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(Working Papers)

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by Maura Francese and Marzia Romanelli

October 2011

Number 828

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HEALTHCARE IN ITALY:
EXPENDITURE DETERMINANTS AND REGIONAL DIFFERENTIALS

by Maura Francese* and Marzia Romanelli*

Abstract

The aim of this work is to identify the determinants of health spending differentials among Italian regions, which could highlight the existence of potential margins for savings. The analysis exploits a dataset for the panel of the 21 Italian regions starting in the early 1990s and ending in 2006. After having controlled for standard healthcare demand indicators, spending differentials appear to be associated with differences in the degree of appropriateness of the treatments, supply structure and social capital indicators. These results suggest that savings could be achieved without reducing the amount of services supplied to citizens. This is particularly important in view of the expected rise in health spending associated with the forecast demographic developments.

JEL Classification: H51, I1
Keywords: government expenditure, health, regional variation.

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1. Introduction[*]

Health spending represents a significant share of public and private budgets in Italy as in the majority of developed countries. Public health expenditure accounts for about 7 per cent of GDP and over the last decades it has been growing significantly faster than income. Given the expected population ageing, it is likely that spending will continue to increase in the future as well, raising a serious challenge to fiscal policy and the sustainability of public finances. According to recent projections published by the Economic Policy Committee (2009) and the OECD (2006), health spending is in fact the budget item with the highest expected growth rate among the age-related expenditures, not only in Italy but in other developed economies as well.

Despite several measures aimed at improving the organisation of the system and the incentives provided by the financing mechanism, the Italian national health system (Sistema Sanitario Nazionale or SSN) has historically displayed not only a sustained growth in outlays, but also large deficits. Expenditure restraint has been achieved only occasionally, mainly through measures with temporary effects on cash payments.[1]

The provision of healthcare in Italy is the responsibility of the regional governments, within guidelines set at the central level to ensure that all citizens access similar amounts and quality of healthcare (see Piperno and Di Orio, 1990; Giannoni and Hitiris, 2002). Notwithstanding a significant redistribution of resources, there remain spending differentials between regions. These could be due to structural differences (such as demographic or epidemiological characteristics) or they could reflect differences in the quality of the services provided to patients and in the degree of efficiency in the use of public resources. In the latter case, spending differentials could highlight potential scope to improve the value for money in healthcare (i.e. reducing healthcare outlays and/or increasing the coverage and the quality of the service).

The objective of this work is to examine whether saving margins exist by identifying the main drivers of regional spending differentials that are not due to structural differences in population or other determinants of healthcare demand. Other works have explored spending differentials in

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The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Italy. We thank for their comments two anonymous referees, the colleagues at the Public Finance Division of the Bank of Italy, the discussant and the participants at conferences and seminars where previous versions of this work were presented. The usual disclaimers apply.

[1] For example, Bordignon and Turati (2009) suggest that the reason behind the expenditure reduction in the mid-1990s was the temporary changes in the expectations of the regions, which at the time perceived central government's threat not to bail them out in the event of spending overruns to be a credible one. Another explanation is the presence of *flypaper effects* (see Levaggi and Zanola, 2003) and the temporary reduction in transfers from the central to local governments in the early 1990s.

order to ascertain whether they reflect differences in the quality and/or access to care (for the US see Skinner et al., 2001; Fisher et al., 2009), either focusing on certain types of services (for example hospital care as in Yasaitis et al., 2009) or on spending for particular public programmes and categories of treatments (for example Fisher et. al., 2003a, consider end-of-life spending for Medicare beneficiaries in the US). These works suggest that higher spending does not systematically reflect better quality or access, but that it is mainly linked to care practices (such as a greater orientation towards inpatient or specialist care) or to targeting specific care practices to the appropriate reference population (see for example Bodenheimer and Berry-Millet, 2009). Furthermore, higher spending does not appear to be systematically related to improved health outcomes or care satisfaction (Fisher et al., 2003b; Fowler et al., 2008).

In this work we follow a more aggregate approach, considering per capita health expenditure in the Italian regions[2] and studying the drivers of unexplained differentials. In doing so we start with an approach similar to that used in the literature to compare health spending across countries.[3] In this respect our setting presents several advantages, given that it is reasonable to assume a similar structure of preferences, input prices and broad institutional arrangements throughout the country. Italian regions have a common legal and institutional framework and, as explained above, are mandated to provide homogeneous healthcare coverage.[4] Importantly, regions share common financing mechanisms. Notwithstanding the many changes and reforms, it can be taken that the resources made available at the regional level are based on the overall need for healthcare in each region and past spending,[5] independently of the source of financing and regional fiscal capacity.[6] In practice, the central government has been responsible for filling the gap between the financial needs of each region and the actual funding derived from revenue directly collected by the regions (e.g. a regional tax on productive activities and a personal income surtax) and through an

[2] In particular, we consider all the Italian regions, both ordinary (Piemonte, Lombardia, Veneto, Liguria, Emilia Romagna, Toscana, Umbria, Marche, Lazio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria) and special statute (Valle d'Aosta, Friuli Venezia Giulia, Sicilia, Sardegna) plus the two autonomous provinces of Trento and Bolzano (which together form the special statute region of Trentino Alto Adige).

