Technical efficiency and regional disparities in Italy

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Abstract

This paper is a contribution to the literature on Italy's regional disparities with a focus on the nature and determinants of firms' technical efficiency. Our analysis concerns a vast number of Italian firms for the decade 2008-2017 and considers the universe of firms that are annually obliged to deposit their balance sheet. A frontier stochastic analysis is used as a method for estimating the technical efficiency of each firm. Our results offer a detailed representation on a provincial basis of disparity gaps. Moreover econometric analysis provides convincing evidence on the importance of territorial variables in the determinants of technical efficiency.

Keywords: Technical Efficiency, regional disparities, stochastic frontier analysis, Italian firms

JEL classification codes: D24, O47, P16, R1

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1. Introduction

In the last two decades, economists and economic historians have devoted considerable research efforts to represent and explain the ultimate causes of Italy's disappointing economic performance and relative long-term decline (for a general survey, see Ciocca 2018). Most scholars agree that the structural fall of factors' productivity must be singled out as the prime explanation of this negative trend in Italy's postwar economic history and the most alarming signal that authorities should focus in the design of policy interventions.

As is well known, ever since the dawning of the first industrial revolution, "productivity" was identified as the major engine of long-run economic prosperity, but also as a very complex phenomenon to estimate, represent and explain. Nowadays, economic research is still very active in the attempt to disentangle proximate and remote causes and variables that affect factors' productivity trends. In particular, a large literature has studied the impact of both economic and meta-economic factors – external and internal to the firm – in the determination of firms' productivity. Many efforts have been undertaken to build up strong and consistent relations between cultural, sociological and institutional elements on one side, and the average evolution of firms' performance and their impact on macroeconomic aggregates on the other.

However, so far not much has been done to analyze and try to explain in a comparative fashion the "technical efficiency" of a vast number of firms – a number that is relatively close to the universe – that operate in all productive sectors of the Italian economy taken together. The two words "productivity" and "technical efficiency" are often taken as synonyms. However, they represent two different analytical dimensions. While productivity is a measure of the input-output relationship, efficiency measures the different capacity of using available factors. From this perspective, estimating the levels and the dynamics of firms' technical efficiency can provide useful knowledge also in relation to its major determinants. From the different constraints imposed by the external environment to the investment and managerial decisions undertook by each productive unit; from the different quality of institutions – broadly understood as the protection of rights and the efficient provision of services – to the internal organization and dimensional structure of the firm. Moreover, relevant variables that can explain the evolution of firms' efficiency may change significantly between macro-areas but also within macro-areas. A study of this subnational heterogeneity may provide new, fruitful insights on the sources of regional disparities and some suggestions for more tailor-made policy interventions.

In this perspective, the main objective of this paper is to provide an original contribution to the estimate, representation and, hopefully, explanation of the levels and dynamics of firms' technical efficiency at a very disaggregated level and in a comparative fashion within and between macro-areas. The paper is structured as follows. In paragraph 2, we shall briefly recall some insights coming from the vast literature on territorial divergences that can be useful for our purposes. In paragraph 3, we shall address all methodological issues in relation to: the construction of our data set; the definition of technical efficiency; the selection and sources of all relevant variables, both

internal and external to the firm; the basic structure of the model that was implemented to represent and establish determinants of technical efficiency in a territorial perspective. The main results of our elaborations are then discussed in paragraph 4. Finally, in paragraph 5 we briefly present our conclusive remarks on what are the main novelties and confirmations that arise from our analysis.

2. Territorial inequalities and technical efficiency in historical perspectives

As is well known, trends toward more relevant territorial divergences have been a common feature for many European countries, particularly since the neo-liberal turn of the 1980s. It is now commonplace to identify territorial divergences – together with income inequalities – as a factor of threat and political concern for more sustainable economic growth and social cohesion. Many empirical studies have shown that the slowdown in European growth rates since the 1970s and more specifically in the new millennium has followed a very uneven trajectory, with a few dynamic metropolitan regions and many declining industrial areas at the two opposite poles (Rosés and Wolf, 2018b).

In this picture, within Europe, Italy stands out as the country where territorial inequalities have proven to be both most substantial and persistent: nowadays, no advanced economy is so unevenly performing as Italy, with Lombardy alone that produces more than one fifth of the Italian GDP, almost the whole GDP produced by the eight Southern regions altogether. As is well known economic divergences do not stand alone. Different strands of scientific literature have shown how these territorial imbalances do not exclusively pertain to the structure of relevant markets or the key macro-economic fundamentals (beginning with labor and per capita income). In fact, regional discrepancies can also be mirrored according to many specific socio-economic features: basic infrastructures; the access to services (public and private); the accumulation of human capital, including levels of education attainments; different indicators of social capital; the quality of institutions (government, bureaucracy, corruption, rule of law etc.); the differences in business models and the dimensional structure of the firms. Finally, territorial divergences have worsened in the first decade of the new millennium: the great financial crisis together with some exogenous developments that more negatively affected the less developed regions. Among them, as has been recently argued (Viesti, 2018), one can count the globalization threat, the fierce competition coming from Eastern Europe and the generally restrictive pressures imposed by domestic economic policies, particularly on public investments and the capital account. As a consequence, Italy's Southern regions seem to be unpleasantly stuck in a typical "intermediate development trap", characterized as they are by premature de-industrialization, an unexpected wave of demographic shocks (ageing, brain drains etc.), together with the incapacity to develop an advanced tertiary sector and resist competitive challenges coming from emerging markets. Moreover, public sector inefficiencies negatively affect trends of labor productivity of the private economy, thus reducing further the general competitiveness (Giordano et al., 2015). A sort of suboptimal equilibrium, from which it seems very difficult to escape.

