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Electoral Accountability and Local Goverrnment Efficiency: Quasi-Experimental Evidence From the Italian Health Care Sector Reforms

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Abstract

This paper evaluates the effect of two policy changes on the efficiency of Italian regional governments in the provision of health care services: first a change in the electoral system; second a process of fiscal decentralisation. The electoral system was changed in 1995 and replaced a pure proportional system by a majoritarian system, fostering the transition of regional governments towards a presidential regime. The process of fiscal decentralisation took effect in 1998, when intergovernmental grants earmarked for the health care sector were replaced by regional taxes. The Italian context offers a unique source of data to test the predictions of recent theoretical models that support a positive relationship between government efficiency and the electoral accountability enhanced by institutions such as electoral rules and fiscal decentralisation. The paper provides two main contributions: 1) a comprehensive analysis of the two main reforms that involved Italian regional governments and the health care sector during the 1990s; 2) the evaluation of the impact of the electoral reform in a quasi-experimental setting. The final results provide empirical evidence in line with the findings of the theoretical models.

Keywords: electoral accountability, DEA, decentralisation, efficiency, health, IRAP, Italy, panel data, stochastic frontier

JEL Codes: H11, H51, H77, I11

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1. Introduction

The main purpose of this paper is to study empirically the relationship between the electoral accountability of politicians and local government efficiency, using a new data-set from Italian regions. The focus of the paper is on health services, which in Italy are mainly the responsibility of the regions. The efficiency of their provision at the regional level is measured in two ways, either by data envelopment analysis, or by stochastic frontier analysis.

The paper takes advantage of a process of decentralisation in Italy that began after the financial and political crises of the early 1990s, which deeply reformed the structure of regional governments. In 1995, new regional elections were held under a new electoral law that replaced the previous proportional system by a new system based on majority rule and which also favoured the establishment of a presidential regime in regional governments. Secondly, while health care expenditures, along with part of the decision-making powers, had been delegated to the regional level since the establishment of the regions, revenues have been characterised by a decentralisation process only during the 1990s. The most important reform occurred in 1998 when two new regional taxes replaced a large amount of the intergovernmental grants that were earmarked for the health care sector. The main intention of both reforms was to stimulate the accountability of the regional public authorities in order to increase the efficiency of local governments.

The main question that this paper will attempt to answer is whether the 1995 reform of political institutions and the process of fiscal decentralisation produced any effect on the efficiency of the health care sector. The empirical strategy is to treat the 1995 change in the regional political institutions and the process of fiscal decentralisation as exogenous policy variations. Unlike previous empirical literature [Barankay and Lockwood, 2007, Adam, Delis, and Kammas, 2008], the impact of the two policy changes is evaluated by estimating a frontier production function by both a parametric (stochastic frontier models) and non parametric approach (data envelopment analysis) thereby testing the robustness of the results with respect to the two approaches. Both methodologies are applied using a longitudinal dataset that includes financial and health care data disaggregated at the regional level for the fifteen year period of 1991–2005. The output of the health care sector will be measured in terms of mortality rates (neonatal and infant), that from many aspects can be considered the best available measure of output; the current public health care expenditures will be used as the main measure of

the inputs; finally, regional tax revenues earmarked for the health care sector will be used as a measure of the fiscal decentralisation process.

The analysis is focussed mainly on the role played by the 1995 electoral reform because the relationship between the new electoral system and the efficiency of regional governments is estimated in a quasi-experimental setting that allows a causal interpretation of this relationship. In particular the fifteen regions with normal statute have been used as the treated group, and the six regions with special statute, that were not affected by the reform, function as the control group. Then the treatment effect is evaluated by a difference-in-differences (DiD) estimator which allows of addressing the counterfactual question of what would have been the efficiency path after 1995 in the group of regions affected by the reform if the new electoral system had not been introduced.

Although the same quasi-experimental setting can not be used to evaluate the impact of the fiscal decentralisation process, it is very important to take also this second reform into account because a proper evaluation of the 1995 electoral reform can not be done regardless of the massive changes that the funding system of the health care sector underwent during those same years. Moreover, the lack of empirical studies makes the analysis of the relationship between fiscal decentralisation and government efficiency very important in itself, especially in the actual Italian political context where the central government is going to embark on a second process of fiscal decentralisation.

The results of the empirical models are very robust with respect to the different methodologies and different mortality rates. In particular the estimates show that the electoral reform unambiguously increased the efficiency of the regional governments by around 3%, a significant number considering that we are studying the health sector of a developed country and we are controlling for the impact of technical change and other environmental factors. As far as the impact of fiscal decentralisation is concerned, the empirical evidence suggests a general positive correlation between regional tax revenues and efficiency[1]. Subsequently, the effect of the 1998 tax reform on efficiency has been estimated between zero and 0.007% in relation to a 1% increase in regional tax revenues. Therefore, the total increase of efficiency due to the fiscal decentralisation reform has been evaluated roughly between zero and

[1]Our estimates report that a 1% increase in real per capita regional tax revenues increases efficiency by between 0.013% and 0.005%.

12% since real per capita regional tax revenues have risen on average from 33 to 630 euros after the reform. However, is important to note that the weak robustness of this last result supports the idea that the effectiveness of the 1998 tax reform might have been seriously undermined by the influence wielded by the central government that hindered regional government from setting an independent tax policy.

These findings are consistent with the theoretical literature that identifies several channels by which increased fiscal decentralisation and electoral accountability can increase the efficiency of service delivery. For example, the principal-agent models of Besley and Case [1995], Bordignon, Cerniglia, and Revelli [2004], Besley and Smart [2007], and Hindriks and Lockwood [2009], argue that fiscal decentralisation can boost electoral accountability via the mechanisms of yardstick competition[2] and tax competition[3], and by reducing the scope for targeting efficient provision to a bare majority of districts. The theoretical models that are relevant to the 1995 reforms in Italy are primarily those which compare proportional and majoritarian systems (see Persson and Tabellini [2000], Chapters 8 and 9). These show that majoritarian systems can affect electoral accountability by either increasing or decreasing the probability of rent diversion by politicians, bringing about an uncertain impact on government efficiency. With regard to the form of government, the theoretical models that compare presidential and parliamentary regimes (see Persson and Tabellini [2000] Chapter 10) show that presidential regimes are associated with smaller governments and less waste than parliamentary regimes. Hence, the positive impact of presidential regimes on government efficiency seems less uncertain.

The rest of the paper is structured as follows. Section 2 describes briefly the changes that affected regional political institutions in 1995 and the main aspects of the fiscal decentralisation process that reformed the regional health

[2]Yardstick competition occurs when voters can compare tax policies and levels of public-good provision that have been adopted by officials in other regions with those offered in their own jurisdiction and then use their ballots as votes on the performance of their incumbents.

[3]Tax competition occurs when local governments compete over tax rates in order to attract more tax-payers to expand their tax base. In the spirit of the Leviathan hypothesis [Brennan and Buchanan, 1980], tax competition should reduce local government taxing power, improving voters welfare, only if officials are rent-seeking. Otherwise, the 'race to the bottom', (reduction of the tax rate) would very likely reduce social welfare due to an undersupply of public goods.

care funding system. Section 3 discusses the empirical strategy, whereas the empirical models are discussed in Section 4. The data are examined in Section 5. Finally, Section 6 reports the main results, Section 7 the robustness checks, and Section 8 presents the conclusions.

2. The 1995 electoral reform and the fiscal decentralisation process

According to the Italian Constitution, there are five tiers of government: metropolitan areas, municipalities, provinces, regions, and the central government. Health care is the most important function of regional governments. According to 2005 figures, almost 98% of health care expenditures are allocated at the regional level and they represent more than 50% of total regional budget expenditures. In this area, central government legislation enacts general principles, and regional governments pass laws within this framework.

It is important to note that the Italian regions can be divided into two different groups—six special statute regions[4] and fifteen normal statute regions.[5] Since their establishment, the special regions have enjoyed a higher level of legislative autonomy from the central government by virtue of a special statute that allows them to make laws in more fields than the other fifteen regions, with the exception of the health care sector. As a result, total budget expenditures, excluding health care, are almost four times higher than in the other regions (see Figure 1) in real per capita terms. However, since these additional expenditures are completely financed by additional grants from the central government in shared national taxes, the level of fiscal decentralisation is, on average, approximately equal in the two groups of regions.