[3] For a survey of the literature and the methodological problems of international comparisons of health expenditure, see Gerdtham and Jönsson (2000).

[4] However, within given gudelines, regions are allowed to define some characteristics of the health system, such as for example the structure of the hospital network, the share of private providers and the extent to which they resort to direct distribution of pharmaceuticals.

[5] The recent measures on fiscal federalism also maintain the principle of equalising resources among the regions on the basis on the population's need for healthcare. The challenge of the reform lies in defining the criteria (the 'standard costs') to compute such needs. For a description of the evolution of the financing mechanisms of the SSN see Mapelli (2000) and Caroppo and Turati (2007).

[6] The fiscal capacity of the Italian regions is strongly (if not mainly) affected by the uneven distribution of the tax bases across the country (see De Matteis and Messina, 2009), which reflects the degree of economic development of the regions themselves and can be marginally changed by the economic policies adopted within each region.

equalising centralised procedure which uses general fiscal revenues.[7] Given that the financing mechanism and equalising procedure are common to all the regions,[8] their incentives/disincentives are likely to be the same, plausibly impacting on the overall level of spending but less on the regional differentials.

In order to set the background for the empirical analysis, we start by describing health expenditure dynamics and their regional distribution. The third section presents the model from which we derive our estimating equations, describes the analysis of per capita regional spending determinants, identifies the drivers of observed differentials and discusses the results. The final section draws some conclusions.

2. Health expenditure developments and regional differentials

Since the establishment of the SSN, total public spending on healthcare has increased significantly (from 5.1 per cent of GDP in 1979 to 7.3 per cent in 2010).[9] The considerable effort made to curb expenditure in the first part of the 1990s owing to the crisis experienced at that time and also in view of the need to meet the Maastricht criteria in order to qualify for admission in the Eurozone[10] was the only real exception: in the period 1991-95 the expenditure to GDP ratio fell by more than one percentage point. However, the nature of the decline was not structural and was achieved mainly through spending postponements and generalised cuts in cash outlays.[11] Indeed, the positive results realised in the first half of the 1990s were more than offset by the large increase over the ensuing decade (Figure 1 and Table 1).

The strong dynamics of health expenditure observed in Italy might reflect not only structural factors (such as the rising costs of new expensive technologies and population ageing) but also

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[7] In more recent years the effort to promote fiscal responsibility of the regions has been enhanced by the rules to discourage the formation of deficits in the health sector. The budget for 2005 and following years introduced automatic procedures for the appointment of special administrators and for increases in the regional income tax surcharge and tax on productive activities.

[8] Different arrangements are in place between the ordinary statute regions and the special statute ones (Valle d'Aosta, Trentino, Bolzano, Friuli Venezia Giulia, Sardegna and Sicilia). However this affects mainly the composition of financing (share of own resources versus funds drawn from national general taxation). The principle of providing comprehensive and homogeneous coverage through a national health system applies to all parts of the country.

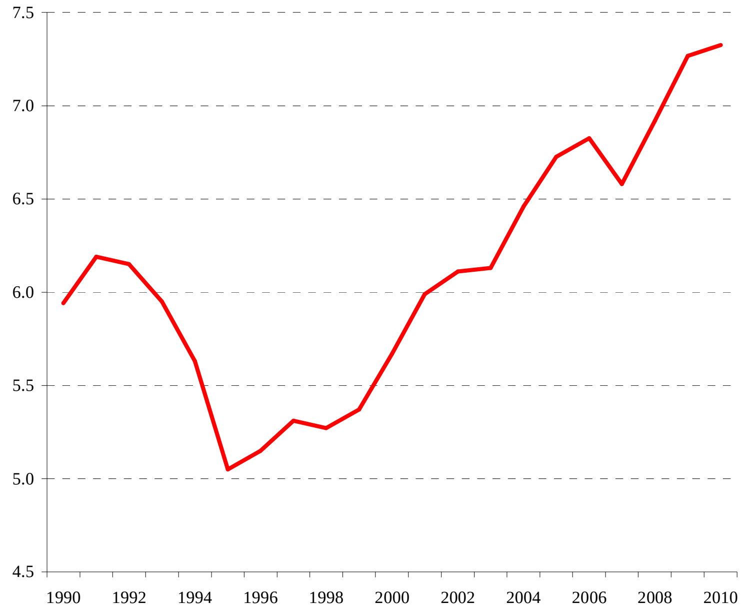
[9] For the first fifteen years since the introduction of the SSN see also Franco (1993).

[10] As already noted, the existence of credible internal and external constraints during the first half of the 1990s might have contributed to expenditure containment (see Bordignon and Turati, 2009).

