

# Drivers of regional efficiency differentials in Italy: technical inefficiency or allocative distortions?\*

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**ABSTRACT:** This paper estimates regional economic efficiency differentials at the firm level in the Italian manufacturing sector over the period 1998-2003. We implement an input distance function approach providing measures of both technical inefficiency and allocative distortions in the choice of input mixes. Our results confirm the substantial technical efficiency gap suffered by firms located in Southern regions, thus providing empirical support to the "structural and technological gap" interpretation of the Italian dualism. On the other hand, allocative distortions in the use of inputs show less remarkable regional differences. As for policy implications, our results suggest the need for a re-allocation of public resources for development policies from business incentives measures towards public investments.

**KEYWORDS:** Technical and allocative efficiency, Input distance function, Development policies

**JEL-CODES:** C44, D21, D24, O14, O20, R0

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## INTRODUCTION

The dualistic structure of the Italian economy – on one side, the so-called “Mezzogiorno”<sup>1</sup> and, on the other one, the rest of the Country – might well be regarded as a unique case within the European Union.

Public intervention for the economic and social development of Southern Italian regions dates back to the end of the Second World War. Since then, both demand and supply-oriented policies have been implemented<sup>2</sup>. Nevertheless, the Italian Mezzogiorno is still lagging behind.

After the recognition of the failure of demand-linked regional policies put forward in the 1980s, supply-side interpretations of the Italian dualism have gained credibility, the latter favouring public policies mainly based on incentives to private capital accumulation and public investments. The emphasis put on either incentives to private investment or public investment policies can be thought – with full knowledge of the crudeness of approximation – as reflecting two alternative supply-side explanations of the Italian dualism: the “market oriented” and the “structural and technological gap” views (Destefanis, 2001).

According to “market-oriented” scholars, market forces fail to allocate available productive resources efficiently to a higher extent in the Mezzogiorno as compared to Northern regions. In this view, allocative

<sup>1</sup> The Mezzogiorno area includes the following Italian Southern regions: Sicilia, Sardegna, Puglia, Campania, Molise, Calabria, Abruzzo and Basilicata. With the exception of Molise and Abruzzo, in the 2000-2006 Community Support Framework, the Mezzogiorno regions belonged to the Objective 1, all of them having an income per capita below the 75% of European level. On the other hand, the belonging of Southern Italian regions to the objectives of the programming period 2007-2013 is the following: Calabria, Campania, Puglia, Sicilia to “Convergence Objective”; Basilicata to “Statistical phasing-out”; Sardegna to “phasing-in”; Molise and Abruzzo to “Competitiveness and Employment Objective”.

<sup>2</sup> For a survey of the different stages of public intervention in the Mezzogiorno see Del Monte and Giannola (1997).

inefficiency is regarded as the main source of performance differentials between Southern and Northern firms. Hence, well-designed incentives to firms are expected to be effective in driving local resources to their most efficient use, even in the presence of a soft “external” public intervention. On the other hand, scholars within the “structural and technological gap” view emphasize the role played by the structural poverty of the Mezzogiorno economy in terms of a less favourable environment (for instance, as far as transports and communications, education, public order are concerned) which considerably reduces technological possibilities of local firms. Indeed, given the uncertainty of the economic system, many Southern entrepreneurs may be – and actually are – reluctant to undertake investment programmes aimed at improving technology and enhancing the operating scale. On the other side, workers have poor incentives to improve their skill and to benefit from extensive learning opportunities (Cenci and Scarlato, 2002). The combination of the two factors is likely to hamper technical efficiency. Hence, public investments are mostly needed in order to improve environmental conditions and reduce uncertainty.

Due to the complexity of the issue – both for the number of variables involved into the analysis and its historical persistence – it would be misleading to favour only one of the mentioned views as fully explanatory. However, as policy implications are concerned, it is easy to recognize that providing empirical support to both views can be helpful to the design and the implementation of effective policies to enhance productivity in the Mezzogiorno economy.

With this purpose in mind, we will evaluate the productivity gap between Southern firms and those located in the rest of the Country by estimating sector specific input distance functions. This approach will allow distinguishing regional differentials related to technical inefficiency from those due to allocative distortions in the choice of input mixes. We will interpret the presence of the former as supporting the “structural and technological gap” view; whereas the existence of the latter will be interpreted as supporting the “market-oriented” view.

The remainder of the paper unfolds as follows. Section 1 briefly reviews the alternative supply-side views on the Italian dualism and introduces the main features of most recent trends in development policies for the Mezzogiorno of Italy, namely, the intervention lines of the so-called *nuova programmazione*. Section 2 provides some insight on the methodological aspects of the input distance function. Section 3 introduces the dataset and the estimated model, while Section 4 describes the empirical specification. Results are presented in Section 5. Finally, Section 6 concludes.

## 1. RECENT TRENDS IN REGIONAL DEVELOPMENT POLICIES AND SUPPLY-SIDE INTERPRETATIONS OF THE ITALIAN DUALISM

### 1.1 *Recent trends in development policies for the Italian Mezzogiorno*

During the 1980s, Italian regional policies have been based on measures aimed at stimulating the demand side of the economy by means of fiscal subsidizing instruments for firms, households' incomes support – via an enforcement of the welfare state – job creation in the public sector and public works. Such policies were grounded on the idea of “endogenous” development: supporting local demand was expected to create its own local supply, thus giving a boost to local industrial activities. This strategy, however, failed due to the strong economic dependence of the Mezzogiorno on Northern regions. Supporting local demand, far from stimulating local supply, did lead to increasing imports from the North, thus crowding-out local industrial activities (Del Monte and Giannola, 1997).

After the recognition of the failure of demand-linked regional policies, supply-side interpretations of the Italian dualism have gained credibility, suggesting to switch to policies based on incentives to private investment and on public investments.