Historically, economic growth and territorial convergence depend on the accumulation of technology and physical capital whose positive effects are significantly strengthened by the accumulation of social and human capital. For a long time, the rich literature on the "Southern

question" has stressed the importance of economic variables, initial conditions and local pre-requisites. Among them, great attention has been put to the dynamics of public and private investments, to geographical and localization factors, to the role of economic policy in stimulating business opportunities. In fact, the last important episode of significant North-South convergence that occurred in the postwar decades (1951-1973), was driven by a strong cycle of public and private investments in infrastructures, heavy industries, energy and public utilities. During those years of Italy's "economic miracle", the average rate of capital accumulation remained systematically higher in the South, with a maximum differential of 16 points in 1971. Things changed drastically after that date. The average rate of net capital accumulation in the South systematically fared worse with respect to the rest of the country ever since the early 1970s. It first declined in the 1980s, then collapsed in the 1990s and finally became negative after 2008 (Iuzzolino, Pellegrini and Viesti, 2011).

Among the more "remote" determinants of economic growth, the literature on Italian regional divergences confirm the existence of long lasting socio-institutional differences that help explain the roots of economic dualism. The basic idea is that local contexts and the different features of the institutional framework have shaped in a fundamental way the incentives to invest, the adoption and diffusion of new technology, the fruitful breeding of ecosystems of innovative and internationalized firms. An increasing number of indicators has been constructed in recent years to find quantitative support about the importance of these meta-economic explanations. Indeed, they have confirmed the existence of deep social disparities at a regional level, both in the accumulation of social capital and in the average quality of institutions. Moreover, differences in education standards, the efficiency of the judicial system, the enforcement of law and the availability of public services and collective goods have been growing through time, often replicating a traditional "North-South" pattern (Felice, 2011 and 2017; Nifo and Vecchione, 2014). Taken together, all these factors have created in Southern Italy an economic environment less favorable to the development of a market economy and to the prospects of an endogenous growth based on a more optimal exploitation of local resources and comparative advantages. As Charron, Dijkstra and Lapuente (2015) have argued, increases of transaction costs also depended on the greater pervasiveness of illegality: "in the historically slow growing regions of Southern Europe, poor quality government, historically pervasive corruption, collusion and lack of trust are more of a barrier for development than a shortage of assets".

In this light, one fruitful research perspective is to strengthen our focus on Southern heterogeneity and try to learn more from the variables and the processes that can ultimately explain it. Many studies, in fact, have challenged the conventional wisdom of a South characterized by uniform backwardness and static economic performance (Iuzzolino, Pellegrini, Viesti, 2011). Other studies have somewhat enriched this literature, in the attempt to identify the micro-foundations of social processes and institutional change that have allowed an increase of innovations, exports and growth thanks to firms operating in backward areas and under many environmental constraints (Fondazione Res 2010, 2013). Using different indicators and qualitative evidences from field surveys and case studies, all these works provide a picture of the South characterized by a much greater heterogeneity.

However, new questions arise. Are these differences in economic and institutional constraints spread in a rather uniform manner within the South? How do they impact on firms' productive

performance and efficiency? Can we attempt to measure the relative importance of "internal" and "external" determinants according to sectoral specialization in different areas? Does the peculiar entrepreneurial structure of the country – dominated as it is by the pervasiveness of micro-units – provide useful insights for the determination of technical efficiency levels? Does the analysis of the determinants of technical efficiency help us in any was to explain the many successful entrepreneurial stories that do occur in backward Southern provinces?

Therefore, if the South is getting behind the rest of the country and is an important part of the story of Italy's general economic decline, it is also becoming increasingly polarized between areas where obstacles and pitfalls are ruling out any prospects for development and areas where growth is underway – obstacles and pitfalls notwithstanding. As we try to show in the next paragraphs, our elaborations confirms that, if we represent the country according to firms' technical efficiency, the picture that we get is more fragmented and multifaceted. Thus, a closer look at the lowest stage of the production function – i.e., at the firms' level – can lead us to identify and understand new sources and explanations of infra-regional dynamics and local development.

3. Methodology and data

The productive process is often defined as a "black box" where inputs are transformed into output. A process of transformation that depends on the available technology and the entrepreneurial skills to use knowledge and organize productive factors in an optimal way. Under many circumstances, these conditions can be influenced by the general territorial environment in which firms operate and are localized.

If we assume that optimal conditions of production exist, inefficiency can be defined as all, possible deviations from such standard. The greater such deviations are from optimal conditions, the higher is the level of inefficiency shown by firms. In other word, inefficiency is a measure of the incapacity of each firm to produce under optimal conditions.

Optimal production conditions represent the hypothetical frontier of productive possibilities and its highest level of output, given technology and the availability of productive factors. As a technical way to estimate the productive frontier, we can follow two different approach: non-parametric methods (such as, for instance, the Data Envelopment Analysis – DEA); or parametric methods (such as the Stochastic Frontier Analysis – SFA). Non-parametric methods adopt linear techniques of mathematical programming that do not require any specification about the production function while, at the same time, assume away the existence of any stochastic error. Conversely, parametric methods imply the necessity of an a-priori specification of the functional form of the production function and offer the opportunity to distinguish between a stochastic error and individual inefficiency (Fried, Lovell and Schmidt, 2008).

Within the family of parametric methods, Aigner, Lovell and Schmidt, 1977 together with Meeusen and van den Broeck, 1977 first introduced the idea of stochastic frontier models. The basic idea of these models is that individual inefficiency is not entirely under the firms' determination but is also quite likely to depend on exogenous factors. Some external conditions to the firm, such as for instance the general "entrepreneurial environment" or the provision of infrastructures or the quality

and pervasiveness of public expenditure, can affect the individual level of production under many ways. Hence, while keeping such factors under control, more accurate measures of inefficiency can be accomplished that identify more precisely those factors that are under the direct control of firms.