[11] In 1992, the SSN was reformed for the first time with the aim, on the one hand, of increasing competition among providers (both public and private) and, on the other, of strenghtening the planning phase. However, several of the measures approved over the years 1992-94 were in fact meant to curb expenditure in the short term, for example introducing co-payments for pharmaceuticals and medical and diagnostic services.

the lack of effective use of public resources.[12] Since in future Italian public finances will have to absorb the costs of the expected demographic developments[13] and those induced by the economic and financial crisis, it is of growing importance to identify room for manoeuvre and appropriate measures to increase efficiency in the use of the funds allocated to the healthcare sector.

Figure 1 Public health expenditure
(% of GDP)



Source: Our computations on data reported in Ministero dell'Economia e delle finanze, *Relazione Generale sulla Situazione Economica del Paese* (RGSEP), various years.

Table 1 – Growth rate of public health expenditure
(per cent)

	Average nominal growth rate	Average real growth rate
1978-1986	17.9	3.7
1987-1995	8.1	2.7
1987-1991	*14.8*	*8.6*
1992-1995	*0.2*	*-4.3*
1996-2010	5.9	3.7

Source: Our computations based on RGSEP, various years. Real expenditure computed using CPI indices published by Istat.

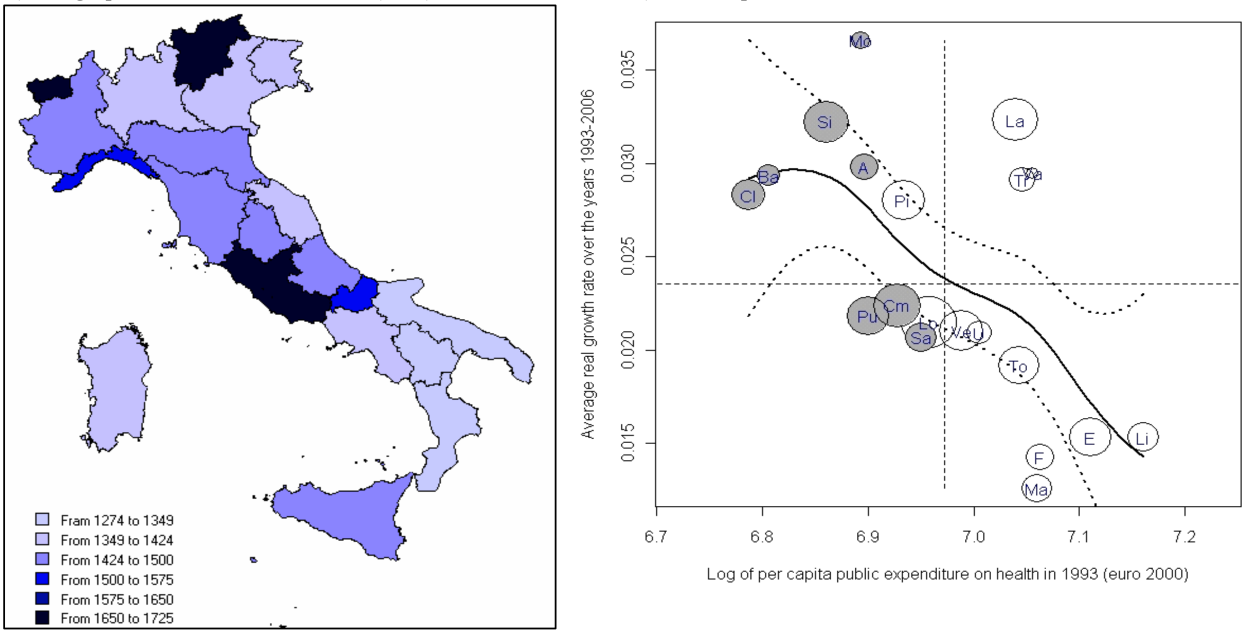
[12] For example, regarding the hospital sector, Iuzzolino (2008) observes that, compared with the other OECD countries, Italy has a larger share of public hospitals of small size, probably because of poorer outpatient care and an unbalanced allocation of resources between different types of services. This is reflected in the unit costs of hospitalisation and the share of outlays for hospital in total spending, which are higher than the OECD average.

[13] For example, the last EPC report on the impact of ageing on public expenditure (EPC, 2009) projects healthcare and long-term care expenditure will increase, under the pure ageing scenario, by about 2.6 percentage points in terms of GDP by 2060.

A descriptive analysis of the gap between expenditure levels among the different Italian regions and its determinants can be a useful starting point to detect possible inefficiencies and room for potential savings. The Italian regions share a common legal framework and the same basic principles (i.e. *universal access* and *comprehensiveness*) but operate in a context of administrative autonomy: each region can adopt, up to a certain extent, different organisational architectures (such as public/private mix, network of hospitals, etc.) and within limits vary the degree of financing through regional taxation and co-payments. A first glance at the per capita public current health expenditure highlights non-negligible variation among the Italian regions (see Figure 2a). However, it is possible to identify at least one cluster formed by the regions of the South, which generally have 1) lower than average per capita expenditure, and 2) higher growth rates. This might suggest convergent dynamics among the different areas of the country. Such findings seem to be confirmed by the estimate of the growth path of per capita health expenditure over the period 1996-2006 (see Figure 2b).[14]