In February, 1995, two months before the regional elections, the central government introduced a new regional electoral system.[6] This reform completed the renewal that involved the electoral systems of all levels of government.[7] The main issue in the parliamentary debate was the proportion

[4]Friuli-Venezia Giulia, the autonomous province of Trento, the autonomous province of Bolzano, Aosta Valley in the north, and the two main islands of Sardinia and Sicily in the south.

[5]Northern regions: Piedmont, Lombardy, Veneto, Liguria, Emilia Romagna. Central regions: Tuscany, Marche, Umbria, Lazio, Abruzzo. Southern regions: Molise, Campania, Apulia, Basilicata, Calabria.

[6]Law no. 43/1995.

[7]In 1993, the direct election of the mayor and the president of the province revolu-

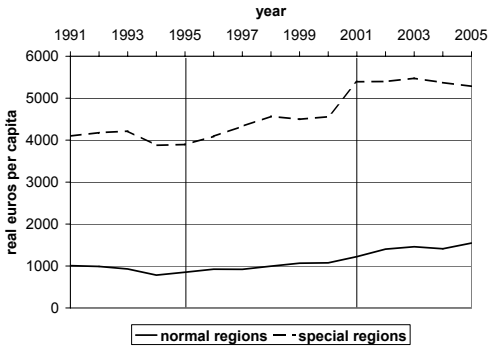


Figure 1: Average total budget expenditure without health care expenditure in special and normal regions, years 1991–2005. Source ISSiRFA-CNR [1982-2008].

of seats to be assigned by a majority method. This indicated a desire to change the previous simple proportional system to a new system in order to stimulate electoral accountability of regional politicians following the political crisis in the early 1990s that involved all levels of governments.[8] Under the new electoral rules, 20% of the seats in the regional parliaments will be assigned by the majority method. This was sufficient to guarantee the formation of a government by the winning coalition and to create a bipolar political space. Moreover, under the new electoral system, the names of the candidates, who compete for the presidency, appeared for the first time on the ballots as heads of the electoral lists. As a result, beginning in 1995, the form of regional governments began to evolve towards a presidential regime, although it was only in 1999 that direct election of the heads of the regional governments was formally introduced. In special regions, however, the special statutes did not allow the central government to introduce the new electoral system by an ordinary law as in the normal regions. As a result, the spe-

tionised the local electoral systems. In 1994, after the referendum of the previous year, the election of members of the national parliament was held under a new majority system, which replaced the previous proportional system.

[8]During those years, the entire political class underwent a change as a result of 'Tangentopoli', the system of corruption that was uncovered by a nationwide judicial investigation of political corruption named *Mani pulite* (Italian for 'clean hands'). *Mani pulite* began in February 1992 and led to the demise of the so-called First Republic, resulting in the disappearance of the parties that had led the political scene since the post-war period.

cial regions changed their previous proportional/parliamentary system only some years after the normal regions, since the required constitutional law was only passed by the central government in 2001.[9] According to the natural expiration of the regional governments in office, the first regional elections under the new system were held in 2001 in Sicily, in 2003 in Friuli V.G. and Trento, in 2004 in Sardinia, and in 2008 in the Aosta Valley (where the new electoral system was introduced only in 2007). In the autonomous province of Bolzano, however, the old proportional/parliamentary system is still in effect.

Figure 2 provides a brief description of the fiscal decentralisation process regarding the funding of the regional health care systems since the beginning of the 1990s in both groups of regions. First of all, it is important to note that, in per capita terms, health care expenditure (dashed line) and its funding sources (grants, regional taxes, and regional health deficit) are very similar in the special and the normal regions. This is a result of the constitutional mandate requiring uniformity in the provision of health services across the national territory that induced the central government to equalise per capita health expenditures and financing across regions. The funding of the regional health care systems underwent three main reforms during the 1990s (see Bordignon, Mapelli, and Turati [2002] for a detailed analysis).

In 1993, two health taxes that were previously collected by the central government were delegated to the regions that were also empowered to raise their rates to avoid running deficits. Moreover, the way of organising the supply of health services was also changed, giving more managerial autonomy to the regions.

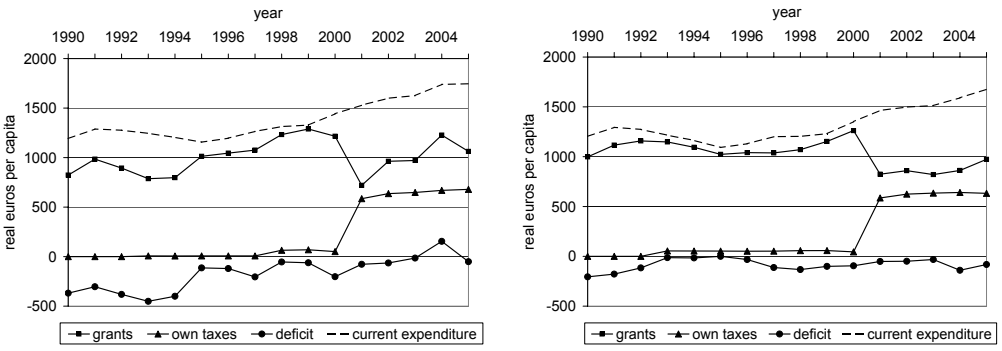
In 1998 a substantial portion of the intergovernmental grants earmarked for the health care sector were replaced by two new regional taxes: first, IRAP[10], a value added tax on productive activities that applies to companies, private and public entities and commercial and non-commercial activities[11]; second, a regional, additional, personal income tax (rPIT)[12]. According to

[9] Constitutional law no. 2/2001

[10] Imposta Regionale sulle Attività Produttive (Regional Tax on Productive Activities).

[11] It is levied on the net value of the production of each region; its standard rate at present is 3.9% and regional governments can increase or decrease it by up to 1% [Longobardi, 2005].

[12] At present, its standard tax rate is 0.9% and each regional government can increase it up to 1.4%.



(a) special regions

(b) normal regions

Figure 2: Structure of the health care funding systems in special and normal regions, years 1990–2005. Source ISSiRFA-CNR [1982-2008].

2005 figures, IRAP and rPIT accounted for 15% and 3%, respectively, of total regional revenues, and together financed almost 40% of total health expenditures.

In 2001, the remaining quota of intergovernmental grants was replaced with revenue-sharing of the value added tax (VAT) and petrol tax, including an equalising transfer for the poor regions. However, after 2001, the way in which grants were allocated changed only from an accounting perspective, because the new mechanism[13] was only partially put into practice and then, after six years, completely abandoned. Finally, the central government forced regional governments to use their own tax resources to finance their residual health care deficit.

As shown in Figure 2, however, intergovernmental grants remained the main source of funding until the year 2000. In fact, the 1993 reform produced only a small increase in the level of regional tax revenues, and the 1998 tax reform, given the uncertainty surrounding its economic effects, became effective only after a three-year transitory regime. Moreover, Figure 2 shows clearly that the process of fiscal decentralisation affected both group of regions in a very similar way.

In conclusion, it is important to note that, because of the influence wielded by the central government, only slight changes have been introduced

[13]Law no. 56/2000.

by regional governments to the standard rates of IRAP and rPIT fixed by the central government.[14] Therefore, most of the differences in the tax revenues among regions can be explained by the 'income gap' between the north and the south of the peninsula, rather than by differences in the fiscal polices adopted by regional governments.[15] From some aspects this is good news, because helps minimise the risk of endogeneity; on the other hand the influence wielded by the central government is bad news, because it increases the scepticism about the possibility that the 1998 tax reform might have stimulated electoral accountability of local politicians sufficiently to affect the efficiency of regional governments in the provision of health care services.

3. Empirical strategy

The main argument that this paper seeks to resolve is whether the 1995 electoral rules and the fiscal decentralisation process that reformed the regional health care funding systems have stimulated the electoral accountability of local politicians.[16] Given the difficulty of measuring electoral accountability, empirical evidence of this relationship can be inferred by studying the impact of the 1995 electoral reform and fiscal decentralisation on the efficiency of Italy's regional governments in the provision of health care services.[17]

[14] In 2003 the center-right government, in order to fulfil its programme of cutting the general tax burden, banned regional governments from raising IRAP and additional personal income tax rates. The ban was then removed in 2006 by the new center-left government.

[15] The average 2005 per capita GDP in the south of the country is around 60% of the average GDP per head in the rest of the country.