For this reason, in this paper, we have followed this strand of the literature. More specifically, following the work of Battese and Coelli (1995), we have used the following production function in order to estimate the frontier and measure the relative technical inefficiency of each firm:

$$y_{it} = \alpha + \beta_k K_{it} + \beta_l L_{it} + \epsilon_{it}$$

where y_{it} represents the natural log of the output produced by the firm i at the time t. K_{it} is the natural log of the stock of capital used by the firm i at the time t. L_{it} is the natural log of labor used by the firm i at the time t. β_k e β_l are, respectively, the returns associated to capital and labor. ε_{it} is a stochastic error term.

In particular, we assume the error term as composed by the difference between a term representing a measurement and specification error (v_{it}) and a term representing the "technical inefficiency" (u_{it}):

$$\varepsilon_{it} = v_{it} - u_{it}$$

where

$$v_{it} \sim N(0, \sigma_v^2)$$

$$u_{it} \sim N^+(\mu_{it}, \sigma_u^2)$$

We also assume that both v_{it} and u_{it} are independent from each other and i.i.d. accross observations.

In order to keep into account the impact of exogenous factors on the technical inefficiency of individual firms, we parametrize the average distribution of technical inefficiency (μ) as follows:

$$\mu_{it} = \gamma + \delta_z z_{it}$$

where z_{it} represents a vector of exogenous variables that characterize a specific territory i at the time t and that are potentially able to affect the inefficiency of each productive unit operating in the same territory. γ is the constant term to be estimated. δ_z is the vector of unknown parameters to be estimated (the so called "inefficiency effects").

Our econometric analysis, therefore, enables us to provide a joint estimate of both the productive frontier and the individual inefficiency together with the likely impact that exogenous variables have on the same inefficiency. This is an important achievement outcome since it allows to obtain overcome the limitations of the so-called two-steps approach. While dealing with the exogenous determination of inefficiency, scholars have often followed a so-called "two steps approach". The first step entails the estimate of inefficiency; the second regards the correlations between inefficiency and the exogenous variables (Green 2012). However, this procedure has not been immune to criticism, basically because all variables that are assumed to be relevant for the second step turn out to be completely overlooked in the first. On these grounds, Wang and Schmidt (2002) convincingly show that the two-steps approach leads to severely biased results. From this angle, our

model is based on simultaneous estimations and consistently overcomes the typical limitations of the two-steps approach.

However, if consider technical inefficiency as to represent the deviation between an individual firm and the optimal productive frontier, it seems possible to envisage the same phenomenon in reverse, under a positive perspective. In other words, the achievements of each firm can be taken as to represent its individual capacity to target the productive frontier. Under this different perspective, the values obtained are an indication of the technical efficiency (TE). For its measurement, we follow what was originally suggested by Battese and Coelli (1988):

$$TE = exp(-u_{it})$$

Under these conditions, TE can take values between 0 and 1. The higher its value, the closer each firm is to the productive frontier, namely to its optimal conditions of production.

For our purposes we have used the data base AIDA provided by Bureau van Dijk. AIDA collects and classifies data from balance sheets from a massive number of firms: joint stock companies, cooperative firms, consortia, insurance companies, domestic subsidiaries of foreign companies, European groups of significant economic interests, local institutions. In this way, we have used the whole universe of Italian firms that are legally obliged to deposit their annual balance sheet in a public "company register" (according to the art. 2435 of the Italian civil code).

For the years 2008-2017, a total of 9.402.820 firms were extracted from AIDA. For different reasons (bankruptcies, liquidation, missing data etc.) the number of available items was considerably reduced to 3.739.733. With respect of this set, 28.84% of firms were localized in the North-West, 20,36% in the North-East, 25,21% in the Center, 18,51 in the South and 7,07% in the two main islands (Sicily and Sardinia). Table 1 provides a general overview of the number of observations distributed for each year.

Tab. 1. Number of observations, by year

Year	Observations
2008	316164
2009	328612
2010	346832
2011	363868
2012	376493
2013	390898
2014	407891
2015	430114
2016	411487
2017	367374

From the balance sheets, we selected the following data: value added, as a measure of output; total assets, as a measure of the stock of capital; labor costs as a measure of the contribution of labor in the productive process. Value added considers the value of production and the consumption of raw

materials. For this reason, it is taken as a proxy of the wealth produced by each individual firms through production. Total assets represent the whole capital that has been used by the firm: buildings, machines, plants but also the value of patents and licenses, expenditures in R&D, the purchase of stakes in other enterprises, advertisement costs, and working capital. Labor costs consider both the number of employees and the qualitative dimension of labor. Higher labor costs with the same number of employees imply a higher level of human capital.

Using data from balance sheets, we were able to build up a number of indicators, which were useful to capture the territorial impact on the individual inefficiency of firms. Such indicators were obtained on a provincial basis for each year under observation. The first indicator – K_prov – represents the overall capital used by firms localized in a certain province. Our intent is to verify, within our data set, the validity of Romer (1986) assumption that the internal accumulation of capital produces positive externalities thus reducing the inefficiency of each individual firm. The second indicator – iBalassa_prov – measures the territorial specialization and is determined (*a là* Balassa) on the basis of the number of employees per productive sector. In this case, our assumption is to verify whether a higher concentration of workers in the same economic sector can reduce inefficiency through informal learning or a more speedy diffusion of knowledge. The third indicator – iOperEster_prov – represents the number of employees in internationalized firms (both imports and exports). This indicator is useful to test whether, on the basis of our evidences – a deeper international openness engenders specific learning processes thus promoting the absorption of new technologies or the construction of new competences (Clerides, Lach and Tybout, 1998). A fourth indicator – iDensità_prov – represents the degree of diffusion of entrepreneurial activities within each territory and is attained by considering the number of firms and the number of residents. Our assumption here is to verify whether a more widespread entrepreneurial activity causes positive externalities through more market oriented attitudes. Finally, a fifth indicator – iDimensione_impr_pro – represents the average dimension of firms for each province and is constructed using the number of employees. Our objective in this case is to estimate whether specific territorial dimensions may generate spillovers effects and, in this way, contribute to the reduction of inefficiencies.