Figure 2 Per capita public current health expenditure

a) Geographical distribution in 2006 (euro) b) Growth path 1993-2006*



* Regions are represented by circles (in grey the southern ones) proportional to the population size.
Source: our computations based on RGSEP (various years)

Figure 2b also depicts four quadrants centred on the national average growth rate and level of per capita expenditure. The picture suggests a clear pattern: while the regions in the Centre and North

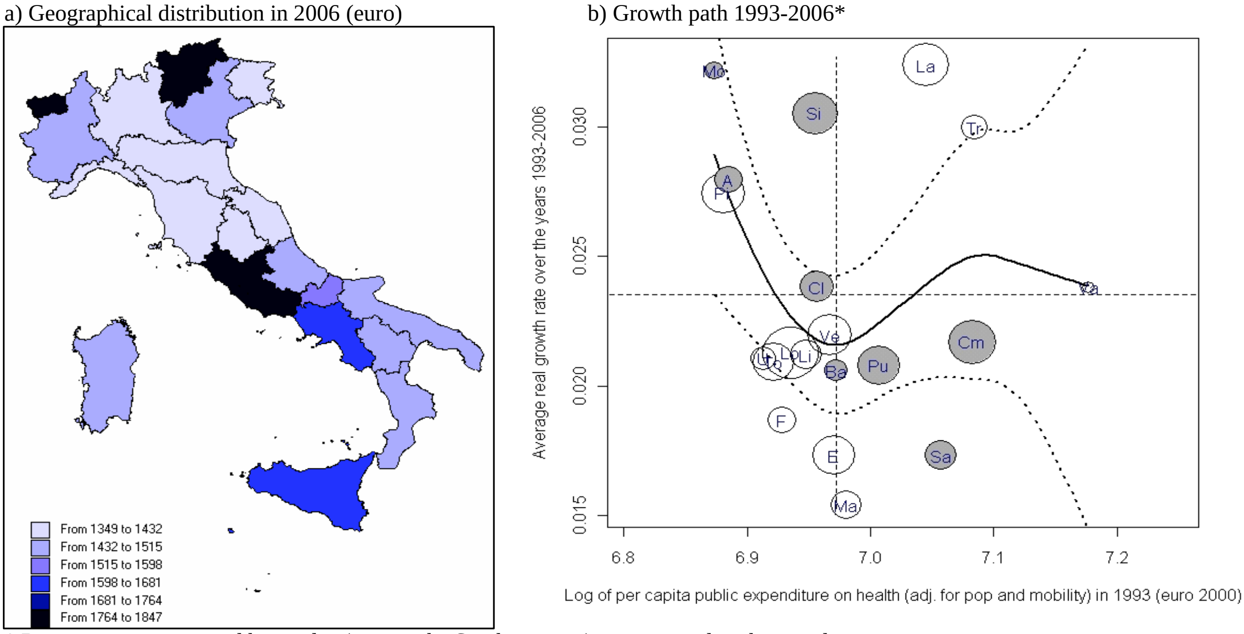
[14] In particular, we estimate the model $g_i^{96-07} = m\left(\log\left(Ex_i^{96}\right)\right) + \varepsilon_i$, where g_i is the average growth rate of per capita health expenditure of region i in the period 1996-2006, Ex_i^{1996} is the value of per capita health expenditure in 1996, and ε_i is a i.i.d. random variable with zero mean. In the estimate of $m(\ )$ we use the Nadaraya-Watson estimator with the optimal normal bandwidth (see Bowman and Azzalini, 1997, for more details). This preliminary estimation ignores cross-region heterogeneity. Estimates are computed using R.

have higher levels of per capita health expenditure with respect to the national average, the South has higher growth rates.

However, this evidence is questioned when adjusting expenditure to take into account patients' mobility among regions and the different age structure of the population. In fact, spending in each region also reflects how many patients it attracts from other parts of the country[15] and how many elderly people need to be taken care of, given that a well-known stylised fact is the 'u' shape of the lifetime health costs profile where higher spending occurs when individuals are older.

Figure 3 Per capita public current health expenditure adjusted for patients' mobility and age structure of the population

a) Geographical distribution in 2006 (euro) b) Growth path 1993-2006*



* Regions are represented by circles (in grey the Southern ones) proportional to the population size.

Source: our computations based on RGSEP (various years) for expenditure and mobility balances, Istat for the population composition and Ministero della Salute (2007) for coefficients used to compute the equivalent population.

In particular, we observe that many southern patients travel to the Centre and North for medical care so that per capita spending for residents in the northern regions is higher than spending per treated person. This pattern is stable over time. Furthermore, as to the impact of the age structure, on average southern regions have a younger population. We therefore adjust per capita expenditure to take into account these two features.[16] In this case, per capita expenditure appears

[15] Patients' mobility among regions is allowed under the national public healthcare system: healthcare costs are covered by the SSN independently of the region actually providing the service.
[16] In order to compute per capita public current health expenditure adjusted for patients' mobility and the age structure of the population we have used population data (broken down by region and age) and the coefficients published by Ministero della Salute (2007), which capture differences in the consumption of pharmaceuticals and hospital services between individuals at different ages. The equivalent population has been obtained using the equation:

to be higher on average in the South. Moreover, variability increases across the country and data do not support the hypothesis of any convergence in the expenditure pattern (see Figure 3).