[16] Electoral accountability is defined in Seabright's 1996 seminal paper [Seabright, 1996] in terms of the probability that welfare levels of a given jurisdiction determine the election of the government. Recently, Lockwood [2006] proposed to characterise this concept more precisely, either by the degree to which institutions allow the government to divert rents or by the degree to which institutions allow special interest groups to distort government decision-making by lobbying.

[17] Government efficiency in the provision of goods and services is usually measured by the difference between the actual level of the output and the maximum level of output achievable, given the inputs employed in the production process. Alternatively, government efficiency can be measured by the difference between the actual cost of local services and the minimum cost attainable, given the actual output and the inputs prices. However, this second approach has been discarded in this paper in order to avoid the problems related to the scarce availability of input price data.

So far, the impact of different political institutions and fiscal decentralisation on government efficiency have been studied separately using mainly cross-sectional data-sets. For example, Persson and Tabellini [2005], using a cross-section of around 70 countries, provide empirical evidence of the effect of majoritarian electoral systems and presidential regimes on rent extraction (measured in terms of perceived corruption by public officials) and productivity (measured in terms of labour and total factor productivity) in line with the theoretical predictions of a positive relationship.

The effect of fiscal decentralisation, instead, has been estimated following a reduced-form approach, where measures of general government performance (e.g., perceived corruption or indicators of the output and/or quality of the service in sectors such as health care and education) have been regressed over measures of fiscal decentralisation, such as the the ratio of local public expenditures over general government expenditures. Most of the empirical evidence, based on cross-sectional data-sets of a wide range of developed and developing countries, attests to the positive effect of fiscal decentralisation on government efficiency [Fisman and Gatti, 2000, Faguet, 2004] with only few exceptions (e.g., Treisman [2000]). Recently, however, Barankay and Lockwood [2007] advocated the need to estimate the effect of decentralisation in a model that mimics the production function of government activities by using longitudinal datasets. To support their criticism, they estimated a model of the education system's production function by means of panel data from Swiss cantons between 1982 and 2000. Following the same idea, but using a different methodology, Adam et al. [2008] identified the effect of fiscal decentralisation following a 'two-stage approach' where data envelopment analysis of a panel of 21 OECD countries between 1970 and 2000 was used to compute country-specific efficiency indices in the first stage. In the second stage, country-specific efficiency indices were regressed on an extensive set of alternative fiscal decentralisation measures. Again, their results supported the evidence of a positive and significant effect of decentralisation on government efficiency.

In line with the previous empirical literature, we estimate a reduced-form relationship since we do not have direct evidence of an increase in electoral accountability like a reduction in rent diversion or in the influence of lobbies. Unlike previous empirical works, however, the impact of the two policy changes are evaluated together by estimating a frontier production function either by data envelopment analysis (DEA hereafter) or by panel data stochastic frontier models (SFM hereafter), using a longitudinal dataset made

up of financial and health care data disaggregated at the regional level over the period between 1991 and 2005. To that end, each regional government will be treated as a decision-making unit that provides health care services under the behavioural assumption that each of them operates in order to maximise the output given the inputs (output approach), or alternatively, that operates in order to minimise the level of inputs given the level of output (input approach). According to these simplified assumptions, and in line with the standard production frontier models, regional governments are assumed to produce health care 'output' according to the following production function:

$$y_{it} = f(\mathbf{x}_{it};\beta)g(\mathbf{z}_{it};\gamma)h(\mathbf{s}_{it};\delta)exp(v_{it}+u_i) \quad i=1,2,...,N \quad \text{and} \quad t=1,2,...,T. \tag{1}$$

where N is the number of regions, T the number of years, y_{it} the output of the health care sector, $\mathbf{x}_{it}$ is an $(L\times 1)$ vector of inputs, $\mathbf{z}_{it}$ is an $(M\times 1)$ vector of policy variables, $\mathbf{s}_{it}$ is a $(P\times 1)$ vector of control variables, β is a vector of technology parameters, γ is the vector of policy variables' coefficients, and finally δ is the vector of control variables' coefficients. For simplicity, and with little loss of generality, we assume separability between $f(.)$, which describes the technology of the health care sector, $g(.)$ and $h(.)$ which, respectively, represent the way in which the policy changes and environment affect the output. Since we are considering a 'stochastic' frontier production function, the error term has two components: the idiosyncratic error $v_{it} \sim i.i.d.(0,\sigma_v^2)$, which accounts for the statistical noise in the production function, and the inefficiency error component u_i, which is assumed to satisfy the restriction $u_i \leqslant 0$, and provides a measure of 'residual' or 'unobservable' efficiency that captures the distance between the actual level of output y_{it} and the frontier once the influence of exogenous environmental and policy variables are taken into account. For this reason u_i can be interpreted as the managerial efficiency component that can not be observed directly but only inferred as a residual. In this case since we are conducting a short term analysis, u_i can be assumed time invariant.

4. The empirical models

The goal of this paper is to evaluate the impact of the policy variables ($\mathbf{z}_{it}$) on $e_{it} = y_{it}/f(\mathbf{x}_{it};\beta)$, corresponding to the Debreu [1951], Farrell [1957] measure of technical efficiency, once both the influence of managerial efficiency

(u_i) and the influence of other environmental variables ($\mathbf{s}_{it}$) are taken into account. Given the baseline model in (1), this goal can be achieved following two different approaches: 1) Data envelopment analysis (DEA)[18], where following a two-stage procedure the effect of the policy variable is evaluated directly on efficiency without imposing any restriction on the shape of the technology $f(.)$. 2) Panel data stochastic frontier models (SFM)[19], where we estimate the impact of the policy variables in one single stage, but the correct specification of the technology f(.) is crucial in order to interpret point estimates of γ as the impact that the policy variables exert on government efficiency.

By following both approaches, it is possible to test the robustness of the results with respect to the assumptions behind the two methodologies, especially the correct specification of the production function $f(.)$ in the case of SFM, and the validity of the two-stage procedure in the case of DEA. If point estimates are not driven by the particular specification of $f(.)$ or by the two-stage approach, then both methodologies should return the same results.

4.1. Data envelopment analysis

The simplest way to describe the two-stage procedure is to proceed backward.[20] In the second stage we estimate the following model, derived directly from the baseline model (1), assuming for simplicity a Cobb–Douglas functional form for $g(.)$ and $h(.)$, and no restriction on the functional form of the technology $f(.)$.

[18]DEA was first developed by Charnes, Cooper, and Rhodes [1978]; a complete survey of data envelopment analysis can be found in Ali and Seiford [1993].

[19]Stochastic frontier models have been developed simultaneously by Aigner, Lovell, and Schmidt [1977] and Meeusen and van den Broeck [1977]; a complete survey of panel data models is provided by Kumbhakar and Lovell [2000].

[20]One of the first applications of this procedure was by Timmer [1971] in an attempt to explain interstate variation in technical efficiency in US agriculture. A two-stage approach has been used also by McCarty and Yaisawarng [1993] to investigate efficiency in New Jersey public school districts. Worthington and Dollery [2002] compare different methods to account for the effect of environmental factors on the efficiency of 73 New South Wales local governments in Australia. Afonso and Aubyn [2006] considered a two-stage approach in relation to the health production process of OECD countries by regressing efficiency scores on a set of variables such as GDP per head, education level, and health behaviour (such as obesity and smoking habits). Recently, Adam et al. [2008] have used the same methodology to estimate the effect of decentralisation on the efficiency of the public sector using a panel of 21 OECD countries over the period 1970 to 2000.

$$\frac{y_{it}}{f(\mathbf{x}_{it},\beta)} = \prod_{m=1}^{M} z_{itm}^{\gamma_m} \times \prod_{p=1}^{P} s_{itp}^{\delta_p} \times \exp\left(v_{it} + u_i\right) \tag{2}$$

In the first stage, DEA is used to estimate $\frac{y_{it}}{f(\mathbf{x}_{it},\beta)}$ non-parametrically without making any assumption about the shape of $f(.)$. In particular, in the case of the output approach,[21] let ϕ_{it} be the solution of the following linear program:[22]

$$\underset{\phi,\lambda}{max}\ \phi \quad s.t.\ \ \mathbf{x_{it}} \geqslant \mathbf{X}\lambda;\ \ \mathbf{Y}\lambda \geqslant \phi y_{it};\ \ \lambda \geqslant 0;\ \ \iota'\lambda = 1. \tag{3}$$

Then, $e_{it}^{DEA} = 1/\phi_{it}$ will provide an estimate of the distance between y_{it} and $f(\mathbf{x}_{it},\beta)$ for each region i in the year t. The e_{it}^{DEA} are numbers constrained to be between 0 and 1 that correspond to the Debreu [1951], Farrell [1957] indices of technical efficiency where 1 is related to a fully efficient regional government.