To the five provincial indicators, we have added two regional indicators using data on public expenditures coming from the General Accounting Office (Ragioneria Generale dello Stato). More precisely, the first indicator is a simple measure of the regional dimension of public expenditure p.c., while the second is a measure of the regional public expenditure for transportations and communications. Our analysis tries to validate the assumption that public intervention can reduce levels of inefficiency and, most specifically, its impact can be significant through investments in local transportation and communication means.

One final remark regards the specification of our productive function. Since it can entail different results according to the different sectors, we have repeated our estimates for 11 different sectoral aggregations. Our diversification follows the Eurostat/OECD classification that distinguishes manufacturing activities according to the technological intensity while services are aggregated according to their specific knowledge content. For the manufacturing sectors, we consider “high technological intensity” industries (HIT), “medium high technological intensity” industries (MHT), “low technological intensity” industries (LOT). As to services, we distinguish between “high technology services” (HITS), “knowledge intensive market services” (KWNMS), “knowledge

intensive financial services" (FIN) and "other services" (OTHER). Finally, we have also decided to produce separate estimates for all firms operating in such sectors as "Mining & Energy", "Construction" and "Farming & Fishing".

4. Results

In order to determine the parameters of our model we followed a method that estimates the maximum likelihood through an application developed for panel data in stochastic frontier models and published by Bellotti et al. (2013).

Tables 2, 3 and 4 summarize the results of our estimates. Tab. 2 provides estimates referred to the manufacturing sectors distinguished by technological intensity. Tab. 3 provides estimates referred to services. Tab. 4 provides estimates referred to the primary sector and the two other aggregates from manufacturing: Mining & Energy" and "Construction. Besides all estimates referred to the productive frontier (Frontier), each table show estimates of parameter μ (Mu), namely the effects of exogenous variables on the technical inefficiency of firms. Among the parametric variables we also decided to introduce a time variable, "timeT", expressed as the difference between the year of observation and the first year of our historical series. This variable tries to capture possible changes of inefficiency through the decade under observation.

As Table 2 shows all estimated parameters in the section referred to the productive frontier present a high statistical significance. Moreover, it shows that the output contribution of the capital stock has a downward trend in line with the reduction of the technological intensity of all industries under observation. As expected, we record an increase in the labor contribution.

If we then consider the relevance of the exogenous variables (parameter Mu, Tab. 2), we observe relevant differences among the various groups of firms. No coefficient estimated for HIT firms shows any statistical significance. This result is confirmed for two other sectoral aggregates: FIN (Tab. 3) and "Mining & Energy" (Tab. 4). In other words, for these specific sub-groups of firms, territorial localization is quite irrelevant as far as their technical efficiency is concerned. Quite likely, for the nature of markets in which they operate (big dimensions, transnational) these firms are rather immune from territorial conditionality.

Quite different, by contrast, is the impact that exogenous variables exert on those firms operating in MHT, MLT e LOT. More specifically, for "medium-high technological intensity" firms, our evidences show that firms have a lower inefficiency if they operate in more specialized territories, enjoying a higher concentration of internationalized firms and if the entrepreneurial dimension is higher (in terms of number of employees). Moreover, a reduction of individual technical inefficiency occurs if, at a regional level, we have a higher public expenditure in transportation and communications. As regards "medium-low technological intensity" firms, it seems that efficiency is positively correlated to capital accumulation, both private and public. Again, in this case we record lower inefficiency levels where the degree of territorial specialization increases, together with the number of internationalized firms, the entrepreneurial density, the average structural dimensions, the amount of public expenditures. Such correlations are confirmed for the group of "low

technological intensity" firms – with the sole exception of the number of internationalized firms that, in this case, loses statistical significance.

It seems interesting to put specific emphasis on the role of public expenditure on the level of inefficiency of manufacturing firms. If p.c. public expenditures exert negligible effects (if not an adverse effect as it occurs for the "medium low technological intensity" firms), the specific quota of public expenditure directed to transportation and communication means is a significant factor for the reduction of individual technical inefficiency.

Tab. 2. Estimation of model parameters. Manufacturing

	HIT	MHT	MLT	LOT
Frontier				
ln_L	0.398***	0.452***	0.501***	0.498***
	(0.00210)	(0.000922)	(0.000835)	(0.000745)
ln_K	0.534***	0.467***	0.418***	0.411***
	(0.00228)	(0.000974)	(0.000841)	(0.000764)
Constant	0.789***	0.985***	1.034***	1.125***
	(0.0179)	(0.00811)	(0.00726)	(0.00732)
Mu				
ln_K_prov	7.095	24.15	81.59***	-30.61
	(20.28)	(16.38)	(18.15)	(20.31)
ln_iBalassa_prov	-144.9	-298.3***	-325.8***	-223.9**
	(90.50)	(90.03)	(58.46)	(92.91)
ln_iOperEster_prov	-58.61	-39.22**	-86.26***	24.36
	(40.12)	(15.34)	(16.81)	(13.39)
ln_Gpc_reg	170.0	-14.48	163.8***	1.301
	(140.9)	(53.73)	(44.74)	(44.39)
ln_iSpesTrasp_reg	-151.6	-459.2***	-357.5***	-398.2**
	(135.2)	(147.2)	(72.05)	(169.4)
ln_iDensità_prov	97.84	127.0	-335.7***	-237.8**
	(122.2)	(67.55)	(71.95)	(112.3)
ln_iDimensione_impr_pro	-552.3	-471.7***	-810.1***	-569.7**
	(339.6)	(147.8)	(145.6)	(237.5)
timeT	26.13	-37.13***	-27.94***	-20.03**
	(18.93)	(12.48)	(6.397)	(9.602)
constant	-2,051	-1,712**	-3,658***	-2,232**
	(1,504)	(720.5)	(750.4)	(1,069)
sigma_u	35.85744	36.0729	29.80475	36.78701
sigma_v	.3769023	.3618688	.3218702	.3745132
Log likelihood	-3.213e+04	-1.513e+05	-1.455e+05	-2.241e+05
Observations	44,209	232,360	276,936	327,931

Tab. 3 shows the results of our estimates for firms operating in services. In this case, parameters related to the productive frontier show that a reduction in the contents of knowledge engenders a

reduction in the output contribution of capital and labor. All parameters present a high statistical significance.

