the road, Ir_{it} for the rail and Im_{it} for the maritime. The parameter A_{it} describes (Hicks-neutral) productivity.

$$Y = F(A_t, L_t, K_t, Is_t, Ir_t, Im_t) \quad (1)$$

To measure logistics unobserved TFP, we follow the standard approach of estimating it as the residual of a production function; within this framework, TFP measures output variations that are not explained by input variations. We assume that regions’ international freight production technology can be described by a Cobb Douglas production function. This simple specification allows us to easily understand if relevant estimated coefficients and return to scale measures assume reasonable values that are coherent with economic theory. The positive effect of public capital on productivity may depend on correlated omitted variables. These omitted variables are regional specific characteristics, if these unobservable variables are omitted and are correlated with public capital, the coefficient which relates public capital to productivity is biased upward. The panel data framework allows to correct the bias: the individual term “reflects not just technology but resources endowments, climate, institutions, and so on” (Islam 1995).

To implement the Cobb-Douglas function requires the logarithms of both sides of the function. This mathematical transformation yield is the Cobb-Douglas function form as described as:

$$\ln Y_{it} = \ln A_{it} \sum_{k=1}^{K} \beta_{it} \ln X_{it} + V_{it} \quad (2)$$

where i = 1,….,n (n = number of entity unit), t = 1,….,T (t = number of time unit), Y_i is the output, A_{it}, is the unobservable TFP component that affects all marginal factors’ productivity simultaneously X_s are inputs, and V_i is *iid* $N \sim (0, \sigma^2_v)$, and captures uncontrollable factors in the process such as measurement error and other statistical noise.

To simplify notation, let us define $y_{it} = lnY_{it}$ and similarly for $A_{it}, L_{it}, K_{it}, Is_{it}, Ir_{it}, Im_{it}$, remembering the previous notation of the input variables. Then we can write:

$$y_{it} = a_{it} + \beta_1 l_{it} + \beta_2 k_{it} + \beta_3 is_{it} + \beta_4 ir_{it} + \beta_5 im_{it} \quad (3)$$

Here $a_{it} = lnA_{it}$ is interpreted as a measure of region level i's productivity at time *t*. If we write $a_{it} \equiv \beta_0 + \varepsilon_{it}$ then we can rewrite the model as (4) and we could interpret β_0 as the mean efficiency level across regions and over time; ε_{it} is the time-varying and region specific deviation from that mean which can then be further decomposed into an observable (or at least predictable) and unobservable component.

$$y_{it} = \beta_0 + \beta_1 l_{it} + \beta_2 k_{it} + \beta_3 is_{it} + \beta_4 ir_{it} + \beta_5 im_{it} + u_i + v_{it} \quad (4)$$

The estimating of equation (4) can be done with fixed and/or random time-invariant effects u_i of entity (individual or subject) or time.

Panel data models examine group (individual-specific) effects, time effects, or both. These effects are either fixed effect or random effect, a fixed effect model examines if intercepts vary across groups or time periods, assuming the same slopes and constant variance across entities or subjects, whereas a random effect model explores differences in error variances, assuming the same intercept and slopes. A *one-way model* includes only one set of dummy variables (e.g., entities), while a *two-way model* considers two sets of dummy variables (e.g., entities and year). So, the two general panel regression equations can be write as:

- *fixed group effect model*: $y_{it} = (\alpha + u_i) + X'_{it}\,\beta + v_{it}$;

- *random group effect model*: $y_{it} = \alpha + X'_{it}\,\beta + (u_i + v_{it})$.

The u_i is a fixed or random effect and error terms are *independent identically distributed*, v_{it} *~iid(0,* σ^2_v*)*.

Also the multidimensional panel data has received particular attention in the last few years. In particular, several model have been proposed in the literature (Baltagi *et al.* 2003, Matyas *et al.* 2011, Anderson 2010). Mostly fixed effects, specification have been worked out to take into account the specific three (or higher) dimensional nature and heterogeneity of these kinds of data sets. In three-dimensional panel data sets the dependent variable of a model is observed along three indices such as $y_{ijt},\ i = 1, \dots, N_1,\ \ j = 1, \dots\dots, N_2,\ and\ \ t = 1, \dots., T$. Any fixed effects three-dimensional panel data model can directly be estimated, by least squares (LS).