3. Regional differentials in health expenditure: are there saving margins?

3.1 The model

This section presents the model from which we derive the estimating equations. We consider a benevolent regional government (*i*) which wants to maximise the following:

$$(1)\qquad \max_{x_h, x_u} p(K_i)U^i{}_h(x^i{}_h, K_i) + (1-p(K_i))U^i{}_u(x^i{}_u, K_i)$$
$$\text{where}$$
$$U^i_g : \exists\, \tilde{x}_g < \infty \text{ such that } U^i_g{}'(x) < 0\ \forall\, x > \tilde{x}_g \qquad g = h,u$$

$U^i{}_h$ is the utility gained by a healthy individual from the consumption of healthcare (x) and $U^i{}_u$ is the utility gained by sick individuals; x^i_h and x^i_u are the quantities of healthcare consumed respectively by a healthy and a sick individual in region *i*; *p* is the fraction of healthy individuals in the region and *1-p* the fraction of sick ones; K_i is a vector of economic, social, demographic and health status characteristics that affect both the probability of being sick and the preference structure for the consumption of healthcare. We assume that the budget constraint is either not binding[17] or that the regional government can draw additional resources from the citizens resident in the region to finance the production of the optimal/desired health spending.

The optimal level of healthcare provision is then:

$$(2)\qquad x_i{}^* = px^i{}_h{}^* + (1-p)x^i{}_u{}^*$$

where $x^i{}_h{}^*$ and $x^i{}_u{}^*$ solve problem (1).

Given the cost function $C_t(x)$, assumed to be the same in all regions, in each period *t* per capita public health expenditure will be:

$$(3)\qquad s_{it} = C_t(x_{it}{}^*(K_{it})) + w_i \qquad \forall i$$

$$P_i^E = \sum_{j=1}^{A} a_j P_{ji} \frac{\sum_{i=1}^{N}\sum_{j=1}^{A} P_{ji}}{\sum_{i=1}^{N}\sum_{j=1}^{A} a_j P_{ji}}$$

where P_i^E is the equivalent population of region *i*, P_{ji} is the population of region *i* in the age class *j*, a_j is the coefficient relative to age class *j*, *A* is the total number of age classes (101), *N* is the number of regions (21). We have then adjusted expenditure to take into account population mobility and finally computed spending per capita values. We thank Demetrio Alampi for having suggested where to retrieve the information necessary to work out the equivalent population.

[17] This assumption is consisent with the literature on soft budget constraints (Bordignon and Turati, 2003) and with the evidence of systematic spending overruns and deficits in the health sector.

where w_i ('waste') captures the distance of region i with respect to the cost frontier.[18] Assuming that each region's relative inefficiency is invariant over time, we can derive the following estimating equation for per capita spending:

$$(4) \qquad s_{it} = \alpha + w_i + \mathbf{k}'_{it}\,\beta + \varepsilon_{it}$$

with ε_{it} being the error term.

This framework assumes that under different financing settings (i.e. resources drawn from a central budget or through local taxation) the regional governments would anyway be able to finance spending s_{it}, hence ensuring the production of $x_{it}*$, whatever the region's fiscal capacity and efficiency level.

For this to be possible:

1) the objective of the central government (CG) must be to ensure the provision of x_i*;

2) CG must be able to collect enough resources to finance the production of x_i* in all the regions;

3) CG and the regions must observe spending levels and the composition of financing but not distinguish efficient technology from waste levels (w_i).

In a setting where the above conditions hold and where healthcare is financed both via transfers received from the central government and using revenue from local taxes, regions have the incentive to set the latter at the minimum if they believe that the CG will cover the remaining costs. In such a framework each region will be able to produce x_i* and tax revenue collected by CG in rich regions will be used to finance spending in poor ones as well. Tax rates at local level will be correlated neither with efficiency in the production of healthcare nor with income differentials.

A similar framework, where the CG announces fixed flat transfers but only some regions believe in its commitment, will have an analogous outcome. Ex post, CG will find that to stick to its commitment is not optimal (otherwise in some regions it will not be possible to produce x_i*) and low local tax rates will not necessarily reflect high productive efficiency. They could also be due to regional beliefs (about the lack of credibility of CG commitment) or low demand levels. Again the ranking of regions according to the level of local tax rates will not necessarily reflect the

[18] w_i can be interpreted as the cost of inefficiency for region i.

ranking in productive efficiency. In this set up regions that overspend with respect to the resources set by the central government are not necessarily the most inefficient ones.[19]

The empirical analysis in the following paragraph then moves forward to the estimation of equation (4) disregarding fiscal capacity, local taxation or regional deficit indicators. The aim being in the first step to infer differentials in spending among regions (w_i) which are not related to structural differences in the demand for healthcare ($\alpha + \mathbf{k}'_{it}\beta$) and in the second step to analyse the possible drivers of such gaps.