The linear program in (3) is solved by using a pooled approach where only one production frontier is estimated and each region is compared also with itself in another year. In this way it is possible to use all the $N \times T$ observations in order to minimise the upward small-sample bias that affects this non-parametric estimator of $\frac{y_{it}}{f(\mathbf{x}_{it},\beta)}$. As argued by Kneip, Park, and Simar [1998] this bias produces a small measurement error in the estimated indices of efficiency e_{it}^{DEA} that vanishes as the number of observations increases.

Taking logs in (2), and taking linear and quadratic time trends to be among the z_{itm} to account for the technical change, the partial effect of the policy variables on regional government's efficiency can be be evaluated estimating the parameters γ in (4).

[21] In the paper both the input and output approach have been used.

[22] In (3) $\mathbf{x_{it}}$ is an $(L\times1)$ vector of input of region i at time t, $\mathbf{X}$ is an $(L \times NT)$ matrix of inputs of all regions, $\mathbf{Y}$ is a $(1\times NT)$ vector of outputs of all regions, λ is a *$(NT\times1)$* vector of optimal weights attached to the peers of regions i; ι is an $(NT\times1)$ vector of ones, the last constraint is important for allowing variable returns to scale.

$$\log\left(e_{it}^{DEA}\times 100\right)=\sum_{m=1}^{M}\gamma_m\log z_{itm}+ \\ +trend+trend^2+\sum_{p=1}^{P}\delta_p\log s_{itp}+v_{it}+u_i \tag{4}$$

The simplest way to disentangle the effect of u_i from the stochastic component of the model (v_{it}) is to interpret the second stage regression in (4) as a standard fixed effect panel data model, where u_i is replaced with the regional fixed effect that will capture the unobserved managerial efficiency of regional governments. Given the long panel structure, regional fixed effects can be treated parametrically, including a set of regional-specific dummies. Consequently, least square dummy variables (LSDV) is the simplest consistent estimator equivalent to the within the group estimator.

4.2. Panel data stochastic frontier models

Assume again a Cobb–Douglas functional form for $f(.)$, $g(.)$, and $h(.)$. Then, the baseline model in Equation (1) can be rewritten in the following way:

$$y_{it}=\prod_{l=1}^{L}x_{itl}^{\beta_l}\times\prod_{m=1}^{M}z_{itm}^{\gamma_m}\times\prod_{p=1}^{P}s_{itp}^{\delta_p}\times\exp\left(v_{it}+u_i\right) \tag{5}$$

Taking logs in (5) yields our linear panel data stochastic frontier model:[23]

$$\log y_{it}=\sum_{l=1}^{L}\beta_l\log x_{itl}+trend+trend^2+ \\ +\sum_{m=1}^{M}\gamma_m\log z_{itm}+\sum_{p=1}^{P}\delta_p\log s_{itp}+v_{it}+u_i \tag{6}$$

The key feature of the panel data SFM approach is the association of the managerial efficiency term (u_i) with the unobserved heterogeneity. The simplest way to disentangle the effect of u_i from the stochastic component of

[23] A quadratic trend will also be included among the inputs in order to control for technical change.

the model (v_{it}) is, again, to interpret the stochastic frontier model in (6) as a standard fixed effect panel data model. To that end, the efficiency error component u_i is replaced with the regional fixed effect.

As said before, since the number of regions is fixed and the asymptotic properties are based on the number of years, the unobserved heterogeneity across regions can be treated parametrically, including a set of regional-specific dummies. The main advantage of doing so is to avoid any assumption of independence between the unobserved heterogeneity and the other regressors, an assumption that would not be tenable in this context, where the unobserved heterogeneity is interpreted as a measure of residual inefficiency and can be easily correlated with the inputs. Consequently, least square dummy variables (LSDV) is the simplest consistent estimator equivalent to the within the group estimator.[24] Finally, point estimates of the parameter vector γ will provide an evaluation of the impact of the policy variables on government efficiency if the production function $f(.)$ has been correctly specified. In fact, the parameter γ captures the partial effect of the policy variables on the level of output once controlling for the level of the inputs (i.e., we are following the output approach).[25]

5. The data

As shown in Table 7 in the Appendix, the variables in the data-set can be split into four main groups: the output and input variables of the health system's 'production function', the policy variables to capture the impact of

[24] In the case of correlation between the input variables and the idiosyncratic error term, lagged input variables will be used as instrumental variables in the estimation of the reduced form equations.

[25] An alternative estimation strategy would be that of assuming a specific distribution for the two error component, usually a standard normal distribution for v_{it} and a truncated normal distribution for u_i. The impact of the policy variables, then, can be estimated through maximum likelihood assuming that the vector $\mathbf{z}$ is a specific component of the mean of the inefficiency error component (see Battese and Coelli [1995] for more details about this approach). The advantage of this approach is that u_i can be time variant, but the consistency of the maximum likelihood estimator depends on two crucial assumptions: the independence between the inefficiency error term and the inputs, and the correct specification of the distributions of the composite error term. In this paper it has been preferred not to rely on results based on these two strong assumptions because the focus is not the measurement of the managerial efficiency.

the policy changes on efficiency, and the control (or environmental) variables to control for the impact of the environment.

5.1. Output measures

The identification of the output of the health system is a difficult issue because it needs to be measured from many angles, such as the increase in the length of life, improvements in quality of life and the equity of the access to services. This means that just one indicator may not be an appropriate measure of output. On the other hand, the composite indicator elaborated by the World Health Organisation [WHO, 2000] has been criticised on several grounds by Hakkinen and Joumard [2007], and in many empirical studies only life expectancy or mortality indices have been used as outcome variables [Afonso and Ammar, 2005, Or, 2000]. For example, in the assessment of the efficiency of the health care sectors across 191 countries, Evans, Tandon, Murray, and Lauer [2000] measured the outcome of health care systems in terms of disability adjusted life expectancy (DALE), an indicator of healthy life expectancy that differs from the 'pure' life expectancy or mortality indices, in that it takes into account the quality of life other than its length. Recently, a report by the Italian government [Bellini, Braga, Rebba, Rodella, and Vendrami, 2001] aimed to develop a system of indicators for the evaluation of the performance of the health care system in different dimensions. On the basis of the action also taken in this direction by other developed countries, the main conclusion of the report is that an all-inclusive index capable of measuring the performance of the system alone does not exist, and that the most suitable indicators are, at the moment, life expectancy[26], DALE, and mortality indices (mainly infant mortality[27] and neonatal mortality rates[28]).

Since DALE disaggregated at the regional level was not available for the whole period between 1991 and 2005, only neonatal mortality rates, infant mortality rates, and life expectancy could be taken into account in this study. In the end it has been decided to measure the output in terms of mortality

[26]Life expectancy is the average number of years of life remaining at a given age and is computed separately for men and women.

[27]Infant mortality is the number of babies who die during the first year of life per 10,000 new-borns.

[28]Neonatal mortality is the rate of new-borns who die during the first day of life per 10,000 new-borns. In some cases it is also measured in relation to the first 6 or 28 days of life.

rates using infant mortality in the main empirical model and neonatal mortality for robustness checks. Figure 3 reports, by special and normal regions, the average infant mortality rate, and the neonatal mortality rate at one day after birth.

The choice of mortality rates has been driven by the fact that from many aspects mortality rates are superior to life expectancy as a proxy for the output of the health care sector.[29] First of all, mortality rates allow of assessing the health care system's effectiveness minimising the influence of environmental factors.[30] In the computation of the mortality rates the event is attributed to the regional health care system where the death of the baby occurred, thereby wiping up most of the spill-over effects of other regional health care systems that typically affect life expectancy that is measured, instead, on a residential basis. Moreover, mortality rates can capture the short run changes that occurred in the health care system during the time span of our analysis better than life expectancy, that instead is believed to reflect changes only in the long run. Finally, mortality rates are not subject to statistical manipulation as are the data on life expectancy.