If we, again, put our attention to the influence of exogenous variables on the levels of inefficiency (parameter Mu, Tab. 3), some of the above mentioned relations find further confirmation. The aggregate stock of capital at the provincial level has little influence on efficiency standards and is also likely to produce adverse consequences (as, for instance, for "knowledge intensive market services" and for firms operating in "other services"). Conversely, statistically significant and inversely correlated with technical inefficiency are the effects produced by such territorial variables as the degree of productive specialization and the entrepreneurial dimension. The presence of internationalized firms produce ambiguous results. Internationalized firms help to reduce the inefficiency of firms operating in "high technology services" while opposite results occur for firms operating in "knowledge intensive market services". Also quite controversial is the impact of a varying degree of entrepreneurial density. Whenever it is higher, we record a lower inefficiency for firms in "high technology services" and "knowledge intensive market services. However, the opposite occurs for firms classified in the aggregate "other services".

As to the incidence of our regional indicators of public expenditure, firms operating in "high technology services" and "knowledge intensive market services" follow the same pattern of manufacturing firms: p.c. public expenditures generate negligible effects while specific public resources invested in transportation and communication exert a positive impact on the efficiency levels of individual firms. A sole exception in this respect, regards firms operating in "other services", for which we have an inversion of the sign.

Tab. 3. Estimation of model parameters. Services

	HITS	KWNMS	FIN	OTHER
Frontier				
ln_L	0.401***	0.362***	0.369***	0.312***
	(0.000926)	(0.000488)	(0.00266)	(0.000362)
ln_K	0.493***	0.453***	0.419***	0.510***
	(0.00119)	(0.000664)	(0.00301)	(0.000489)
Constant	1.381***	2.399***	2.688***	2.111***
	(0.0108)	(0.00827)	(0.0313)	(0.00536)
Mu				
ln_K_prov	59.41**	56.17***	138.0	88.02***
	(24.82)	(19.00)	(333.9)	(10.94)
ln_iBalassa_prov	-101.3**	-84.50***	-543.1	-188.3***
	(42.10)	(28.22)	(1,312)	(21.64)
ln_iOperEster_prov	-18.71**	13.34**	40.85	-17.85***
	(9.160)	(5.492)	(101.5)	(5.215)
ln_Gpc_reg	-4.300	-20.73	-212.3	-131.2***
	(20.50)	(16.86)	(527.3)	(26.44)
ln_iSpesTrasp_reg	-149.3**	-152.2***	90.29	288.6***
	(65.01)	(52.81)	(254.2)	(36.67)
ln_iDensità_prov	-93.01**	-57.24**	651.0	197.7***
	(46.80)	(27.20)	(1,577)	(34.52)
ln_iDimensione_impr_pro	-281.9**	-113.9***	-4.885	-1,295***

	(117.0)	(39.62)	(75.34)	(133.4)
timeT	14.83**	-20.07***	-90.53	381.4***
	(6.577)	(6.859)	(219.2)	(39.13)
constant	-2,364**	-2,748***	-4,492	-7,142***
	(995.0)	(923.3)	(10,894)	(773.4)
sigma_u	24.33197	31.0292	45.74856	55.94536
sigma_v	.4427631	.5786779	.5329315	.5426509
Log likelihood	-1.650e+05	-5.895e+05	-3.926e+04	-1.651e+06
Observations	195,848	526,347	36,217	1,445,432

Unlike Tabs 2 and 3, estimates represented in Tab. 4 are particularly heterogeneous. If we observe the estimates regarding the productive frontier, "labor" emerges as the most important factor both in the primary sector and in building. The opposite occurs for firms operating in "Mining & Energy", where the return of the stock of capital is double than that of labor. Again, all estimates present a robust statistical significance.

The impact of exogenous factors on inefficiency provides mixed results. Inefficiency of firms in "Mining & Energy" has no significant correlation with our territorial variables. The opposite is true for firms that operate in the building sector where the effects of localization are particularly pervasive and statistically significant. In fact, with the sole exception of the stock of capital, all other variables positively contribute to the reduction of inefficiency. Particularly weak are the estimates for the primary sector, where technical inefficiency of individual firms is negatively affected by the degree of sectoral specialization, the presence of internationalized firms, the average structural dimensions. The impact of public expenditure is also negligible and does not significantly influence the level of efficiency of firms operating in the primary sector.

Tab. 4. Estimation of model parameters. Primary sector and other manufacturing

	Farming & Fishing	Mining & Energy	Construction
Frontier			
ln_L	0.475***	0.283***	0.415***
	(0.00194)	(0.00150)	(0.000534)
ln_K	0.359***	0.613***	0.406***
	(0.00178)	(0.00169)	(0.000598)
Constant	2.099***	1.129***	2.223***
	(0.0238)	(0.0207)	(0.00697)
Mu			
ln_K_prov	167.0*	225.0	249.4***
	(87.06)	(368.7)	(85.54)
ln_iBalassa_prov	-139.9*	-317.7	-232.9***
	(73.03)	(520.1)	(81.87)
ln_iOperEster_prov	-25.54*	-20.16	-99.20***
	(14.99)	(37.89)	(34.65)
ln_Gpc_reg	68.97	-277.5	-268.3***

	(47.89)	(461.4)	(97.33)
ln_iSpesTrasp_reg	179.6	-199.5	-693.8***
	(97.87)	(337.9)	(238.5)
ln_iDensità_prov	-20.37	-282.7	-670.8***
	(47.79)	(473.7)	(232.5)
ln_iDimensione_impr_pro	-189.8*	-446.7	-832.0***
	(100.9)	(733.5)	(284.7)
timeT	-20.04*	2.127	55.84***
	(11.31)	(10.85)	(19.52)
constant	-5,272*	-8,898	-9,729***
	(2,753)	(14,586)	(3,339)
sigma_u	30.93261	47.62981	7.427776
sigma_v	.5271178	.4681539	.0007178
Log likelihood	-7.328e+04	-5.946e+04	-4.463e+05
Observations	67,746	59,211	527,496

As we observed in the previous paragraph, from the transformation of the level of technical inefficiency it is possible to attain a measure of technical efficiency. The results we obtained for the Italian economy as a whole (considering all the estimates in relation to all sectoral aggregates) find a synthetic representation in Tab. 5.