3.2 The empirical analysis – first step: the impact of demand factors

The first step considers regional per capita spending levels and their determinants in order to control for the forces that lie behind the observed dynamics of outlays embedded in the demand structure (such as demography, education, etc.) which can be assumed, at least in the short and medium term, to be independent of healthcare policies.

The empirical analysis at the international level has pinpointed the correlations between health spending levels and demand factors such as income, the demographic structure and the health status of the population (Newhouse, 1977; Gerdtham et al., 1998; Gerdtham and Jonsson, 2000). Usually, most of the empirical literature also controls for labour market and education indicators or variables capturing institutional differences between healthcare systems.[20]

Table 2 – Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Real per capita health expenditure (corrected for mobility)	294	1,222	203	884	1,810
Real per capita health expenditure (corrected for mobility and structure of the population)	294	1,283	214	923	2,030
Real per capita GDP	294	19,818	5,102	10,836	28,504
Dependency ratio for children (0-4)	294	21.22	3.66	15.05	30.22
Dependency ratio for elderly (75+)	294	12.36	3.02	6.38	21.08
Life expectancy (female)	294	82.38	1.28	78.87	85.00
Bad habit					
alcohol	*294*	*7.02*	*2.55*	*3.65*	*11.92*
wine	*294*	*5.72*	*1.49*	*2.12*	*8.94*
smoke	*294*	*23.50*	*2.47*	*17.33*	*30.68*
Health status					
high blood pressure	*294*	*125.32*	*22.42*	*75.10*	*179.20*
heart attack	*294*	*14.62*	*3.79*	*6.90*	*24.80*
angina	*294*	*8.51*	*2.80*	*3.90*	*17.60*
other heart deseases	*294*	*33.70*	*5.18*	*22.90*	*49.70*
diabetes	*294*	*40.34*	*8.49*	*19.20*	*57.90*
ictus	*294*	*11.43*	*2.69*	*6.80*	*18.50*
malignant cancer (males)	*294*	*21.84*	*6.97*	*9.84*	*38.67*
malignant cancer (females)	*294*	*26.25*	*8.61*	*11.71*	*47.75*
Participation rate (female)	294	40.81	11.15	18.82	61.54
Tertiary Education	294	7.64	2.16	3.65	14.20
Share of employed in agriculture (%)	294	7.28	4.05	1.53	21.43
Share of employed in manufacturing (%)	294	29.56	6.96	17.96	43.97

[19] For a more detailed discussion of the impact of the financing mechanism in our framework see Appendix A.
[20] In our analysis we do not include the latter variables as the regions share a common institutional framework.

We use a similar approach to investigate regional per capita spending levels and in turn identify "unexplained" differentials. We use a panel of the 21 Italian regions for 14 years (1993-2006), which includes variables on per capita health expenditure and its breakdown,[21] per capita GDP, [22] health status indicators,[23] variables relating to the labour market and education[24] (for descriptive statistics see Table 2).

In particular, we estimate the following *semilog* expenditure model:[25]

$$\text{(5)} \qquad \ln(rexp\_pc_{it}) = \alpha + g(i) + \mathbf{x}_{it}'\beta + \varepsilon_{it}$$

where $rexp\_pc_{it}$ is the real per capita expenditure observed in region i at time t, $g(i)$ are the region specific effects that we initially assume to be composed of fixed effects,[26] i.e. $g(i) = \alpha_i$, and $\mathbf{x}$ includes: real per capita GDP; the dependency ratios of the elderly and children, to capture the U-shape of the age-expenditure profile; female life expectancy and a proxy for the health status of the population (this proxy takes into account the incidence series for the following conditions: high blood pressure, heart attack, angina, other heart diseases, diabetes, ictus, together with male and female prevalence rates for malignant cancer); a proxy[27] for habits that affect health (such as tobacco and alcohol);[28] the female employment rate, as an indicator for the provision of informal care; the level of education (percentage of people with at least a bachelor degree); proxies for the regions' development measured as the percentage of employees respectively in agriculture and in manufacturing.

We also consider a time specific effect in order to separate the years before and after 1995.[29] As said above, the first half of the 1990s was a period of exceptional expenditure containment, achieved mainly through spending postponements and generalised cuts at the national level in