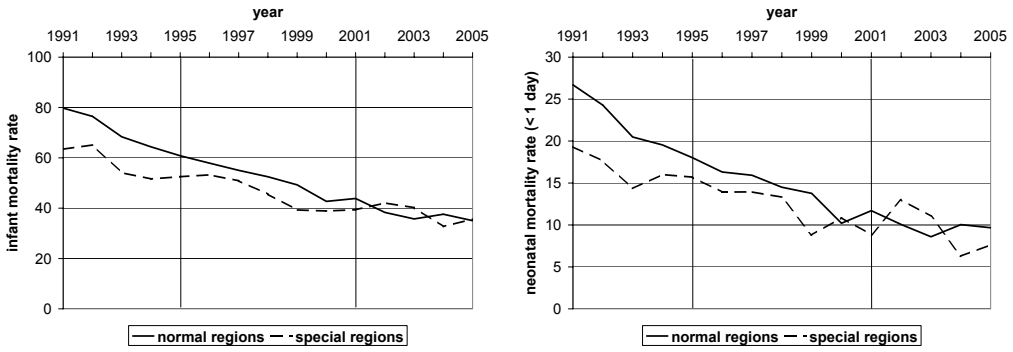
5.2. Input measures

As far as the input side is concerned, with regard to data availability, the real current public health care expenditure for services provided directly has been used as a measure of labour, and the number of public outpatient clinics and laboratories per 100,000 inhabitants that provided services directly has been used as a measure of capital (see Figure 4).[31] The choice to exclude from the inputs the health expenditure in reimbursement and the number

[29]The empirical evidence obtained using life expectancy as a measure of output (not shown for brevity in the paper but available on request) is only partially in line with the results reported in the paper. However, given the lower reliability of life expectancy as a measure of output this discrepancy does not undermine the robustness of the results discussed in the paper.

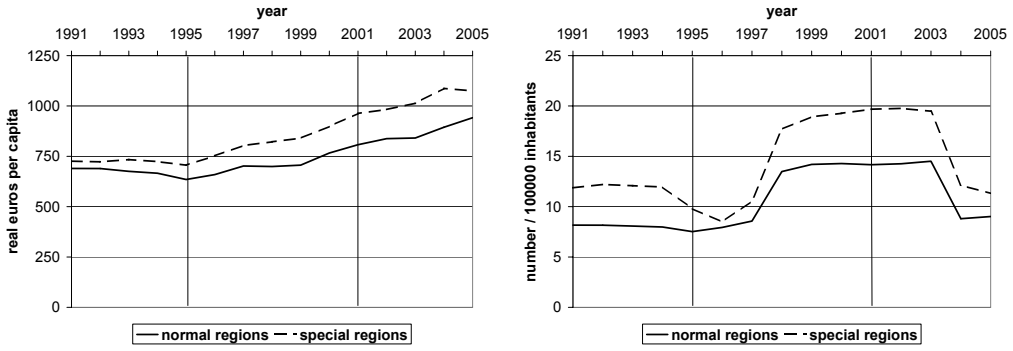
[30]It is also important to note that most of the variables linked directly to lifestyle, such as, for example, the consumption of tobacco or the level of pollution, are not available disaggregated at the regional level for the entire time series dimension. Instead data about variables that might influence mortality rates, like the mother's age at the birth of her first child, the birth rate, and the percentage of caesarean births can be easily collected.

[31]Although current public expenditure is included among the inputs, either DEA or SFM will be used to estimate technical efficiency because current health expenditure is only a proxy of current physical inputs.



(a) infant mortality (b) neonatal mortality rate at 1 day after birth

Figure 3: Output variables by special and normal regions, years 1991–2005. Source ISTAT [2008].



a) public health care expenditure for services provided directly

(b) number of public outpatient clinics and laboratories

Figure 4: Input variables by special and normal regions, years 1991–2005. Source ISTAT [2008].

of private clinics has been determined by the necessity to avoid mixing up expenditure values and clinics of different nature in the specification of the production function $f(.)$. This information, however, will be included in the empirical models in terms of control variables.

5.3. Policy variables

The relationship between the new electoral system and the efficiency of regional governments can be estimated in a quasi-experimental setting. The idea is to form the control group with the six special regions whose electoral system remained unchanged, so that the difference-in-differences (DID) estimator can be used to assess the magnitude of the 'treatment effect' of the electoral reform. To that end, a discrete variable that takes the value 1 starting from 1995 onwards and its interaction with the treated group dummy will be included among the policy variables. It is important to note that the 1995 electoral reform can be considered an exogenous policy variation since this policy change was not an autonomous decision of the regional governments: the new electoral system was introduced through a central government law.

The degree of fiscal decentralisation will be measured in terms of the real per capita amount of regional tax revenues earmarked for the health care sector (see Figure 2). Then, to evaluate the impact of the 1998 tax reform, the interaction term between our measure of fiscal decentralisation and a discrete variable that takes the value 1 starting from 2001 (the year in which this reform became effective) is included among the policy variables. The exogeneity of the regional tax revenues earmarked for the health care sector can be supported by the fact that all the changes in the level of fiscal decentralisation were implemented by central government provisions, and most of the difference among the values of per capita regional tax revenues is due to the unequal distribution of income, rather than to different regional tax rates, as discussed at the end of Section 2. In fact, our measure of fiscal decentralisation mainly captures the effect of the central government policy aimed at reducing the dependence of regions on intergovernmental grants. However, a formal test for the exogeneity of the regional tax revenues is performed, and the null hypothesis of exogeneity is never rejected.

5.4. Control variables

This last set of variables can be split into four groups. First, in order to take into account all changes that occurred in the funding system of the

health care sector, the other two sources of financing—grants and deficit—will be also included among the policy variables. In particular, a negative effect of intergovernmental grants on efficiency is expected because, as pointed out by Rodden [2003], grants might influence electoral accountability in the opposite way with respect to regional tax revenues. As far as the impact of a health care deficit is concerned, it is not clear what its sign should be. However, in the Italian context, where regional deficits are usually settled by the central government, the level of deficit can be associated with the intensity of regional expectations of future bailouts. As pointed out by Bordignon and Turati [2009], higher bailout expectations are associated with softer budget constraints, therefore a negative relationship between regional health deficit and efficiency can be expected.

In the second group have been included the variables useful for controlling for the contribution of the private sector to the health condition of the population such as: household private health expenditure not covered by public funds; the health expenditure in reimbursement; and finally the number of private clinics.

The third group includes more general variables such as: the regional gross domestic product to control for the standard of living and for differences in the tax base; the total regional budget expenditures net of health care expenditure, to take into account the amount of resources employed in other sectors; the population density that can be used to capture either the possibility of economies of scale or the possibility of congestion in service provision; the dependency index, which is the ratio of the population which is either over 65 or below 14 to the rest of the population, i.e., those between 15 and 64, which is useful for taking into account the demand pressure on the health care system.

Finally, in order to control for those aspects that might influence directly mortality rates, the following variables have been included: the maternal age at the time of birth of her first child, the birth rate, and the percentage of caesarean births.

6. Analysis of the results

Point estimates for the impact of the 1995 electoral reform and the 1998 fiscal reform are summarised in Table 1. The first column displays the results obtained following the two-stage procedure where, in the first stage,

data envelopment analysis is performed following the output approach in order to be compared with the panel data stochastic frontier model approach whose results are displayed in the last column. A general description of the control variables included in each regression and the point estimates of their coefficients are reported in the Appendix.

Table 1: Point estimates of the policy variable effect, output of the health care sector measured in terms of infant mortality.

Medotology	**DEA**	**SFM**
Dependent variable	*Efficiency index*	*100 - morality rate*
dummy 1995[(1)]	2.06 (2.23)	-2.81 (2.34)
treatment effect of 1995 elctoral reform[(1)]	2.98* (1.52)	2.75* (1.46)
dummy 2001[(1)]	-52.2* (27.2)	-29.8 (23.9)
tax revenue earmarked for the health care sector[(2)]	0.013***(0.005)	0.008** (0.004)
tax revenue earmarked for the health care sector X dummy 2001[(2)]	0.007* (0.043)	0.004 (0.037)
Quadratic trend	yes	yes
Control variables	yes	yes
Observations	315	315
Number of regions	21	21

*Robust standard errors in brackets () * significant at 10%; ** significant at 5%; *** significant at 1%.*

(1) Percentage variation in efficiency.