Table 5 reports a slight reduction of the average levels of technical efficiency for all Italian firms together with an increase of the standard deviation – with the sole exception of 2015 and 2016. In other words, the reduction in the average technical efficiency does not seem to affect all the firms in roughly the same proportions while there are strong evidences of growing disparities among firms.

Tab. 5 Average technycal efficiency, by year

Year	average TE	Std. Dev.	Min	Max
2008	0.720709	0.1397	0.000035	0.978812
2009	0.705431	0.1447	0.000031	0.985226
2010	0.706054	0.1424	0.000027	0.981392
2011	0.709337	0.1421	0.000058	0.980232
2012	0.701793	0.1489	0.000182	0.973934
2013	0.698348	0.1496	0.000039	0.978728
2014	0.697712	0.1499	0.00005	0.979926
2015	0.702297	0.1477	0.000006	0.983813
2016	0.712702	0.1616	0.000007	0.97907
2017	0.690503	0.1801	0.000053	0.978144

Having a measure of the technical efficiency of all firms for the Italian economy, we are now able to represent territorial disparities in terms of efficiency.

Graph 1 pictures the trend of technical efficiency for the manufacturing sector trying to capture different dimensions of the analysis: the comparison between macro-areas; the dynamic changes;

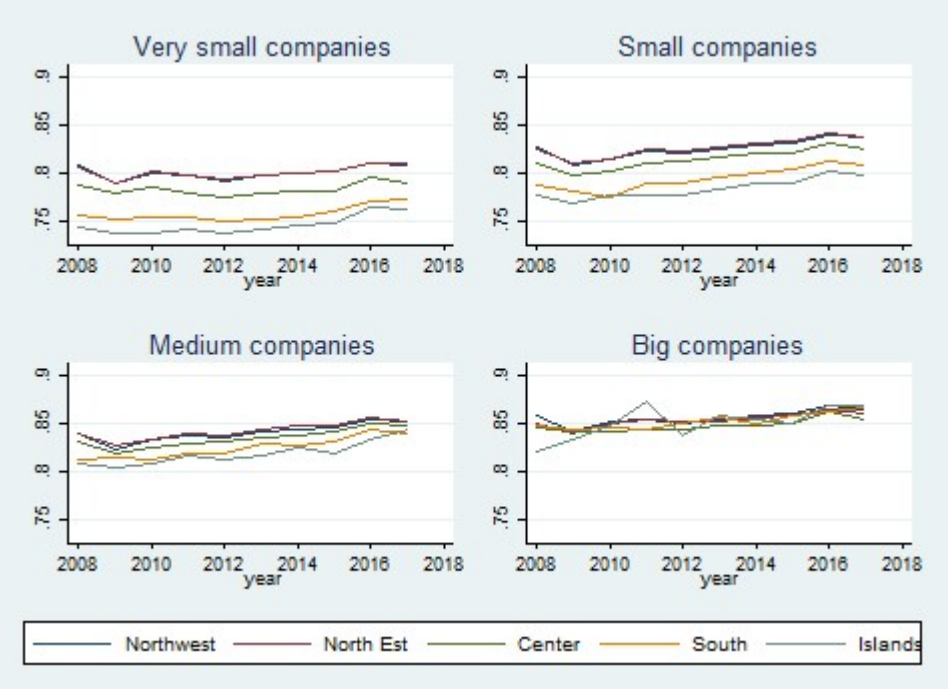
the differences according to the structural dimension. It appears evident, that technical efficiency is mostly linked to dimensions. The greater is the dimension, in terms of the number of employees, the higher the technical efficiency. Moreover, the dimension of firms does not entail on the average levels of efficiency but also on territorial disparities. In fact, among the big firms, the process of convergence among the different macro areas is particularly significant while it is positive but lower if we look at the other categories of firms.

If we observe the whole decade (2008-2017), we obtain, on the whole, a general increase in the levels of efficiency. After a first period of decrease in efficiency – that coincided with the great financial crisis – all macro areas show a general improvement in the levels of efficiency for all dimensions of firms.