The specification of the fixed effects model is:

$$y_{ijt} = X'_{ijt}\beta + \alpha_i + \gamma_j + \lambda_t + \varepsilon_{ijt} \quad (5)$$

i=1,…….N_1, *j*=1,…… N_2, *t*=1,…….T

where α, γ and λ parameters are countries (regions), industrial sectors and time specific fixed effects, the *X* variables are the usual covariates, $\beta(K \times 1)$ the focus structural parameters ε is the idiosyncratic disturbance term.

The standard panel random effects specification is :

$$y_{ijt} = X'_{ijt}\beta + \mu_{ij} + \varepsilon_{ijt}$$

i=1,……. N_1, *j*=1,…… N_2, *t*=1,…….T

A natural extension of the previous model is the following:

$$y_{ijt} = X'_{ijt}\beta + \mu_{ij} + v_{it} + u_{jt} + \varepsilon_{ijt} \quad (6)$$

where $E(\mu_{ij}) = 0, E(u_{jt}) = 0, E(v_{it}) = 0,$ all random effects are pairwise uncorrelated, and:

$$E(\mu_{ij}\mu_{i'j'}) = \begin{Bmatrix} \sigma^2_\mu\ i = i' and\ j = j' \\ 0\ otherwise \end{Bmatrix}$$

$$E(u_{jt}u_{j't'}) = \begin{Bmatrix} \sigma^2_u\ j = j' and\ t = t' \\ 0\ otherwise \end{Bmatrix}$$

$$E(v_{jt}v_{i't'}) = \begin{Bmatrix} \sigma^2_v\ i = i' and\ t = t' \\ 0\ otherwise \end{Bmatrix}$$

Finally in our case the TFP at region, sector and time levels can be recovered as follows:

$$exp(\hat{a}_{ijt}) = y_{ijt} - \hat{\beta}_1 l_{ijt} + \hat{\beta}_2 k_{ijt} + \hat{\beta}_3 is_{ijt} + \hat{\beta}_4 ir_{ijt} + \hat{\beta}_5 im_{ijt} \quad (7)$$

Measurement of log TFP (i.e. lnA_{ijt}) requires estimates of the parameters β, following the production function approach (Klette, 1999), we can estimate these parameters from a regression of log international freight traffic (inbound and outbound) of each Italian region on log capital, log labour (employed workers),

log of transport infrastructural endowments and hence estimates log TFP as the residual of this estimated production function. The procedure for estimating TFP from the output measure in physical unit of the production function is similar to the estimation for the value-added base production functions. The difference is that there are additional parameters beyond the traditional production factors which account for the output elasticity of transport infrastructure regional endowment.

Evaluating TFP as a residual of a production function estimated on firm-level data implies some econometrics problems that may lead to biased estimates if not accounted, for example, about the possible endogeneity of input choice. Van Beveren (2012) provide a reviews on TFP regression estimation pros and cons. Again, since the random effects model consider the “not observable” effects stochastically, the main difference than the fixed effects model is the assumption that these effects are not correlated with the regressors of the model (for all *i* and *t*).

In our regional logistics TFP analysis we also intend to control for the “time-invariant heterogeneity” among the various regions due the geographical position, morphology, cultural linkages with other countries and other characteristics that are generally not correlated with the selected regressors but some other unobservable individual effect could be captured by the specific error term and cause a problem of endogenous regressors in the random effects model case. Instead, one side effect of the features of fixed-effects models is that they cannot be used to investigate time-invariant causes of the dependent variables. Technically, time-invariant characteristics of the individuals are perfectly collinear with the entity dummies. Substantively, fixed-effects models are designed to study the causes of changes within an entity and the TFP component is understood as an unobservable “entity-specific” but “time-invariant” effect that does not keep the temporal dimension into account and is not depending on some others potential cause of heterogeneity across entities.