Since the late 1990s, a new strategy of public intervention has been trying to reconcile the policy maker confidence in the capability of less

developed areas to attain endogenous development, and the call for an extensive “external” intervention aimed at improving the social and economic local context. The ultimate declared aim was indeed the creation of the conditions for a self-sustaining development process via an improvement of the socio-economic and institutional context of the area.

A distinguishing feature of this new deal of public intervention is that policies are designed not only in favour of Mezzogiorno regions, but of all the “depressed areas” in the Country. Furthermore, following a “bottom-up” strategy, both planning and implementation processes have been extensively decentralized to regional administrations<sup>3</sup>.

Development policies have been targeted at improving: market competition for labour, products and capital; tangible and intangible communication with other areas; training of human resources and opportunities for innovation; social infrastructures; internal relations and externalities of entrepreneurs' agglomeration; accessibility of natural and cultural resources (Barca, 2003 and 2006). As for the instruments employed to achieve such ambitious goals, they can be grouped – as mentioned above – into two main categories: incentives to private investment<sup>4</sup> and the provision of public goods via public investment.

<sup>3</sup> In a former configuration of the supply-based policy (approximately during the period 1950-1992), development strategies typically followed a “top-down” approach which required a full centralization at the national level of any public intervention. The National Agency for Mezzogiorno (*Cassa per il Mezzogiorno*) has been in charge of both planning and funding processes until 1992. The main intervention lines within industrialization policies were: a) public investment in infrastructure, b) public investment in state-owned enterprises and c) the funding of private investment in the form of both capital and interest contributions.

<sup>4</sup> Business incentives are regulated by a number of different laws. They differ for the duration of incentives (from short term to permanent) and targeted variables (employment, innovation, investment). As for the manufacturing sector, they can be grouped into a) interest rates subsidies; b) capital grants and tax credits (Destefanis and Storti, 2006).

TABLE 1: DEVELOPMENT-RELATED PUBLIC SPENDING IN SOUTHERN AND CENTRE-NORTHERN REGIONS, EUROS PER CAPITA (2000-2003)

Industry	CENTRE-NORTH				MEZZOGIORNO			
	2000	2001	2002	2003	2000	2001	2002	2003
<i>Environment</i>	46.2	46.4	53.2	62.5	46.1	53.4	43.6	39.3
<i>Energy</i>	103.9	112	135.7	119.1	80.9	59.0	74.3	85.3
<i>Cultural services</i>	48.6	46.1	46.0	54.1	32.7	36.2	24.0	29.1
<i>Education</i>	86.2	97.5	112.4	120.4	80.2	91.7	102.7	103.3
<i>Industry and services*</i>	100.1	111.8	159.4	155.9	202.8	299.3	333.2	275.9
<i>Public health</i>	56.3	55.2	56.7	60.2	30.3	41.8	34.1	35.9
<i>Transport networks</i>	243.6	292.6	327.6	374.1	214.7	254.9	221.2	234.9
<i>Public order &amp; law enforcement</i>	18.8	21.6	34.4	33.4	16.5	22.5	27.2	19.4

Source: Our elaborations on “*Conti pubblici territoriali, Dipartimento per le politiche di sviluppo*”

(\*) mainly business incentives

In particular, in the view of the policy maker, any business support needs to be temporary, fostering capital accumulation (and thus local employment and income) in less developed areas, until the taking-off of a local endogenous growth process. It is recognized, however, that the latter can be attained only if the support to local private investment is balanced by public investments aimed at making the context of backward regions more favourable (and as attractive as the one of the leading regions) in terms of endowment of public goods (Ministero dello Sviluppo Economico, 2006). However, despite this declared strategy of balanced intervention, data on public spending – shown in Table 1 – seem to reveal that incentive instruments still play a major role, whereas the Mezzogiorno does not benefit from a higher provision of neither material of immaterial infrastructures as compared to the rest of the Country<sup>5</sup>. On the contrary, the item “Industry and services”, which mainly concerns business incentives, highlights the greatest differential between the two macro-regions.

### 1.2 Supply-side interpretations of the Italian dualism

The priority to be given to either well-designed

incentives or public investment policies reflects two different supply-side interpretations of the Italian dualism: the “market-oriented” and the “structural and technological gap” views. The key point put forward by “market-oriented” scholars is the higher extent to which Southern firms fail to allocate available productive resources efficiently. Many examples may be mentioned here. The pervasive asymmetric information between the two sides of the labour market, associated with the uncertainty about the true workers’ skill on the one hand and the actual opportunities of job advancement offered by the firms on the other, brings about a mismatch between the two groups of agents (Cenci and Scarlato, 2002), thus leading to an inefficient allocation of the workforce.

Furthermore, credit market imperfections can lead to incorrect evaluation of investment projects, thus either causing under-investment or forcing firms to finance investment using their own resources. Hence, performance differences across Italian regions are mainly interpreted as stemming from higher allocative inefficiencies in the South. In this view, well-designed incentives to firms would be expected to be effective in driving resources to their most efficient use, even in the presence of a soft “external” public intervention.

<sup>5</sup> Reported data refer to the period 2000-2003, however, similar evidence is available for the longer time period 1998-2005.