(2) Percentage variation in efficiency after 1% change of the regional tax revenue.

As shown in the first two rows of Table 1, point estimates of the treatment effect of the 1995 electoral reform are very robust with respect to the econometric approach, it is possible to observe an average increase in efficiency of roughly 3% in the 'treated group' of normal regions after the introduction of the new electoral system. The positive effect attributed to the electoral reform is driven both by the input and the output sides. As shown in the previous Figure 3 (a) the gap in the level of infant mortality shrank rapidly between the two groups, and as reported before in Figure 4 (a) health care expenditure has been growing faster since 1995 in the control group of special regions.

As shown in the last three rows of Table 1, the relationship between the regional tax revenues earmarked for the health care sector and efficiency is positive and very robust with respect to the econometric approach, generally a 1% increase in real per capita regional tax revenues corresponds to an increase of efficiency between 0.013% and 0.008%. The impact of fiscal decentralisation related to the 1998 tax reform, estimated through the interaction term between regional tax revenues and the dummy 2001, can instead

be seen as follows. A 1% increase in real per capita regional tax revenues increased efficiency by 0.007% after 2001, the year in which the 1998 tax reform became effective. Averaging across regions, real per capita regional tax revenues have risen by a multiple of 18 after the 1998 tax reform (from 33 to 630 euros as show in Figure 2), so the final impact of this decentralisation reform on efficiency can be estimated as approximately equal to 12%.

In conclusion, it is also interesting to note the results obtained for the impact exerted on regional government efficiency by the the other two sources of financing. As reported in Table 5 and Table 6 of the Appendix, especially in the case of the input approach, the estimates show that a 1% increase in the level of grants is related to a reduction in government efficiency between 0.15% and 0.08%; and a 1% increase in the level of the health care deficit generates a negative impact on government efficiency between 0.016% and 0.006% in the group of normal regions.[32] The negative relationship observed between government efficiency and the other two sources of financing supports the idea, advocated in many empirical and theoretical works (see, for example, Oates [1985], Rodden [2003], and Bordignon and Turati [2009]), that a centralised funding system based on intergovernmental grants and deficits settled by the central government may not stimulate local government efficiency because local politicians are induced to exploit the 'fiscal commons' represented by the national budget.

7. Robustness checks

7.1. In-depth analysis

The first concern is about the robustness of the results with respect to other mortality rates. In this regard, the conclusions obtained using the neonatal mortality rate at 1 day, reported in the following Table 2, are in line with the results discussed above in support of the hypothesis that the 1995 electoral reform exerted a positive impact on the efficiency of regional governments in the delivery of health care services. Instead in relation to the impact of fiscal decentralisation, although the point estimates are still positive, the standard errors are now larger making our estimations not statistically different from zero.

[32] The impact of the health care deficit has been estimated separately for the two group of regions because this last source of financing followed a different pattern in the two groups (see Figure 2).

Table 2: Point estimates of the policy variable effect, output of the health care sector measured in terms of neonatal mortality rate at 1 day.

Medotology	**DEA**	**SFM**
Dependent variable	*Efficiency index*	*100 - morality rate*
dummy 1995[(1)]	-0.71 (1.97)	-3.51* (2.04)
treatment effect of 1995 elctoral reform[(1)]	3.87*** (1.21)	3.35*** (1.20)
dummy 2001[(1)]	-24.6 (21.2)	-17.5 (21.5)
tax revenue earmarked for the health sector[(2)]	0.009** (0.004)	0.008** (0.004)
tax revenue earmarked for the health sector X dummy 2001[(2)]	0.032 (0.034)	0.022 (0.035)
Quadratic trend	yes	yes
Other policy variables	yes	yes
Control variables	yes	yes
Observations	315	315
Number of regions	21	21

*Robust standard errors in brackets () * significant at 10%; ** significant at 5%; *** significant at 1%.*

(1) Percentage variation in efficiency.

(2) Percentage variation in efficiency after 1% change of the regional tax revenue.

The second concern is the linearity assumption used in the estimation of the second stage panel data model reported in (4). The linearity assumption may not be appropriate here because the dependent variable can vary only between zero and one. A possible solution would be to estimate the following non-linear panel data model in (7):

$$e_{it}^{DEA} = \Phi\left(\sum_{m=1}^{M} \gamma_m \log z_{itm} + \sum_{p=1}^{P} \delta_p \log s_{itp} + u_i\right) + v_{it} \tag{7}$$

where $\Phi(.)$ is the standard normal cumulative distribution function, so that the fitted values of the efficiency scores will neither exceed 1 nor be less than 0. In this framework, the impact of the policy variables can be consistently estimated by a pooled Bernoulli quasi-MLE (QMLE) as proposed by Papke and Wooldridge [2008].[33] The coefficients' point estimates for the two output

[33]Most of the empirical works (for example, Goudriaan and de Groot [1991], Bjurek, Kjulin, and Gustafsson [1992], McCarty and Yaisawarng [1993], Lovell, Walters, and Wood [1993], Borger, Kerstens, Moesen, and Vanneste [1994], Vitalianno [1998], and more recently Afonso and Aubyn [2006]) that use a two-stage approach usually account for the fractional nature of the dependent variable using a Tobit model in the second-stage regression (one-limit or two-limits). The only case similar to Bernoulli quasi-MLE has been

Table 3: DEA second stage, summary of the policy variables' point estimates in case of non-linear model and input approach, output measured in terms of infant mortality.

Approach	**Output**	**Input**	
Model	*non linear*	*linear*	*non linear*
dummy 1995[(1)]	3.23**	4.95	6.83**
	(1.63)	(3.18)	(2.68)
treatment effect of 1995 elctoral reform[(1)]	2.23*	2.20	2.06
	(1.00)	(2.44)	(2.07)
dummy 2001[(2)]	-47.19**	-7.15	-36.72
	(23.81)	(33.5)	(31.71)
tax revenue earmarked for the health care sector[(2)]	0.009***	0.007	0.007*
	(0.003)	(0.005)	(0.004)
tax revenue earmarked for the health care sector X dummy 2001[(2)]	0.052	-0.013	0.037
	(0.032)	(0.054)	(0.041)
Quadratic trend	yes	yes	yes
Control variables	yes	yes	yes
Observations	315	294	294
Number of regions	21	21	21

Robust standard errors in brackets () * significant at 10%; ** significant at 5%; *** significant at 1%

(1) Percentage variation in efficiency.

(2) Percentage variation in efficiency after 1% change of the regional tax revenue.

measures are presented in the first column of Tables 3 and 4. The magnitude as well as the significance level of the treatment effect related to the 1995 electoral reform (expressed here in terms of average partial effects) is clearly in line with those obtained in the case of linear model. The impact of the 1998 fiscal reform appears always positive but the level of statistical significance is worse than 10% making our estimates not statistically different from zero.

Finally, as argued in Section 4, panel data stochastic frontier models and the two-stage procedure based on DEA provide equivalent ways of estimating the impact of the policy variables on government efficiency given the baseline empirical model presented in (1). The stability of the point estimates registered across different methodologies corroborates the robustness of the results with respect to the assumptions behind the two methodologies, i.e., the specification of the production function in the case of SFM, and the statistical properties of the efficiency indices in the case of DEA. The only concern may arise in relation to the input approach, alternatively followed

found in Worthington [1999], who uses a second-stage logistic model. Essentially, as suggested by Papke and Wooldridge [2008], the possible choice of a two-limit Tobit model for the second-stage regression is not suitable in this context because, although our response variable is bounded from below by zero, there are no observations at zero.

Table 4: DEA second stage, summary of the policy variables' point estimates in case of non-linear model and input approach, output measured in terms of neonatal mortality rate at 1 day.

Approach	**Output**	**Input**	
Model	*non linear*	*linear*	*non linear*
dummy 1995[(1)]	-0.142	4.68	5.44*
	(1.49)	(3.92)	(2.85)
treatment effect of 1995 elctoral reform[(1)]	3.42***	4.42	3.72*
	(1.00)	(2.86)	(1.98)
dummy 2001[(1)]	-36.37	-9.97	-41.3
	(29.76)	(4.22)	(32.36)
tax revenue earmarked for the health care sector[(2)]	0.005*	0.006	0.005
	(0.003)	0.008)	(0.005)
tax revenue earmarked for the health care sector X dummy 2001[(2)]	0.035	-0.016	0.043
	(0.028)	(0.068)	(0.050)
Quadratic trend	yes	yes	yes
Control variables	yes	yes	yes
Observations	315	294	294
Number of regions	21	21	21

*Robust standard errors in brackets () * significant at 10%; ** significant at 5%; *** significant at 1%.*

(1) Percentage variation in efficiency.