Random effects models of time invariant heterogeneity are often very good (potentially better than fixed effects), in the our case the region are entities where is difficult that unmeasured factors, like managerial efficiency and other human quality inside the single firm, will be correlated with the explanatory variable such as to cause the random effects estimator to be inconsistent. So we can remove the possibility that a firm has knowledge of its unobservable error component u_i when making input choices, so these choices will be not correlate with this error component incurring endogeneity.

Our strategy of analysis start with the fixed effect “within” model which take the difference of each observation from the within-group time average and after running a random effect GLS regression, on the basis of the Hausman test result we considered the appropriate choice about the correct way to efficiently estimating the regional production function and the relative total factor productivity. The Hausman specification test (Hausman, 1978) compares fixed effect and random effect models. If the null hypothesis that the individual effects are uncorrelated with the other regressors in the model is not rejected, a random effect model is better than its fixed counterpart.

The Hausman test compares the coefficient estimates from the random effects model to those from the fixed effects model and the null hypothesis that the difference between the estimators is zero will be rejected for any reason that makes the two sets of estimate different, including a mis-specified model (Wooldridge, 2002).

The empirical analyses were carried out with panel data from Italian official source. In particular: the Italian Institute of Statics (ISTAT), the Tagliacarne Istitute/Unioncamere and the Prometeia economic research Italian company. The study focuses on the intermediate level of local governments to obtain more degrees of freedom. In particular, it uses data on 20 Italian regions (NUT2 of the EU). The time span encompassed by the study is from 2007 to 2012. Table 1 provides the definition of all the variables the present study uses.

Table 1 – Definition of Regional Input and Output variables

Type of variable	*Definition*	*Source*	*Unit*
Output	International road freight traffic	Prometeia	Tons
Output	International rail freight traffic	Prometeia	Tons
Output	International maritime freight traffic	Prometeia	Tons
Input	Roads endowment index	Tagliacarne/Unioncamere	Index Italy=100
Input	Rails endowment index	Tagliacarne/Unioncamere	Index Italy=100
Input	Ports endowment index	Tagliacarne/Unioncamere	Index Italy=100
Input	Net capital of firms - Transport and warehouse sectors	ISTAT	Euro deflated values 2007 (two digits NACE/ATECO 2007 codes: 49, 50, 52)
Input	Transport and logistics employees	ISTAT	Nr. (two digits NACE/ATECO 2007 codes: 49, 50, 52)

We apply the production frontier models (4) that indicate the maximum production capacity given the combination of available resources. The construction of the regional production model and the estimate of a logistics productivity is based on a hypothesis of a relationship between the technical facilities and the aggregate sectorial production factors (labour and capital) of the region and international traffic performance, by estimating the relationship with a Cobb-Douglas log-linear type production function. The definition of the output variable descriptive of the production process is the international freight traffic of each Italian region in tons. With reference to input variables, the explanatory variables selected to represent the labour factor and the physical and structural (capital factor) characteristics for the *i-th* regions as reported in table 1.

We construct the physical capital stocks of the firms for each region and each sector of interest by using the perpetual inventory method: $Kit = (1 - r)Kit–1 + Iit-1$, where Kit is the stock of physical capital of region *i* at time *t*, $Iit-1$ is the flow of gross investment in period $t-1$ that becomes productive in period *t* and *r* is the constant depreciation rate (constant depreciation rate of 8% is considered). The annual flows of fixed investments were deflated by gross fixed capital formation deflators and the mean annual rate of growth *g* for the period 2007 to 2012 is used to estimate the initial regional capital stocks: $K_0 = \frac{I_0}{g+r}$ (OECD, 2009).