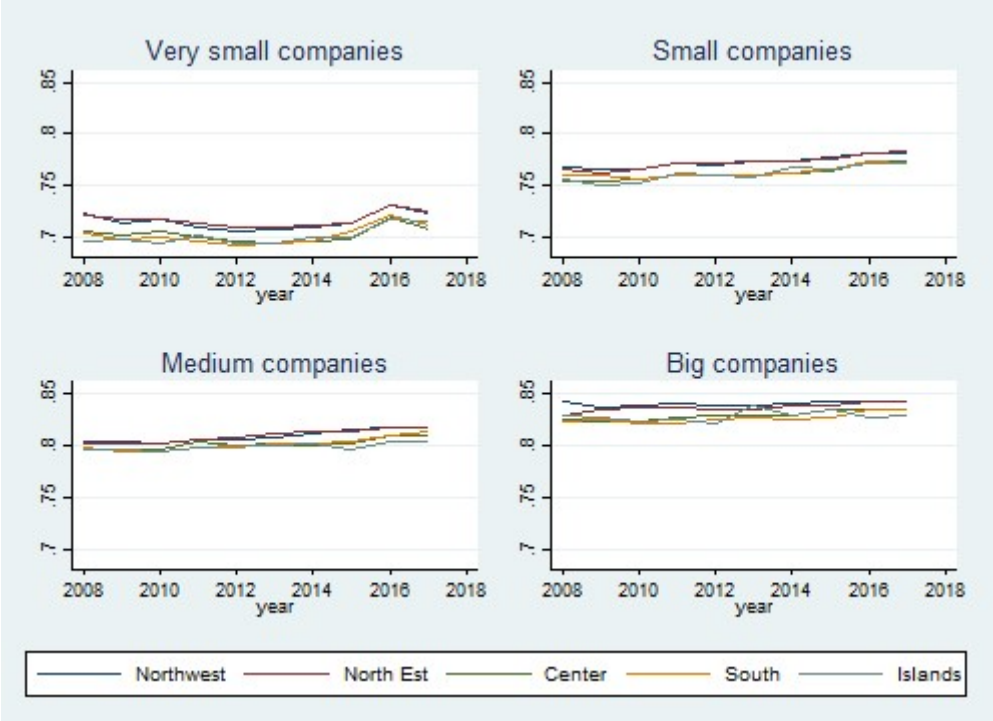
As to services, technical efficiency of firms is very much dependent on dimensions (Graph 2). The relation is positive: the higher the dimensions, the higher the levels of efficiency. However, quite differently from the previous case, in services we register a lower variability among the territories and quite independently from the structural dimensions.

Our evidences regarding firms operating in the primary sector (graph. 3) confirm the significance of structural dimensions in terms of efficiency while, as was in the case of services, inter-regional variability is not particularly significant. For the primary sector, the least efficient firms are localized in the Center and not in the Southern provinces, as was the case for the other sectoral aggregates. Again, if we observe time trends, all dimensions of firms show an improvement in technical efficiency.

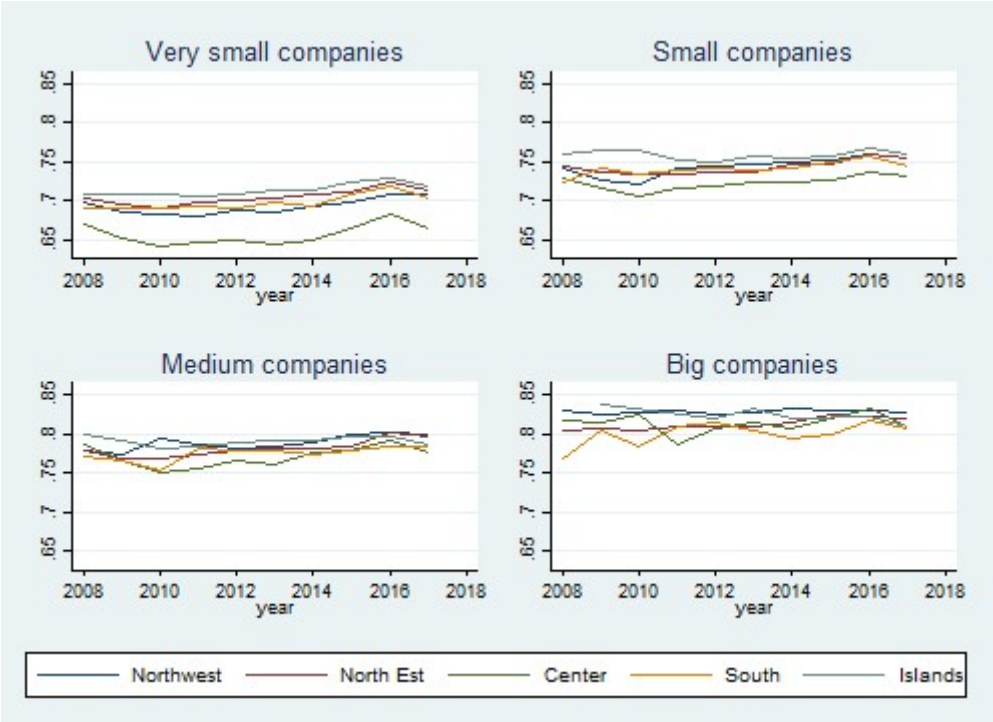
Graph 1. Technical Efficiency in manufacturing. Trends, dimensions, macro regions