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[21] Expenditure data are derived from Ministero dell'Economia e delle finanze (various years).
[22] Regional GDP is published by Istat (2007 and 2008).
[23] Health status indicators are drawn form the databases published by Istat (2009).
[24] Data on labour market participation, employment rates and education levels of the population (broken down by region and sex) have been computed using individual data provided by Istat (see Istat, *Rilevazione sulle forze di lavoro*). We thank Federico Giorgi for having provided such computations.
[25] The specification used reflects the nature of the regressors. All of them, apart from per capita GDP are ratios or dummies.
[26] An alternative estimation strategy would be to implement a multilevel model which simultaneously considers both the first and the second step. Even though this procedure could be more efficient, it has two main drawbacks: 1) it requires stronger distributional assumptions on the error terms; 2) it would make it less straightforward to work out an estimate of the inefficiency levels and decompose and analyse them as reported in the following paragraph. We have estimated such a model as a robustenss check, however; estimated coefficients of the variables from the first and the second step and their significance are in line with those obtained following a two-step procedure.
[27] Both the proxies for the health status and 'bad' habits are obtained via a principal component analysis (see Table 3), which allows us to reduce the dimension of the set of regressors and exploit the correlation among the variables.
[28] In particular, the following are taken into account: the share of smokers (variable 'smoke'), the share of the population drinking at least half a litre of wine a day (variable 'wine') and the share of those who drink alcohol at least twice a week (variable 'alcohol').
[29] In particular, we include a dummy variable equal to 1 for the years after 1995.

view of the need to contain government deficits and favour adjustment to meet the Maastricht parameters. Finally, ε_{it} is the error term.

In particular, we consider three specifications (Table 4), which simply differ as to the denominator used to compute the dependent variable (population, equivalent population for the consumption of hospital services or equivalent population for the consumption of pharmaceuticals – see footnote 16 – in the latter cases the variables accounting for the demographic structure of the population are not included among the regressors). We estimate (5) using a panel fixed effect estimator.

Table 3 – Principal component analysis

a - 'Bad' habit

Component	Eigenvalue	Proportion of total variance
1	1.3487	0.4496
2	1.1482	0.3827
3	0.5031	0.1677

Variable	Eigenvectors 1	2	3
alcohol	0.7091	-0.3333	0.6213
wine	0.7050	0.3445	-0.6199
smoke	-0.0074	0.8776	0.4793

b - Health status

Component	Eigenvalue	Proportion of total variance
1	3.2161	0.4020
2	1.8551	0.2319
3	1.4196	0.1775
4	0.6054	0.0757
5	0.4638	0.0580
6	0.2730	0.0341
7	0.1577	0.0197
8	0.0092	0.0012

Variable	Eigenvectors 1	2	3	4	5	6	7	8
high blood pressure	0.4919	-0.0908	0.1407	0.0192	0.4545	0.0011	-0.7223	-0.0363
heart attack	0.4062	0.0853	0.1948	-0.5873	-0.6186	0.2274	-0.1013	0.012
angina	0.0858	0.5692	-0.3986	-0.0022	0.2466	0.6654	0.063	0.047
other heart deseases	0.2433	0.5693	-0.089	-0.2872	0.2052	-0.6673	0.1972	0.0001
diabetes	0.2242	-0.0076	0.7149	0.0236	0.3487	0.2289	0.5138	-0.0106
ictus	0.3096	0.3514	0.1558	0.7492	-0.431	-0.079	-0.0537	-0.0128
malignant cancer (males)	0.4399	-0.3397	-0.3178	0.0823	0.0208	-0.0392	0.2596	0.7169
malignant cancer (females)	0.4322	-0.3122	-0.3729	0.0595	0.0064	0.0063	0.3015	-0.6944

Results[30] are broadly in line with those generally found in the literature on international health expenditure comparisons (Gerdtham et al., 1998; Gerdtham and Jönsson, 2000). Per capita

[30] Since the modified Wald suggests the presence of heteroskedasticity and the Wooldridge test for autocorrelation in panel data (Wooldridge, 2002; Drukker, 2003) does reject the null hypothesis of no first order autocorrelation, the standard errors estimator used is robust to both hetoreskedasticity and serial correlation.

expenditure is positively correlated with income (even though the variable is not always significant) as well as with life expectancy. As for labour market indicators, we consider female employment rates, since the more women are employed in the labour market the more often formal care substitutes informal care that is provided within the household (and thus the higher is the demand for formal healthcare). However, the employment rate turns out to be not statistically significant.

Table 4 Step 1 – Panel estimation with fixed effects
(standard errors robust to heteroskedasticity and autocorrelation)