4. Main results

The first step of our empirical analysis consists of the estimation of equation (4). All monetary variables have been deflated by the specific industry deflator. All variables are expressed in logarithms. Table 2 presents the results. As our data have a panel structure, we first estimate the production function by fixed effect within group estimator and the test on the significance of region-specific fixed effects suggests that these are strongly significant. Therefore, the inclusion of region specific fixed effects improves the estimation. The dummy variables capture unobservable time-invariant ‘industrial sector effects’ (such as skills, planning and management differences and location advantages/disadvantages) and region-invariant ‘time effects’ (such as central or local economic policy effects and geographic location advantages/disadvantages).

We also present an estimate including random effects in Table 3. To see if there are random effects we have carried out the Breusch-Pagan Lagrange Multiplier (LM) test. The null hypothesis is that individual-specific or time-specific error variance components are zero. If the null hypothesis is not rejected, the pooled OLS is preferred; otherwise, the random effect model is better. In our case study the test shows the presence of the random effects (p-value = 0.0000) and these are again significant. However, a random effects model assumes that there is no correlation between explanatory variables and region effects. We then perform the Hausman test in order to catch differences between fixed and random effects estimates and choose between the two alternative specifications. We cannot reject the null hypothesis with a p-value of 0.6760 well above the critical value of 0.05 and a $\chi^2(12) = 9.31$. As the matter of fact, under H_0 the RE is the best (the estimation GLS is BLUE), while, under H_1, the statistics properties of the estimator GLS of the RE are not

met. Therefore the test suggests estimating the model with GLS. We choose GLS random effects as our correct specification of the model. The fixed effects specification produce good results in terms of the general statistical power of the model but less satisfying results for the expected signs of the coefficients. In fact the coefficient of port endowment is not significant and entered with the wrong sign together with the capital of the transport and logistics firms localised into the region which presents a not significant coefficient. The random effect specification produce correct and significant coefficient for all the variables considered in the production function assumptions.

Table 2 - Estimation results FE within model

Variable	Coefficient	Std. Err.	t	P>|t| or F
ln_indroad	0.4652503**	0.1873311	2.48	0.014
ln_indrail	0.9177569***	0.1811202	5.07	0.000
ln_indports	-0.0885805	0.412891	-0.21	0.830
ln_emp	0.3479376***	0.1037504	3.35	0.001
ln_cap	0.0837714	0.0630636	1.33	0.185
y_2008	0.2044018	0.3370547	0.61	0.545
y_2009	-0.7535942**	0.3364915	-2.24	0.026
y_2010	-0.364089	0.3378732	-1.08	0.282
y_2011	-0.4811725	0.3386398	-1.42	0.156
y_2012	0.2043939	0.3366873	0.61	0.544
Sector_50	2.773204***	0.443366	6.25	0.000
Sector_52	2.202403***	0.2516105	8.75	0.000
Constant	-3.32053**	1.546.631	-2.15	0.033
Observation	360			
R^2 *within*	0.5000			
R^2 *between*	0.6249			
R^2 *overall*	0.5449			
F test on model's coefficients	F(12,328) = 27.33			0.000
σ_u	1.5381481			
σ_e	1.8160262			
$\rho = \sigma_u^2/(\sigma_u^2 + \sigma_e^2)$	0.41771928			
Test on fixed effects	F(19, 328) = 5.57			0.000
Test on time/sector dummies	F(7, 328) = 14.32			0.000

Notes: Dependent variable is lnY_{it} the log of the international freight inbound and outbound traffic for each Italian region. ***, **, * indicates the significance at 1%, 5% and 10% level respectively. Test on effects provides an F test that all fixed effects are equal to zero. F test on time/sector dummies tests the null hypothesis that all dummies are statistically equal to zero.