Graph 2. Technical Efficiency in services. Trend, dimensions, macro regions



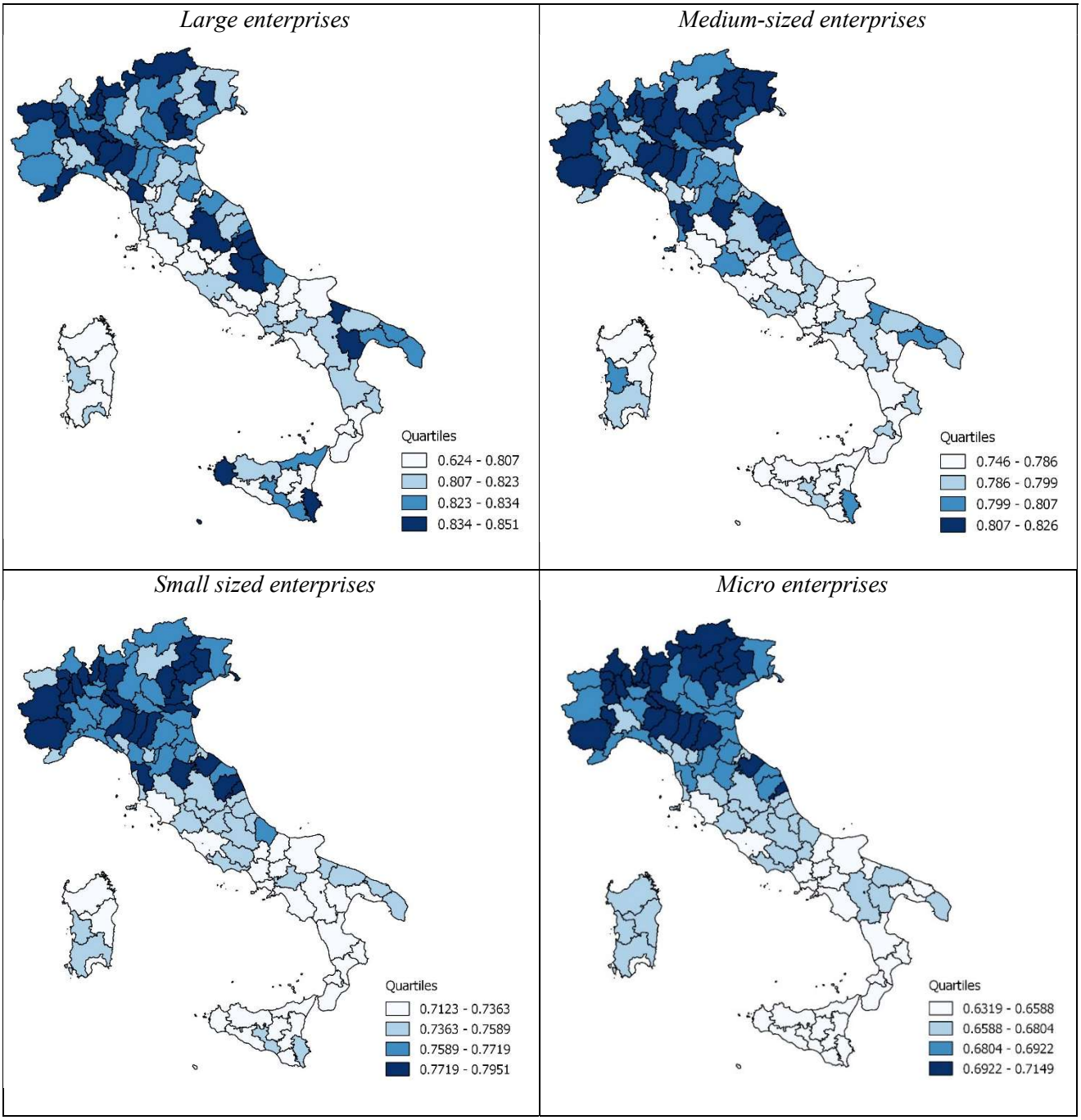
Graph 3. Technical Efficiency in the primary sector. Trend, dimensions, macro regions



Finally, using thematic charts, we represent the average values of the technical efficiency of all Italian firms on a provincial basis (graph 4). Through such charts, it is possible to get a quick glance of territorial disparities according to four groups of firms and to their structural dimension.

If we focus on the technical efficiency of big firms, it can be detected a rather significant degree of territorial uniformity. However, as the average dimension of firms decreases, traditional "North-South" disparities in technical efficiency become very apparent. In the case of small and micro firms, a very clear line of demarcation joining Tuscany with Marche divides the country in two. To the North of this line, all small and micro firms enjoying a higher level of efficiency are localized.

Graph 4. Territorial disparities on Technical Efficiency. The cartography of Italy



5. Conclusions

Growing territorial disparities are today a serious matter for most European countries and a typical phenomenon that deeply permeates Italian economic history – past and present. At least judging from academic debates and scientific research, the North-South divide is still an open question: while it can be traced back to the first post-unification decades, it has acquired a new flavor in times of rising global markets and European crisis.

Different strands of scientific literature have tried to explain the sources and determinants of territorial disparities, putting the emphasis, from time to time, on economic or socio-institutional variables. Using an original and very large set of data that contains detailed information on the universe of all Italian firms that are legally obliged to deposit a balance sheet, our contribution throws new light on one specific dimension: the levels of technical efficiency of firms. From this specific perspective, our analysis confirms the existence of deep territorial disparities.

If measured in terms of technical efficiency, Italian firms differ according to their respective productive sector. Moreover, strong evidences confirm that efficiency varies significantly according to the structural dimension of the firm. According to this latter explanation, our data support two general conclusions: first, medium-sized firms and big firms generally reach higher levels of efficiency; second, a more interestingly for our purposes, we do not have a clear territorial divide. Localization does not affect efficiency to a significant extent, at least if we limit our attention to this specific group of Italian enterprises. On the contrary, if we focus on micro and small firms, the traditional North-South divide emerges very clearly, reproducing traditional disparities of efficiency on behalf of Northern territories. Moreover, within this more fragile (and much more numerous) fraction of the Italian productive system, the incidence of environmental conditions – what me may define the "breeding background" in which individual firms operate – becomes more significant in supporting and preserving market competitiveness. Wherever the "breeding ground" shows signs of weakness and backwardness, lower levels of efficiency become more frequent and evident.

Hence, our analysis had tried to investigate more deeply the nature of this "breeding ground" and its different connections with efficiency standards. At a first glance, for instance, we do not get a monolithic picture: different firms operating in different productive sectors require different "breeding grounds" in order to increase their technical efficiency. It is not always true, for example, that a higher rate of accumulation of physical capital, or a higher concentration of public expenditure or a higher level of territorial specialization necessarily (and positively) affect the average level of efficiency. Quite to the contrary, a rather frequent indication that comes out from our model is that the accumulation of physical capital does not seem to be positively correlated with an increase of technical efficiency. In certain circumstances, the opposite is true. As to increases of public expenditure, the evidence is generally weak if we look at the impact of general expenditures, while beneficial effects are generated whenever public expenditures are invested in the transportation system and in logistic services. As already shown by the literature, our study confirms that infrastructures and transportation are decisive elements to increase efficiency and reduce territorial disparities.

Finally, our analysis may provide useful indications on how to promote local development strategies. In this sense, policy measures designed to exclusively increase physical capital are less

conducive to a general increase of technical efficiency. Conversely, favorable results can be expected if the dimensional growth of enterprises is attained and if straightforward policies can increase the potentialities coming from the external environment.

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