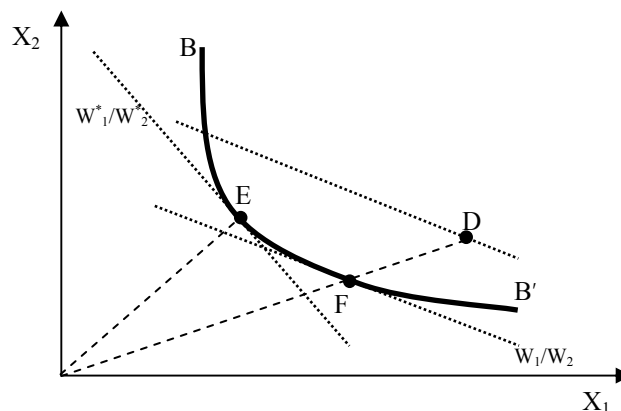


FIGURE 1: TECHNICAL AND ALLOCATIVE INEFFICIENCY

Figure 1 illustrates this point. Assuming a simple technology using two inputs ( $x_1$  and  $x_2$ , whose prices are  $W_1$  and  $W_2$  respectively) to produce one output, the units on the boundary of the input requirement set,  $BB'$ , are technically efficient since it is not possible to further reduce simultaneously the use of all inputs. However, the units lying on the boundary are not equivalent in terms of allocative inefficiency. According to the definition used by Schmidt and Lovell (1979), a producer is allocatively efficient if it succeeds to allocate inputs in such a way to equate the marginal rates of technical substitution to the ratio of the respective input prices. The optimal input bundle is given by point F, i.e. the tangency point between the boundary  $BB'$  and the isocost line, whose slope is given by  $W_1/W_2$ . On the contrary, unit E – though technically efficient – uses too much of input 2 and too little of input 1 with respect to the input price ratio  $W_1/W_2$ . Such a distortion disappears in correspondence to the input price ratio  $W^*_1/W^*_2$ , wherein prices  $W^*_1$  and  $W^*_2$  are the so-called *shadow prices* (i.e. the input prices that make an allocatively inefficient firm efficient). The allocatively inefficient input combination corresponding to unit E is due to a perceived (and not directly observed) shadow price ratio which is different from the market (and observed) price ratio, thus leading to over-utilization of input 2 and under-utilization of input 1<sup>6</sup>. Therefore, the discrepancy between

<sup>6</sup> It is worth noting that such failure to efficiently allocate inputs are not necessarily due to a mistake, but rather to environmental factors that may affect producers' behaviour.

market and shadow price ratios (graphically represented by the different slopes of the two dotted isocost lines tangent to  $BB'$  at the points F and E) may be regarded as a proper measure of allocative distortion. In order to eliminate this form of inefficiency, firm E should be given well-designed incentives to change its input mix given the input market prices it faces.

On the other hand, scholars within the “structural and technological gap” view – see, for instance, Costabile (1996) – emphasize the role played by the structural poverty of the Mezzogiorno economy in terms of less favourable environmental conditions. In other words, the main source of regional differentials in performance is technical inefficiency. Turning to figure 1, point D is allocatively but not technically efficient. The main problem affecting unit D's performance lies in an excessive use of both inputs. In this view, development policies should put more emphasis on the improvement of the environmental conditions, the latter being the fundamental prerequisite for (technical as well as human) capital accumulation in less developed areas. Hence, an “external” intervention is mostly needed in the form of public investments in both material and immaterial public capital. Improving communications and transportation infrastructures, enhancing law enforcement, enforcing public order, establishing high-quality educational institutions just represent a few possible interventions able to create the conditions to make more productive private investments in less developed areas.

## 2. MODELLING TECHNICAL INEFFICIENCIES AND ALLOCATIVE DISTORTIONS

Economic efficiency can be decomposed into two components: technical efficiency and allocative efficiency (Farrell, 1957). In general terms, technical efficiency reflects managers' capacity to minimise input utilization and reduce wastes, whereas – given input prices – allocative efficiency is associated with the ability to set a cost-minimising input mix. In order to derive measures of technical and allocative efficiency, we have estimated a set of by sector input distance functions<sup>7</sup>, which entail many advantages with respect to the estimation of traditional cost functions (see, for more details, Färe and Grosskopf, 1990; Färe and Primont, 1995; Grosskopf *et al.*, 2001; Coelli and Perelman, 2000 among others)<sup>8</sup>. Indeed, given observed input prices, the estimation of a traditional cost function implies the assumption that all firms are equally able to express input requirements consistent with cost minimisation. As a consequence, any discrepancy between actual and fitted cost is solely due to random noise. Using a cost frontier specification allows removing such assumption of full efficiency – even in a context of assumed cost-minimising behaviour – as actual cost can differ from fitted cost by both random noise and a composite technical and allocative inefficiency term. Unfortunately, separate measures of technical and allocative inefficiency are difficult to obtain. This difficulty to separate the two effects has been denoted by Bauer (1990) as the “Greene problem” (Kumbhakar and Tsionas, 2005 and Kumbhakar and Wang, 2006, developed new approaches to solve this problem

<sup>7</sup> Technological homogeneity requires analysing each industry on its own. The disaggregation of the sample was carried out bearing in mind the potential trade-off between the need to have homogeneous groups and the risk associated with small-sample bias. More details on the composition of the sample will be provided in Section 3.

<sup>8</sup> In principle, by sector technology might be estimated using a production frontier (see the study by Harris (2001) who applied a stochastic frontier production function to derive estimates of technical efficiency for several UK manufacturing industries). However, this approach does not allow accounting for potential allocative distortions in the use of inputs.

using a flexible cost and primal system). In this sense, the distance function approach used here has many convenient properties. First, it does not impose the restrictive assumption of cost-minimising behaviour<sup>9</sup>, since each firm is allowed to select the input mix consistently with its own shadow input prices rather than its market input prices. Secondly, it provides a pure measure of technical inefficiency, whereas traditional cost frontier functions solely allow measuring excess cost without distinguishing between technical and allocative components. Thirdly, the input distance function accommodates multi-input multi-output bundles without requiring information on input prices, the latter being difficult to obtain. Finally, the input distance function is dual to the shadow cost function (Färe and Primont, 1995) and such relationship can be used for the identification of shadow price ratios, which enables to provide evidence on the presence of input misallocation.