Table 3 - Estimation results GLS random effects model

Variable	Coefficient	Std. Err.	t	P>|t| or F
ln_indroad	0.490639**	.1756491	2.79	0.005
ln_indrail	0.732879***	.1656725	4.42	0.000
ln_indports	0.3339487***	.0793271	4.21	0.000
ln_emp	0.4292227***	.0983506	4.36	0.000
ln_cap	0.1047741*	.0617855	1.70	0.090
y_2008	0.1901101	.3444991	0.55	0.581
y_2009	*-0.7121175***	*.344137*	*-2.07*	*0.039*
y_2010	*-0.3184603*	*.3454922*	*-0.92*	*0.357*
y_2011	*-0.5824369**	*.344144*	*-1.69*	*0.091*
y_2012	0.1873755	.3440525	0.54	0.586
Sector_50	3.10516***	.4116817	7.54	0.000
Sector_52	2.212915***	.2569081	8.61	0.000
Constant	-4.982684***	.8119432	-6.14	0.000
Observation	360			
R^2 *within*	0.4943			
R^2 *between*	0.8099			
R^2 *overall*	0.6426			
Wald test on model's coefficients	$\chi^2(12)$ = 442.42			0.000
σ_u	0.65513478			
σ_e	1.8160262			
$\rho = \sigma_u^2/(\sigma_u^2 + \sigma_e^2)$	0.11515536			
BP test on random effects	$\chi^2(1)$ = 77.65			0.000
Test on time/sector dummies	$\chi^2(1)$ = 104.54			0.000

Notes: Dependent variable is lnY_{it} the log of the international freight inbound and outbound for each Italian region. ***, **, * indicates the significance at 1%, 5% and 10% level respectively. Breush and Pagan Lagrangian multiplier test provides an χ^2 test for random effects. χ^2 test on time/sector dummies tests the null hypothesis that all dummies are statistically equal to zero.

We recover the regional measure of transport and logistics TFP as the difference between observed and predicted output in the estimation of the random effects production function (equation 7). Figure 1 and 2 show the average TFP for the three sector together considered in the analysis. In tables 4, 5 and 6 are reported the transport and regional logistics productivity ranking based on the average TFP for the years 2007-2012 divided for the three sectors considered.

Figure 1 – Average transport and logistics TFP levels for Italian Regions 2007-2012 (sectors 49,50,52)