(2) Percentage variation in efficiency after 1% change of the regional tax revenue.

in the case of DEA even if not directly comparable with the parametric approach. As reported the last two columns of Tables 3 and 4, in the case of the input approach, both reforms exhibit a positive impact but the statistical significance of the results is quite weak, however this could be mainly due to the smaller number of the observations available for the input approach.

7.2. The fundamental identifying assumption of the treatment effect

In this paper, as a main contribution, the effect of the 1995 electoral reform on regional government efficiency has been estimated in a quasi-experimental setting using a difference-in-differences estimator. The goal is to address the counterfactual question of what would have been the efficiency path after 1995 in the group of regions affected by the reform, if the new electoral system had not been introduced. To that end, the group of special regions not affected by the reform has been used as the control group. The fundamental identifying assumption underlying this approach is that, in the absence of the reform, the path of the input and output variables would have been the same for the two groups of regions. As shown in Table 7 in the Appendix, where some general statistics of the data are displayed, the

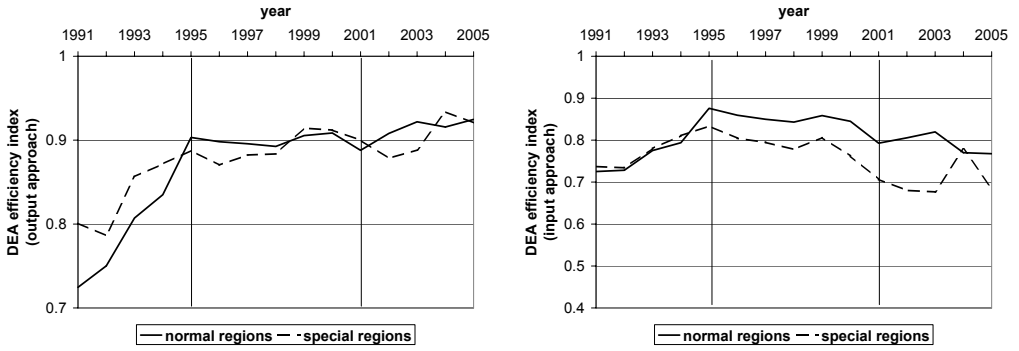
two groups are very similar in relation to almost all features of the health care sector. Some differences can be registered in the health sector budget deficit and especially in the total regional budget expenditure without health expenditure as a result of the larger legislative power of the special regions. However, looking at Figures 5 and 6, clearly the DEA indices of efficiency were following, on average, the same trend before the the 1995 electoral reform independently from the output measures and the approach employed in the estimation of efficiency. The same can be argued in relation to the the input and output variables previously plotted in Figures 3 and 4.

A formal test for the fundamental identifying assumption of the treatment effect is provided by the absence of significant interactions in the pre-reform period between the groups of regions and the time effects in relation to regional efficiency [Stewart, 2004]. This means that the two groups were following the same efficiency path before the reform. This test has been performed for the input and output variables and the DEA indices of efficiency by estimating the following model for the pre-reform period 1991–1994: $\omega_{it} = \eta_t + \theta_t(\eta_t D) + \alpha_i + \epsilon_{it}$ where ω_{it} is replaced by the variable of interest, η_t is the set of year dummies, D is a dummy for normal regions, α_i is the regional fixed effect, ϵ_{it} is the idiosyncratic error, and θ_t is the parameter of interest. Strong evidence in favour of the underlying identifying assumption of no interactions in the pre-reform period has been obtained by the impossibility of rejecting the following null hypothesis $H_0 : \theta_{91}, \theta_{92}, \theta_{93}, \theta_{94} = 0$ in relation to all the DEA indices of efficiency, the inputs, and outputs.[34]

8. Conclusions

This paper provides an empirical analysis of the impact of electoral rules and fiscal decentralisation on the efficiency of local governments when these institutions are assumed to stimulate the electoral accountability of local politicians. This mechanism has been the subject of more theoretical work than empirical analysis so far. Therefore, as a first contribution, this paper seeks to fill some of the gaps left on the empirical side. It does so by estimating an empirical model where both electoral rules and fiscal decentralisation can be treated as exogenous policy variations, then their impact on govern-

[34]The same results are obtained, including the control and policy variables among the regressors.



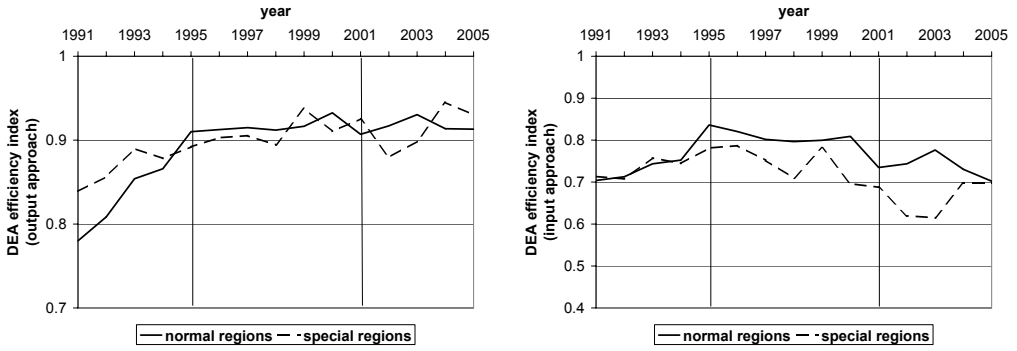
a) output approach (b) input approach

Figure 5: DEA average indices of efficiency by type of region, output measured in terms of infant mortality.

ment efficiency has been evaluated using both panel data stochastic frontier models and a two-stage procedure based on data envelopment analysis.

The sequence of events that have affected the Italian regional governments since the beginning of the 1990s provide a suitable data-set. In 1995, a new electoral system was introduced at the regional level and, since 1993, an intense process of fiscal decentralisation has been taking place culminating in 1998 in a radical reform of the funding system of the health care sector (which in Italy is managed by regional governments). The second contribution of the paper is, therefore, a comprehensive analysis of the main reforms that involved the Italian regional governments during the last years.

The analysis of the 1995 electoral reform takes advantage of the particular structure of the Italian regional governments and it has been conducted in a quasi-experimental setting where a minority group of Italian regions with special statute functioned as a control group since they were affected by the electoral reform with a different timing. Using a difference-in-differences estimator, it has been possible to conclude that the reform of regional political institutions fostered electoral accountability sufficiently to stimulate government efficiency. This result is important because, unlike previous empirical analysis, the quasi-experimental approach unveiled the positive causal relationship between political institutions—such as majoritarian electoral systems and a presidential form of government—and government efficiency predicted in most of the theoretical literature. Although the same quasi-experimental approach could not be used to study the impact of the



a) output approach (b) input approach

Figure 6: DEA average indices of efficiency by type of region, output measured in terms of neonatal mortality at 1 day.

1998 fiscal reform, it has been possible to report also weak empirical evidence in favour of a positive relationship between fiscal decentralisation and government efficiency. This result is very important for the actual Italian political and economic context, since Italy is moving towards a more decentralised system of government.

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Appendix

Table 5: Point estimates of the parameters related to the control variables, output of the health care sector measured in terms of infant mortality.