Formally, the input distance function is defined as follows:

$$D_I(y,x) = \max_{\delta} \{ \delta \geq 1 : x/\delta \in L(y) \} \quad (1)$$

where  $x$  denotes the  $N \times 1$  input vector,  $y$  denotes the  $M \times 1$  output vector and  $L(y)$  denotes the production possibility set, given the level of  $y$ , modelling the transformation of inputs  $x$  into outputs  $y$ . For  $x \in L(y)$  the distance parameter  $\delta$  is  $\geq 1$ , being equal to 1 if and only if  $x$  is technically efficient<sup>10</sup>. Therefore, the greater  $D_I(y,x)$  the lower the technical efficiency associated with each producer.

As argued by Färe and Primont (1995),  $D_I(y,x)$  should satisfy some regularity conditions, i.e. it must be non-decreasing in input vector,  $x$ , non-increasing in output vector,

<sup>9</sup> Violation of cost-minimising assumption would occur in a number of circumstances, such as when performance of highly regulated or public firms is evaluated, and, more in general, when bureaucratic behaviour imposes utility maximisation rather than cost minimisation. Such an input distance function property is also suitable when market forces are expected to fail organizing available resources in an economically convenient manner, so that public intervention is needed in order to promote adjustment of input misallocation.

<sup>10</sup> The input distance function, ranging from 1 to infinity, is the inverse of the input-oriented Farrell technical efficiency measure (Farrell, 1957), which ranges from 0 to 1.



$y$ , and linearly homogeneous and concave in  $x$ .

The duality relationship between the input distance function and the shadow cost function is defined by the two following equations:

$$C(y, w^s) = \min_x \{ w^s x : D_I(y, x) \geq 1 \} \quad (2)$$

$$D_I(y, x) = \min_{w^s} \{ W^s x : C(y, W^s) \geq 1 \} \quad (3)$$

where  $C(y, w^s)$  is the shadow cost of producing an output vector,  $y$ , given the input shadow price vector,  $w^s$ , and  $W^s = w^s/C(y, w^s)$  are cost-deflated input shadow prices obtained by dividing this vector by the value of  $C(y, w^s)$ . Since the cost function is homogenous of degree 1 in input prices, the resulting value of  $C(y, W^s)$  will be greater or equal to one. Shadow prices,  $w^s$ , represent implicit (unobserved) input prices that support managers' optimal input demand, given the output level to be produced. If relative input shadow prices differ from relative input market prices, then an allocative distortion problem will arise, meaning that input demand levels deviate from the cost-minimising input combination.

Following Färe and Grosskopf (1990), in a shadow price model – like the one defined in eqs. (2)-(3) – where firms are assumed to minimise the shadow cost, the application of the dual Shephard's lemma yields the following expression for the first partial derivative of the input distance function with respect to input quantity  $x_i$ :

$$\frac{\partial D_I(y, x)}{\partial x_i} = W_i^s(y, x) = \frac{w_i^s}{C(y, w^s)} \quad (4)$$

for  $i = 1, \dots, N$

Since the shadow cost function  $C(y, w^s)$  is not observable, the input shadow prices,  $w^s$ , can not be directly calculated. However, the ratio between the two first partial derivatives of the input distance function with respect to inputs  $i$  and  $j$  yields the shadow price ratio (Grosskopf *et al.*, 2001; Rodriguez-Álvarez *et al.*, 2004):

$$\frac{\partial D_I(y, x) / \partial x_i}{\partial D_I(y, x) / \partial x_j} = \frac{w_i^s}{w_j^s} \quad (5)$$

for  $i, j = 1, \dots, N$  and  $i \neq j$

This ratio can be used to evaluate the existence of input misallocation. Indeed, a measure of input allocative distortion can be obtained by comparing the shadow price ratio with the market price ratio (or, in other words, by comparing the slopes of the two isocost lines depicted in Figure 1) as follows:

$$\frac{w_i^s / w_j^s}{w_i / w_j} = k_{ij} \quad (6)$$

If  $k_{ij} = 1$  (i.e.  $w_i^s/w_j^s = w_i/w_j$ ), then allocative efficiency exists. Based on the magnitude of the price ratios index, it is possible to retrieve information on the extent of allocative distortion. If  $k_{ij} > 1$  firms' preference behaviour to under-utilise input  $i$  relative to input  $j$  occurs, while if  $k_{ij} < 1$  firms' preference behaviour to over-utilise input  $i$  relative to input  $j$  holds. In both the cases, the non-optimal input mix deviates from the cost-minimising one, as the prices that support the managers' input demand differ from market prices, thus providing expense preference behaviour in one or another direction.

### 3. DATA AND ESTIMATED MODEL

We use data from the last two waves (8th and 9th) of the Capitalia survey on Italian manufacturing firms, covering the periods 1998-2000 and 2001-2003 respectively (Capitalia, 2002 and 2005). The survey conducted by Capitalia is based on a representative rotating panel of firms stratified by sector of activity, Pavitt (1984) taxonomy, geographical area and size. The rotating nature of the panel implies that about half of the firms included in the 8th wave have been dropped in the 9th wave, while new firms have being added in such a way to preserve the stratified nature of the sample. The survey provides both balance sheet data and a number of qualitative information. However, the latter are available only for a three-year period as a whole in most cases. Our estimations are based on yearly balanced sheet data.