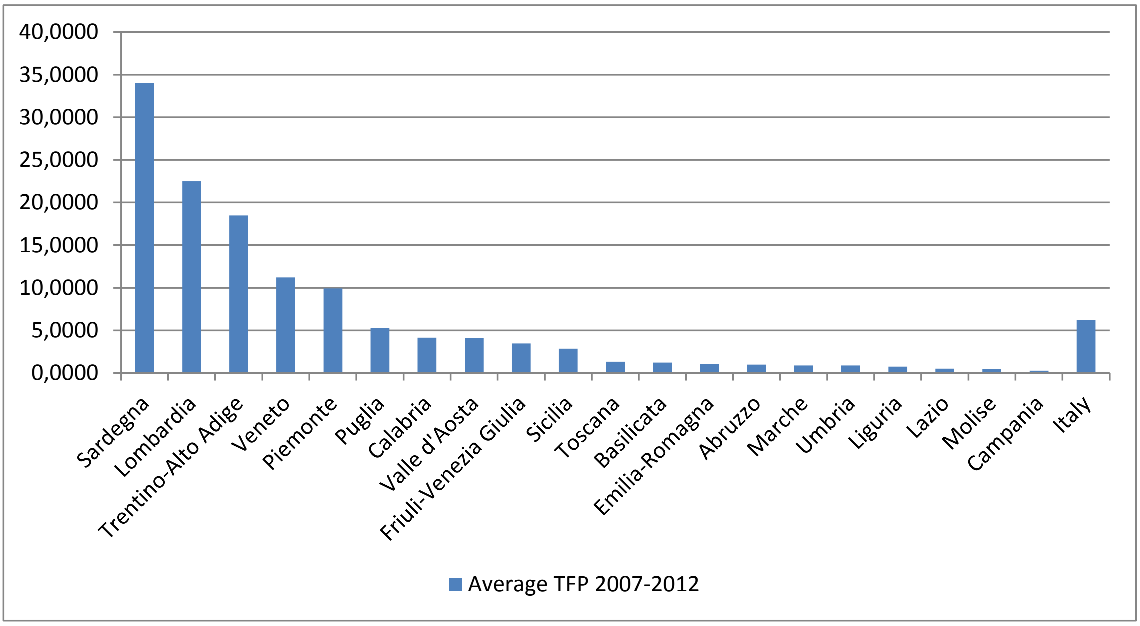
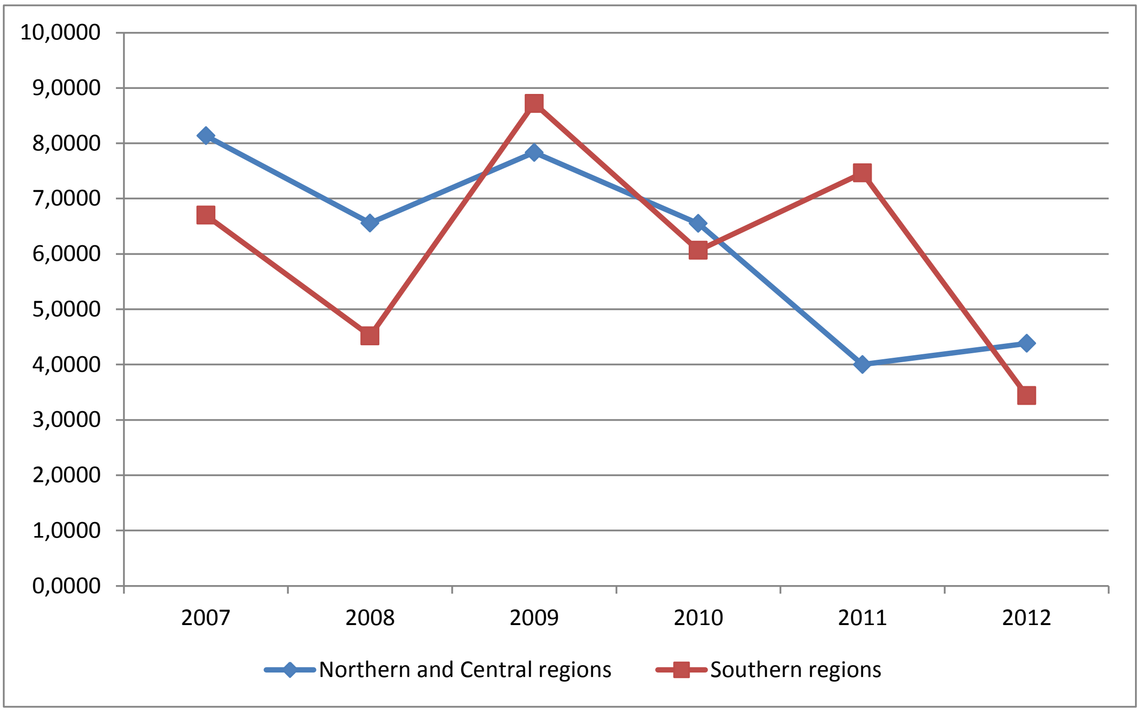


Figure 2 - Average TFP levels for Central-Northern and Southern macro-regions1 2007-2012 (sectors 49,50,52)



[1] Central-Northern is composed of the regions: Piemonte, Valle d'Aosta, Lombardia, Trentino Alto Adige, Friuli, Liguria, Emilia Romagna, Toscana, Umbria, Marche and Lazio. Southern is composed of the regions: Abruzzo, Campania, Puglia, Basilicata, Calabria, Sicilia and Sardegna.

Table 4 – Logistics productivity ranking for the Italian regions – sector 49

Region	*Average TFP 2007-2012*	*TFP CAGR 2007-2012*
Lombardia	63,4150	-7,6%
Trentino-Alto Adige	47,0078	9,4%
Piemonte	26,5653	-0,6%
Valle d'Aosta	9,7240	4,4%
Friuli-Venezia Giulia	3,9435	13,7%
Veneto	3,9423	-0,4%
Basilicata	1,5510	-2,5%
Emilia-Romagna	1,4973	-1,4%
Umbria	0,8501	-14,8%
Marche	0,5758	-5,2%
Toscana	0,5578	-5,7%
Abruzzo	0,5409	-3,9%
Sardegna	0,39	-1,1%
Lazio	0,3631	-10,9%
Puglia	0,3316	-10,2%
Liguria	0,3060	7,1%
Campania	0,2862	-3,8%
Molise	0,2700	-12,6%
Sicilia	0,2010	-11,2%
Calabria	0,0739	-3,7%
Italy	*8,1197*	*-3,05%*