Approach	**Output**			**Input**	
Methodology	*SFA*	*DEA*		*DEA*	
Model	*linear*	*linear*	*non linear*	*linear*	*non linear*
Intergovernmental grants	-0.023	-0.017	-0.040	-0.132***	-0.081**
real euros per capita	*(0.029)*	*(0.034)*	*(0.027)*	*(0.047)*	*(0.035)*
Regional health deficit	0.002	0.002	0.002	0.004	0.002
real euros per capita	*(0.003)*	*(0.004)*	*(0.003)*	*(0.007)*	*(0.005)*
Reg. health deficit X normal regions	-0.004	-0.005	-0.006*	-0.014*	-0.010*
real euros per capita	*(0.003)*	*(0.004)*	*(0.003)*	*(0.008)*	*(0.006)*
Budget expenditure without health	-0.174**	-0.258***	-0.141**	-0.092	-0.033
real euros per capita	*(0.072)*	*(0.081)*	*(0.061)*	*(0.073)*	*(0.057)*
Budget expend. without health X normal reg.	0.149**	0.171**	0.071	0.105	0.035
real euros per capita	*(0.064)*	*(0.073)*	*(0.055)*	*(0.071)*	*(0.057)*
Health expenditure in reimbursement	0.039	-0.024	0.011	0.013	0.012
real euros per capita	*(0.037)*	*(0.043)*	*(0.036)*	*(0.070)*	*(0.054)*
Private outpatient clinics and laboratories	0.002	-0.030*	-0.013	-0.015	0.011
number per 100000 inhabitants	*(0.017)*	*(0.017)*	*(0.010)*	*(0.032)*	*(0.024)*
Private household health expenditure	-0.547**	-0.341	-0.270*	0.003	-0.010
real euros per capita	*(0.224)*	*(0.221)*	*(0.148)*	*(0.167)*	*(0.134)*
Regional GDP	-0.210	-0.508***	-0.352***	-0.174	-0.241
real euros per capita	*(0.147)*	*(0.159)*	*(0.113)*	*(0.291)*	*(0.228)*
Mother age (first child)	-0.217	-0.318	-0.412	0.553	0.437
years	*(0.505)*	*(0.576)*	*(0.447)*	*(0.753)*	*(0.652)*
Birth rate	0.150	0.292***	0.275***	0.196	0.139
number per 1000 inhabitants	*(0.095)*	*(0.113)*	*(0.083)*	*(0.139)*	*(0.105)*
Caesarean birth rate	0.038	0.141**	0.094**	-0.002	0.053
number per 1000 inhabitants	*(0.056)*	*(0.058)*	*(0.042)*	*(0.080)*	*(0.056)*
Dependecy index	-0.601***	-0.434	-0.253	-0.189	-0.215
[pop (0 - 14)+pop (+65)] / pop (15- 65)	*(0.217)*	*(0.280)*	*(0.176)*	*(0.479)*	*(0.335)*
Population density	-1.289***	-1.119***	-0.669**	-1.209**	-0.874**
inhabitants per Km square	*(0.365)*	*(0.393)*	*(0.311)*	*(0.516)*	*(0.373)*
trend	0.109***	0.067**	0.044**	0.016	0.007
	(0.030)	*(0.030)*	*(0.020)*	*(0.026)*	*(0.021)*
trendsq	-0.002***	-0.001*	-0.001	-0.000	-0.000
	(0.001)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
Observations	315	315	315	294	294
Number of regions	21	21	21	21	21

*Robust standard errors in brackets () * significant at 10%; ** significant at 5%; *** significant at 1%*
Coefficients' estimates report the percentage variation in efficiency after 1% change of the regressors.

Table 6: Point estimates of the parameters related to the control variables, output of the health care sector measured in terms of neonatal mortality at 1 day.

Approach	**Output**			**Input**	
Methodology	*SFA*	*DEA*		*DEA*	
Model	*linear*	*linear*	*non linear*	*linear*	*non linear*
Intergovernmental grants	0.005	-0.008	-0.015	-0.156**	-0.102**
real euros per capita	*(0.035)*	*(0.032)*	*(0.027)*	*(0.067)*	*(0.049)*
Regional health deficit	0.001	0.000	0.000	-0.001	-0.000
real euros per capita	*(0.003)*	*(0.003)*	*(0.002)*	*(0.008)*	*(0.004)*
Reg. health deficit X normal regions	-0.000	-0.003	-0.004	-0.016*	-0.014***
real euros per capita	*(0.003)*	*(0.004)*	*(0.003)*	*(0.008)*	*(0.005)*
Budget expenditure without health	-0.178***	-0.198***	-0.111**	-0.068	-0.020
real euros per capita	*(0.068)*	*(0.073)*	*(0.051)*	*(0.096)*	*(0.062)*
Budget expend. without health X normal reg.	0.126**	0.107	0.038	0.022	-0.018
real euros per capita	*(0.059)*	*(0.065)*	*(0.047)*	*(0.092)*	*(0.062)*
Health expenditure in reimbursement	0.061	0.027	0.040	0.046	0.041
real euros per capita	*(0.038)*	*(0.040)*	*(0.033)*	*(0.102)*	*(0.064)*
Private outpatient clinics and laboratories	0.006	-0.032**	-0.018*	-0.013	0.015
number per 100000 inhabitants	*(0.014)*	*(0.013)*	*(0.009)*	*(0.059)*	*(0.035)*
Private household health expenditure	-0.448**	-0.418**	-0.396***	-0.399*	-0.327**
real euros per capita	*(0.206)*	*(0.193)*	*(0.133)*	*(0.218)*	*(0.144)*
Regional GDP	-0.120	-0.328**	-0.268***	0.388	0.139
real euros per capita	*(0.132)*	*(0.134)*	*(0.097)*	*(0.401)*	*(0.275)*
Mother age (first child)	0.492	0.440	0.254	0.600	0.412
years	*(0.439)*	*(0.464)*	*(0.387)*	*(0.903)*	*(0.705)*
Birth rate	0.231**	0.289***	0.228***	0.078	0.031
number per 1000 inhabitants	*(0.092)*	*(0.103)*	*(0.074)*	*(0.192)*	*(0.126)*
Caesarean birth rate	0.007	0.033	0.025	-0.141	-0.046
number per 1000 inhabitants	*(0.051)*	*(0.049)*	*(0.037)*	*(0.121)*	*(0.080)*
Dependecy index	-0.378*	-0.231	-0.159	-0.219	-0.135
[pop (0-14)+pop (+65)] / pop (15-65)	*(0.194)*	*(0.224)*	*(0.151)*	*(0.617)*	*(0.379)*
Population density	-0.629*	-0.605*	-0.413*	-0.081	-0.205
inhabitants per Km square	*(0.359)*	*(0.355)*	*(0.240)*	*(0.702)*	*(0.441)*
trend	0.088***	0.077***	0.067***	0.042	0.031
	(0.028)	*(0.026)*	*(0.018)*	*(0.036)*	*(0.024)*
trendsq	-0.002***	-0.002***	-0.001***	-0.001	-0.000
	(0.000)	*(0.000)*	*(0.000)*	*(0.001)*	*(0.000)*
Observations	315	315	315	294	294
Number of regions	21	21	21	21	21

*Robust standard errors in brackets () * significant at 10%; ** significant at 5%; *** significant at 1%.*

Coefficients' estimates report the percentage variation in efficiency after 1% change of the regressors.

Table 7: General statistics and variable definitions.

Variables	**Normal regions**		**Special regions**	
	Mean	Std. Dev.	Mean	Std. Dev.
Output variable				
Infant mortality rate (number of dead children per 10000 new births)	53.17	18.52	46.98	17.58
Neonatal mortality rate at 1 day (number of dead children per 10000 new births)	15.31	7.07	12.70	6.98
Input variables				
Public current expenditure (real euros per capita)	847	159	968	229
Public outpatient clinics and laboratories (number per 100000 inhabitants)	10.43	4.81	14.72	9.7
Policy variables				
1995 electoral reform (dummy = 1 from 1995 to 2005)				
Regional tax revenues for the health sector (real euros per capita)	221	297	214	311
Control (or environmental) variables				
Intergovernmental grants for the health sector (real euros per capita)	1027	185	1006	230
Regional health care sector deficit (real euros per capita)	84	114	169	237
Private health expenditure in reimbursement (real euros per capita)	494	113	438	93
Private outpatient clinics and laboratories (number per 100000 inhabitants)	9.68	5.30	10.82	12.30
Households health expenditure not covered by public funds (real euros per capita)	393	105	400	116
Total regional budget expenditure without health (real euros per capita)	1095	686	4563	2750
Regional GDP (real euros per capita)	21188	5472	24100	6446
Maternal age at first child (years)	30.21	1.05	30.28	1.10
Birth-rate (new born per 1000 inhabitants)	9.05	1.55	9.82	1.64
Caesarean birth-rate (number per 100 new births)	29.37	8.71	24.14	8.43
Dependency index (percentage of Pop. (0–14) + Pop. above 65 over Pop. (15–64))	49.48	4.04	47.27	3.47
Population density (inhabitants per Km^2)	199.38	105.32	98.02	55.97