TABLE 2: SAMPLE COMPOSITION  
(BALANCED PANEL 1998-2003 AND CAPITALIA SAMPLES 1998-2000/2001-2003)

	Panel 1998-2003 (N=1019)	Capitalia 1998-2000 (N=4289)	Capitalia 2000-2003 (N=4289)
<b>Size</b>	<b>%</b>	<b>%</b>	<b>%</b>
11-20 employees	34.00	39.9	22.1
21-50 employees	37.6	37.1	29.6
51-250 employees	21.8	16.2	36.9
251-500 employees	3.3	3.9	5.1
>500 employees	3.2	2.9	6.1
<b>Location</b>	<b>%</b>	<b>%</b>	<b>%</b>
North West	37.39	37.6	35.9
North East	31.5	27.4	30.1
Centre	18.8	20.6	17.7
South	12.27	14.4	16.3
<b>Pavitt</b>	<b>%</b>	<b>%</b>	<b>%</b>
Traditional sectors	51.2	52.3	51.9
Scale sectors	16.8	18.1	16.8
Specialized sectors	27.7	24.3	26.7
High-tech sectors	4.0	5.3	4.6

In order to increase the time span of our analysis, we used the balanced panel of firms obtained in Morone *et al.* (2007) by merging the 8<sup>th</sup> and 9<sup>th</sup> waves of the Capitalia survey<sup>11</sup>. Hence, we observe firms' behaviour over the period 1998-2003. This choice implies a reduction in the number of firms in the sample. However, data reported in Table 2 show that the composition of the sample by size, geographical area and Pavitt taxonomy remains essentially unchanged, which implies that our sample is as representative as the Capitalia one.

As for the estimated model, based on Shephard's lemma, we formulate the following input distance function system in log terms:

$$\ln(1) = \ln D_I(y, x) + v$$

$$\frac{w_i x_i}{C(y, w)} = \frac{\partial \ln D_I(y, x)}{\partial \ln(x_i)} + v_i \quad (7)$$

where  $C(y, w)$  is the actual cost and  $v$  and  $v_i$  denote the usual normally distributed with zero mean random noise terms. The first equation in the stochastic frontier model (7) represents the input distance function. The log specification of the input distance function implies that a firm is technically inefficient with respect to the stochastic boundary if  $\ln DI(y, x)$  is greater than

<sup>11</sup> The adopted merging procedure is described in detail in Morone *et al.* (2007).

$\ln(1)$ , i.e. if the distance function  $DI(y, x)$  is greater than 1. The second equation represents the  $i$ -th input cost share derived from the input distance function. To formally explain this relationship, we express the dual Shephard's lemma defined in eq. (4) as follows:

$$\frac{\partial \ln D_I(y, x)}{\partial \ln(x_i)} = \frac{w_i^s}{C(y, w^s)} \frac{x_i}{D_I(y, x)} \quad (8)$$

Recalling that at the frontier the shadow cost is equal to the radially contracted actual cost (Rodríguez-Álvarez and Lovell, 2004) – i.e.,  $C(y, w^s) = C(y, w)/D_I(y, x)$  – we obtain:

$$\frac{\partial \ln D_I(y, x)}{\partial \ln(x_i)} = \frac{w_i^s x_i}{C(y, w)} \quad (9)$$

which defines the optimal input cost share. Deviation from such optimal share is attributable to both allocation inefficiency and noise, both encompassed into the unique disturbance term,  $v_i$ <sup>12</sup>.

The index of allocative distortion,  $k_{ij}$ , introduced in eq. (6), has been computed for each observation using the following

<sup>12</sup> Rodríguez-Álvarez and Lovell (2004) and Rodríguez-Álvarez *et al.* (2004) propose a model to separate input-specific systematic allocative inefficiency from noise.

expression:

$$\frac{\partial \ln D_i(y, x)}{\partial \ln x_i} \bigg/ \frac{\partial \ln D_i(y, x)}{\partial \ln x_j} = k_{ij} \left( \frac{w_i x_i / C}{w_j x_j / C} \right)$$

for  $i, j = 1, \dots, N$  and  $i \neq j$  (10)

where C is the actual total cost. Given that the first partial derivative of the log distance function with respect to the log of input  $i$  represents the  $i$ -th input optimal cost share, the  $k_{ij}$  coefficient may be seen as the ratio of the optimal input cost shares compared to the ratio of the actual input cost shares.

#### 4. EMPIRICAL SPECIFICATION

In order to estimate the model, we have specified by sector flexible (translog) input distance function systems, as follows:

$$\ln(1) = \alpha_0 + \alpha_y \ln y_{ht} + \sum_{i=1}^M \beta_i \ln x_{hit} + \frac{1}{2} \alpha_{yy} (\ln y_{ht})^2 + \frac{1}{2} \sum_{i=1}^M \sum_{j=1}^M \beta_{ij} \ln x_{hit} \ln x_{hjt} + \sum_{i=1}^M \beta_{yi} \ln y_{ht} \ln x_{hit} + \sum_{t=1}^T \gamma D_t + \delta D_{SOUTH} + \varepsilon_{ht}$$
 (11)

$$\frac{w_i x_i}{C(y, w)} = \beta_i + \sum_{j=1}^M \beta_{ij} \ln x_{hjt} + \beta_{yi} \ln y_{ht} + v_{iht}$$

where  $y$  is turnover,  $x_i$  ( $i=1, \dots, M$ ) denotes the input vector – including labour (number of employees, L), operating costs for materials and services (CMS) and capital (tangible and intangible fixed asset values, K) – and  $h$  denotes firms<sup>13</sup>. All monetary variables were opportunely deflated at 2000 prices. As for turnover and CMS, specific production price indices were used<sup>14</sup>. Deflation of the capital time

<sup>13</sup> Due to the singularity problem one of the cost share equation was dropped, the results not being affected by the choice on the dropped share equation. As one of the aims of this study is to analyse the coefficients of allocative distortion for each input pair, the model has been run two times, getting parameters estimates for two share equations (for instance, including K and L, and dropping CMS) and then re-running the system of equations including the dropped share equation and dropping another one.

<sup>14</sup> To this purpose we used ATECO 2 digits industry-specific production price indices, with base year in 2000.

series variable was carried out using a perpetual inventory method. Since capital stock value may be affected by jumps due to monetary revaluation, it was necessary to adjust the deflated capital series to account for these changes. Therefore, it was assumed that the last capital value reflected the most accurate estimate as it embodies all the previous adjustments. Adjusted capital stock series for the entire period was then determined by starting from the last year and proceeding backwards by subtracting yearly deflated net investments.