Table 5 – Logistics productivity ranking for the Italian regions – sector 50

Region	*Average TFP 2007-2012*	*TFP CAGR 2007-2012*
Sardegna	81,75	-14,8%
Puglia	12,016	-2,9%
Calabria	9,3937	-6,6%
Sicilia	4,5375	-24,7%
Veneto	3,2045	-8,2%
Friuli-Venezia Giulia	3,1759	2,2%
Toscana	2,7679	-11,8%
Abruzzo	2,3017	76,0%
Basilicata	1,7852	38,2%
Umbria	1,7041	40,0%
Valle d'Aosta	1,6861	46,2%
Emilia-Romagna	1,0753	-10,1%
Liguria	0,9841	-8,0%

Molise	0,9507	87,3%
Marche	0,8858	0,4%
Lazio	0,7949	-2,2%
Trentino-Alto Adige	0,6016	3,1%
Piemonte	0,3056	92,0%
Campania	0,2298	2,4%
Lombardia	0,1682	5,1%
Italy	*6.5160*	*15.19%*

Table 6 – Logistics productivity ranking for the Italian regions – sector 52

Region	*Average TFP 2007-2012*	*TFP CAGR 2007-2012*
Veneto	26,4618	-58,8%
Sardegna	19,88	-4,0%
Trentino-Alto Adige	7,8186	7,1%
Lombardia	3,8324	-10,7%
Sicilia	3,7575	-3,9%
Puglia	3,5814	-6,0%
Friuli-Venezia Giulia	3,2249	0,1%
Calabria	2,9688	-3,1%
Piemonte	2,8772	-1,0%
Marche	1,2054	3,7%
Liguria	0,9229	-5,5%
Valle d'Aosta	0,7703	6,9%
Toscana	0,5869	-10,1%
Emilia-Romagna	0,5551	-4,1%
Lazio	0,3082	-2,9%
Basilicata	0,2815	-6,6%
Campania	0,2527	0,4%
Molise	0,1540	7,2%
Abruzzo	0,1357	3,9%
Umbria	0,1070	-16,1%
Italy	3.9839	5.17%

5. Concluding remarks

This study attempts to evaluate the logistics productivity of Italian NUT2 of the European territorial classification, called Regions, by measuring their logistics total factor productivity and, more importantly, to examine the effects of the multimodal transport infrastructural endowment together considered in an unique microeconomic production function context with the traditional input factors like labour and capital. The empirical analyses were carried out with a panel data on 20 Italian provinces over the period 2007-2012

utilizing an original panel dataset built by the authors on several sources. The results are very different with reference to the geographic position and the economic sector considered, a large degree of heterogeneity among the Italian regions is confirmed. Some features are evident:

1) different regions exhibit very different transport and logistics total TFP levels along the sample period as Figure 1 shows, with the northern regions that have the higher level in the period except Sardegna which it seems to be a particular island-case;

2) TFP levels of Northern and Central regions (North) are substantially not so bigger than the ones of Southern regions (South) if is considered the annual TFP of all three sectors, as evident from Figure 2;

3) TFP levels of Northern and Central regions are substantially bigger than the ones of Southern regions in the sector 49 - terrestrial transport. The regions bordering foreign countries of the Alps presents the higher level of productivity relative the international freight traffic;

4) the situation is very different in the sector 50 - maritime transport, where many Southern regions have a preeminent level of productivity (Sardegna, Puglia, Calabria e Sicilia), evidently resulting from the presence of important ports;

5) about the sector 52 - warehousing and support activities for transportation the results are more influenced by the logistics activity linked both to the terrestrial and maritime international freight transport. In fact the ranking shows a mix situation between Northern, Central and Southern regions.

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