A set of dummy variables was also included.  $D_t$  ( $t = 1, \dots, T$ ) are time dummies controlling for technical progress (or regress). The geographical dummy  $D_{SOUTH}$  takes on value 1 if firms are located in the Mezzogiorno area and 0 otherwise (that is, for firms located in Northern and Central regions), thus capturing the effect on the distance function of time-invariant characteristics associated with location. By including such dummies into the model, we aimed at testing whether – and if so, to which extent – Southern economic environment and time play a role in affecting technical efficiency. Intuitively, given that the first equation in the distance function system (11) must equal zero, a negative sign for  $D_{SOUTH}$  and  $D_t$  would mean an upward shift of the distance function, thus indicating a deterioration in performance (obviously the inverse is valid when a positive sign occurs). Based on the discussion provided in Section 1, we expect a negative sign for  $D_{SOUTH}$ , which would confirm the existence of a technical gap suffered by Southern firms, according to the predictions of the “structural and technological gap” view.

The stochastic input distance function has then be used to calculate technical efficiency indices for each firm in each year, as well as mean technical efficiency by year and for the whole period. Following Greene (1980) and Grosskopf *et al.* (2001), measure of technical efficiency by firm and by year are given by:

$$TE_{ht} = \frac{1}{\exp(\ln D_1(y, x) + |\min(\hat{\varepsilon})|)} \quad (12)$$

where the intercept correction – obtained by adding the absolute value of the most negative residual – forces the predicted values of  $\ln D_1(y, x)$

to be greater than 1<sup>15</sup>. Then, inverting the distance function value yields the traditional measure of Farrell technical efficiency, ranging from 0 to 1 (with 1 indicating full technical efficiency). In addition, through the observation of the  $k$ -factors we can verify the existence of different patterns of allocative distortion across macro-regions.

The question to be addressed is whether the main source of the performance gap dividing Southern firms and those located in the rest of the Country mainly stems from either technical or allocative inefficiency. The associated policy implication would be to provide empirical support to either what we have referred to as the “structural and technological gap” view or the “market-oriented” one.

## 5. RESULTS

By industry results of the maximum likelihood estimation of the equation system (11) are not presented here<sup>16</sup>. In all cases, however, the input distance function is found to be well-shaped, satisfying the regularity conditions at the majority of the observations.

Average technical efficiency estimates for each industry – calculated using eq. (12) – are reported in Table 3. Average efficiency scores seem quite low and range from 0.504 for textile industry to 0.771 for the wood & paper industry. This seems to reveal a generalised lack of competition, implying poor incentives to decision makers to enforce benchmarking

<sup>15</sup> Given that, in eq. (12),  $\ln D_I(y, x) = \ln \tilde{D}_I(y, x) + \sum_{t=1}^T \gamma_t D_t + \delta D_{SOUTH}$ , the first term should represent a measure of pure technical inefficiency while the other two terms capture the effects associated with time and location respectively. Given such formulation,  $\ln \tilde{D}_I(y, x)$  is cleaned out of the exogenous effects which bring about shifts in the efficient frontier. However, since the rescaling approach used in eq. (12) is based on the estimated residuals,  $\varepsilon_{ht}$ , from the first equation in the distance function system (11), the use of  $\ln D_I(y, x)$ , instead of  $\ln \tilde{D}_I(y, x)$ , became compulsory. As a consequence, the technical efficiency score,  $TE_{ht}$ , must be interpreted as the efficiency level attained by a firm observed at a certain time and operating in a certain geographical context.

<sup>16</sup> They are however available upon request.

activities in order to achieve higher performance.

The sign and magnitude of  $D_{SOUTH}$  address the question whether geographical location actually affects productive efficiency. Results are shown in Table 4.

The coefficients are always negative and statistically significant at 1% level (with exception of the “electrical machinery” industry), and range from  $-0.028$  to  $-0.073$ . In line with previous studies implementing different approaches within the frontier literature – see, for instance, Destefanis (2001) and Giannola and Petraglia (2006) – these results show that Southern firms face a less favorable environment as compared to firms located in the rest of the Country. This confirms our *ex-ante* assumption on the competitive disadvantage suffered by Southern firms. Explanations for these results are various and range – as already noted – from poor infrastructural endowment to less qualified workforce. Besides, an important point concerns the role of credit market imperfections which heavily impact on investment opportunities and growth process (Sarno, 2003). As for the peculiarities of such imperfections in the Mezzogiorno area, many remarks are in order here. First, it is well documented that financial pressure is higher, *ceteris paribus*, for Southern firms in terms of higher interest rates (ISAE, 2003). This may hinder Southern firms from achieving larger size, thus preventing them from taking advantage from scale economies. Moreover, Nickell and Nicolitsas (1999) – analysing a sample of UK manufacturing firms – point out that a rise in borrowing costs leads to long-run negative effect on employment and very small positive effects on long-run productivity gains. Secondly, Southern firms are mainly oriented towards traditional and less innovative productions. This is likely to worsen the selective power of risk adverse financial operators, making credit rationing more binding. Third, the consolidation process experienced by the Italian banking system during the 1990s, has followed a clear territorial pattern: the acquisition of local Southern banks by Northern large credit institutes. This warns about the worsening of external financial conditions for firm growth in the South (Giannola, 2002).

TABLE 3: TECHNICAL EFFICIENCY ESTIMATES

<i>Industry</i>	<i>Average Technical Efficiency</i>	<i>Min Technical Efficiency</i>	<i>Standard deviation</i>
Food	0.623	0.468	0.059
Textiles, Apparel & Leather	0.504	0.194	0.056
Wood & Paper	0.771	0.533	0.057
Chemicals & Rubber	0.687	0.498	0.062
Non-metallic Mineral Products	0.667	0.471	0.063
Metal Products	0.629	0.360	0.065
Non-electrical Machinery	0.626	0.357	0.067
Electrical Machinery	0.692	0.412	0.065

TABLE 4: PARAMETERS FOR DUMMY  $D_{SOUTH}$  IN THE INPUT DISTANCE FUNCTION

<i>Industry</i>	<i>Coefficient</i>	<i>t-statistics</i>
Food	-0.030	-3.94 ***
Textiles, Apparel & Leather	-0.037	-3.97 ***
Wood & Paper	-0.030	-2.96 ***
Chemicals & Rubber	-0.073	-6.04 ***
Non-metallic Mineral Products	-0.028	-2.93 ***
Metal Products	-0.032	-4.35 ***
Non-electrical Machinery	-0.052	-2.71 ***
Electrical Machinery	-0.009	-0.49

\*\*\* Statistically significant at 1% level

Other than technical efficiency, our main focus is on input misallocation. The parameters of the equation system (11) were used to calculate yearly measures of input allocative distortions at the firm level. Mean allocative distortion values,  $k_{ij}$  (with  $i, j = L, K, CMS$ ) by geographical area and industry, along with their confidence intervals (at 95% level), are presented in Table 5.

In general,  $k_{K,CMS}$  is significant and greater than 1 in both macro-regions. This implies that – with a few exceptions – capital is significantly under-utilised with respect to variable inputs (typically, materials and services), both in the full sample and in each sector. As for regional differences, the magnitude of the  $k$ -coefficients reveals a major under-utilization problem for Southern firms. Two remarks are worth to be discussed here.

First, this finding is consistent with the growing deverticalisation trend that characterized Italian manufacturing starting from the 1970s in the North (Traù, 1999; Trento, 2003) and more recently in Central and Southern regions (Giunta and Scalera, 2006). Typically, deverticalisation and contracting out processes involving non-core activities –

through the creation of a network of vertical supply relationships – have allowed Italian firms to lighten their asset structures and to save on both labour and capital costs with the aim of improving profitability. If such a restructuring process has led to better performances is a questionable issue. Our findings try to address this question, suggesting that deverticalisation processes have often taken the form of excessive external purchases, violating allocative efficiency conditions. In that, Southern firms show stronger evidence.

Secondly, the finding of higher capital under-utilization for Southern firms is coherent with the specialization of Southern firms in traditional and relatively low value added productions. One way to enhance capital level (and consequently capital cost share) with respect to  $CMS$  might consist in addressing major efforts to attain a capital quality improvement, through a multi-level investment program which in turn requires a strong commitment on behalf of both firms and government. Obviously this would require a more efficient credit market and removing the rigidities in the allotment of financial resources.

TABLE 5: MEAN INPUT ALLOCATIVE DISTORTION COEFFICIENTS<sup>a</sup>

	CENTRE-NORTH				SOUTH			
	N.	$k_{L,K}$	$k_{K,CMS}$	$k_{L,CMS}$	N.	$k_{L,K}$	$k_{K,CMS}$	$k_{L,CMS}$
Food	300	1.110 (0.987-1.233)	0.983 (0.827-1.139)	0.984 (0.957-1.011)	186	1.035 (0.953-1.117)	<b>1.409*</b> (1.264-1.555)	<b>1.095*</b> (1.057-1.132)
Textiles, Apparel & Leather	816	1.214 (0.694-1.734)	<b>1.189</b> (1.078-1.299)	0.985 (0.959-1.012)	120	0.865* (0.671-1.059)	<b>2.091</b> (1.763-2.420)	1.018* (0.948-1.088)
Wood & Paper	504	0.907 (0.664-1.151)	<b>1.243</b> (1.123-1.362)	1.005 (0.988-1.022)	36	0.832 (0.633-1.031)	<b>1.948</b> (1.553-2.343)	<b>1.164</b> (1.054-1.274)
Chemicals & Rubber	582	1.058 (0.656-1.460)	<b>1.118</b> (1.055-1.180)	1.019 (0.996-1.042)	48	0.876* (0.750-1.002)	<b>1.529</b> (1.359-1.700)	<b>1.149</b> (1.082-1.217)
Non-metallic Min. Prod.	294	1.048 (0.927-1.168)	<b>1.189</b> (1.107-1.271)	<b>1.042</b> (1.014-1.070)	90	1.947 (0.781-3.112)	1.018 (0.920-1.117)	<b>1.055</b> (1.004-1.106)
Metal Products	905	1.074 (0.971-1.176)	<b>1.202</b> (1.149-1.255)	1.001 (0.987-1.016)	132	<b>0.889*</b> (0.781-0.997)	<b>1.478</b> (1.300-1.655)	1.031 (0.977-1.085)
Non-electr. Machinery	870	<b>1.081</b> (1.020-1.143)	<b>1.209</b> (1.155-1.263)	<b>1.015</b> (1.000-1.030)	24	<b>0.773*</b> (0.556-0.990)	<b>2.108</b> (1.596-2.620)	<b>1.128</b> (1.053-1.203)
Electrical Machinery	522	1.065 (0.965-1.164)	<b>1.323</b> (1.161-1.485)	1.006 (0.984-1.028)	30	1.095 (0.850-1.340)	<b>1.335</b> (1.075-1.595)	<b>1.069</b> (1.001-1.138)
Overall mean		1.079	1.194	1.005		1.070	1.552	1.071

<sup>a</sup> Confidence intervals, calculated by percentile method at 95% statistical level, are in parentheses. Values statistically different from 1 are in bold. Asterisks in SOUTH columns indicate that allocative distortion for Southern area changes direction with respect to CENTRE-NORTH (i.e.  $k_{ij}$  for SOUTH is  $> 1$  while it is  $< 1$  for CENTRE-NORTH, or viceversa).

As for  $k_{L,CMS}$ , a slightly average under-utilization of  $L$  with respect to  $CMS$  is observed for Southern firms. By industry results of the  $k$ -coefficients reveal a greater – and generally significant – potential for Southern firms to achieve higher cost saving via a reduction of  $CMS$  share and a simultaneous increase in the labour cost share. This evidence is consistent with the above considerations associated with the capital- $CMS$  mix. On the contrary, firms located in the rest of the Country seem to adopt an allocatively efficient labour- $CMS$  mix in most sectors. Finally, the finding of major labour misallocation in Southern regions, is in line with their relatively high – and in some cases dramatic – unemployment rates and with the persistent mismatch between the two sides of local labour markets.

As for  $k_{L,K}$ , results indicate the absence of a systematic distortion in the choice of the capital-labour mix. “Metal products” and “non-electrical machinery” sectors in the Mezzogiorno and “non-electrical machinery” sector in the Centre-North are the only exceptions. This result is partly in contrast to Destefanis (2001). Indeed, Destefanis (2001) provides non-parametric estimations of allocative inefficiency differentials between

Southern and Northern manufacturing firms over the period 1989-1997 and – assuming a two input (capital and labour) technology – finds capital over-utilization to be significantly higher in the South. However, due to the adoption of a different approach, the consideration of a different time span and the imposition of alternative assumptions on the technology, his results are not directly comparable to ours.

In summary, Southern and Centre-Northern firms show similarities in terms of allocative distortions between labour and capital on the one hand, and  $CMS$  on the other. The main peculiarity related to firm location is the difference in magnitude of the  $k$ -coefficients across the two macro-regions (especially  $k_{K,CMS}$ ). On the other hand, the  $k$ -coefficients change direction among regional contexts (that is, they assume values greater than 1 in one macro-region and less than 1 in the other one, or viceversa) only in a few cases. These cases are labelled with an asterisk in Table 5. In particular, in the food industry, Southern firms show significant labour and capital under-utilisation with respect to  $CMS$ , whereas we find very small (and not significant) over-utilisation for firms located elsewhere. On the other hand, in the “metal products” and “non-electrical

machinery” sectors, labour is over-utilized with respect to capital in the South, whereas the opposite occurs in Northern firms.

This set of results on allocative efficiency regional differentials – in combination with the evidence on the sign of the dummy  $D_{SOUTH}$  – provides useful information for the policy maker. Indeed, our results suggest that development policies should be committed to reducing the structural gap of the Mezzogiorno prior to providing reallocation incentives under the form of financial support to local firms, and

mainly addressed to contrast the under-investment problem in relation to the excessive outsourcing for Southern firms.

Finally, time dummies effects are presented in Table 6. Signs are mostly negative and significant especially in the last years (i.e., for the period after 2001). Therefore, evidence concerning performance deterioration along time exists. In general, this evidence reflects the productivity slowdown recently experienced by the Italian economy.

TABLE 6: TIME DUMMIES IN THE INPUT DISTANCE FUNCTION

	$D_{t=1999}$	$D_{t=2000}$	$D_{t=2001}$	$D_{t=2002}$	$D_{t=2003}$
Food	-0.012 (-0.95)	-0.005 (-0.38)	-0.025 (-2.02)**	-0.035 (-2.74)***	-0.023 (-1.86)*
Textiles, Apparel & Leather	-0.005 (-0.47)	0.007 (0.66)	-0.011 (-1.05)	-0.024 (-2.26)**	-0.046 (-4.32)***
Wood & Paper	-0.012 (-1.27)	0.026 (2.73)***	-0.014 (-1.48)	-0.038 (-4.06)***	-0.037 (-3.87)***
Chemicals & Rubber	-0.005 (-0.42)	0.178 (1.61)*	-0.028 (-2.51)***	-0.057 (-5.15)***	-0.062 (-5.58)***
Non-metallic Mineral Products	0.013 (0.91)	0.038 (2.67)***	0.017 (1.23)	0.024 (1.71)*	0.010 (0.71)
Metal Products	-0.027 (-3.16)***	0.0004 (0.05)	-0.043 (-5.05)***	-0.077 (-9.09)***	-0.076 (8.93)***
Non-electrical Machinery	0.001 (0.10)	0.001 (0.09)	-0.039 (-3.68)***	-0.065 (-6.06)***	-0.098 (-9.18)***
Electrical Machinery	-0.003 (-0.21)	-0.004 (-0.28)	-0.060 (-4.35)***	-0.100 (-7.18)***	-0.114 (-8.21)***

*t*-statistics are in parenthesis; \*\*\* statistically significant at 1%; \*\* statistically significant at 5%; \* statistically significant at 10%

## 6. CONCLUSIONS

We have studied regional economic efficiency differentials at the firm level in the Italian manufacturing sector, by estimating sector specific flexible (translog) input distance functions over the period 1998-2003. The implementation of such approach represents a methodological advance in the literature on the topic, allowing for pure measures of both technical and allocative efficiency within the same framework.

As for technical inefficiency, our results are in line with previous studies showing that firms located in the Italian Mezzogiorno suffer from a significant relative gap. Such a result provides

empirical support to the so-called “structural and technological gap” interpretation of the Italian dualism. On the other hand, we have found less remarkable regional differentials in allocative distortions in the choice of input mixes. In particular, capital and labour have been estimated to be both under-utilised with respect to variable inputs (typically represented by materials and services) for all firms in the sample. As main differences between firms in the two macro-regions, we found that capital is under-utilized to a higher extent in the South and labour under-utilization is statistically significant only for a few sectors in Northern firms. On the other hand, we do not find strong evidence of systematic distortion in the choice of the capital-labour mix.

A general policy recommendation follows from our analysis: a re-allocation of public resources available for development policies from business incentives measures towards public investment is needed. As a matter of fact, in contrast to the priorities declared by the policy maker, recent data on public spending in favour of Italian backward regions show that regional policies still devote too many resources to business incentives, rather than public investments. However, our results indicate that business support policy instruments are likely to be ineffective in the absence of a stronger commitment to narrow the structural gap of Southern regions.

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