	(Model 1a) Real total expenditure (corrected to take into account patient mobility)		(Model 2a) Real total expenditure (corrected to take into account patient mobility and adjusted for equivalent population (1))		(Model 3a) Real total expenditure (corrected to take into account patient mobility and adjusted for equivalent population (2))	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
Per capita GDP	0.00001	0.248	0.00001	0.436	0.00002 *	0.078
Dependency ratio for children (0-4)	-0.00645	0.279				
Dependency ratio for elderly (75+)	0.04337 ***	0.010				
Life expectancy (female)	0.04133 ***	0.003	0.05461 ***	0.000	0.05890 ***	0.000
Bad habit	0.02172 **	0.015	0.02645 ***	0.002	0.01479 *	0.066
Health status	0.01763 ***	0.008	0.03100 ***	0.000	0.02298 ***	0.000
Participation rate (female)	0.00154	0.703	0.00559	0.150	0.00544	0.181
Tertiary education	0.00317	0.575	0.01234	0.178	0.01393	0.135
Share of employed in agriculture (%)	-0.00678 *	0.089	-0.00986 **	0.045	-0.01121 **	0.020
Share of employed in manufacturing (%)	0.00127	0.254	0.00211 *	0.078	0.00216 *	0.075
Dummy for the years after 1995	-0.11747 ***	0.000	-0.09603 ***	0.000	-0.11564 ***	0.000
Constant	3.11231 ***	0.003	2.28089 **	0.012	1.72265 *	0.051
No. Observations	294		294		294	
F(11, 20)	115.76		123.72		123.96	
Prob > F	0.0000		0.0000		0.0000	
R-squared	0.9304		0.9239		0.9244	
Adj R-squared	0.9222		0.9156		0.9161	
Root MSE	0.0453		0.0462		0.0477	
Regional fixed effects (□$_i$)						
1 Piemonte	-0.144		-0.170		-0.175	
2 Valle d'Aosta	0.065		0.056		0.007	
3 Lombardia	-0.135		-0.230		-0.286	
4 Bolzano	0.263		0.221		0.152	
5 Trento	-0.034		-0.071		-0.108	
6 Veneto	-0.131		-0.199		-0.214	
7 Friuli Venezia Giulia	-0.251		-0.252		-0.233	
8 Liguria	-0.270		-0.201		-0.159	
9 Emilia Romagna	-0.278		-0.305		-0.303	
10 Toscana	-0.260		-0.254		-0.249	
11 Umbria	-0.245		-0.261		-0.221	
12 Marche	-0.227		-0.259		-0.242	
13 Lazio	0.104		0.045		-0.000	
14 Abruzzo	-0.034		-0.018		-0.004	
15 Molise	0.017		0.079		0.123	
16 Campania	0.412		0.434		0.437	
17 Puglia	0.259		0.304		0.315	
18 Basilicata	0.139		0.188		0.223	
19 Calabria	0.223		0.259		0.300	
20 Sicilia	0.285		0.352		0.372	
21 Sardegna	0.243		0.280		0.266	

(1) using weights for hospital services; (2) using weights for pharmaceutical consumption
*, **, *** significance at respectively 10, 5 and 1 per cent level

The dependency ratios for children (0-4 years old) and for the elderly (75 years of age or older) allow us to capture the effect of the age structure of the population. The age profile of per capita expenditure highlights how the demand for healthcare is greater at very young ages and for older age cohorts (Jacobzone, 2002; EPC, 2006). The results are partially unexpected: while the elderly dependency ratio has a positive and significant sign, the dependency ratio of the very young is not significant. This finding may be driven by considering too broad an age class (0-4 years of age) as the expenditure profile is higher at younger ages, particularly in infancy or early childhood (Cutler and Meara, 1997).

The health status and bad habit indicators are both significant and have the expected sign (‘poorer’ health and ‘worse’ habits are associated with higher expenditure).

The dummy variable aimed at capturing the general cost containment effort exerted in the first part of the 1990s is highly significant and has the expected sign (the intercept of the expenditure curve is shifted downwards after 1995).

Regional fixed effects are shown in the lower panel of Table 4. They are strongly consistent between the three specifications, with the correlations among the series ranging from 0.95 to 0.99.

3.3 First step: robustness checks

To check the robustness of our estimates we perform a series of exercises described in Appendix B. First, we re-estimate the three specifications discussed above using different indices for computing real values for per capita health expenditure and GDP. Secondly, we re-estimate the model using a stochastic frontier approach. We consider both time invariant and time varying specifications. All of the estimated models give very similar results; the correlation between the estimated regional effects series ranges between 0.95 and 1. The time varying models, in which unexplained expenditure is a function of time, indicate that, other things being equal, differentials in spending between regions are increasing over time, i.e. more efficient regions are also at an advantage to contain expenditure growth (not only levels).

Following a similar approach to Schmidt and Sickles (1984), we approximate ‘waste’ (or unexplained differentials) for each region with the estimated fixed effects, that is $\hat{w}_i = \hat{\alpha}_i$. In this way, however, any time invariant heterogeneity between the regions is also captured by the waste term.[31] Even though we acknowledge this identification issue, we also believe that it is not as relevant in this study as in other applications. In particular, the common legal and institutional framework and the shared rules set at the central level significantly mitigate the problem of heterogeneity among regions potentially associated with institutional factors. Secondly, at this stage we are interested in isolating unexplained (by demand factors) differentials whatever the source might be (time invariant heterogeneity or ‘technical’ inefficiency). In the second step of

[31] See Greene (2004), (2005) and (2008).

the analysis we will try to see whether the waste levels are correlated with indicators aimed at capturing the quality of the public administration or other exogenous regional characteristics.

3.4 First step: a disaggregated analysis by spending category and the relation to quality

Before moving to the second step we estimate regional fixed effects using (5) (according to the specification adopted for Model *1a*) also breaking down the dependent variable into its main sub-categories. We consider two types of breakdown: (i) the first by economic category (in which we distinguish between wages, purchases of goods and services, spending for private hospitals recognised within the SSN, primary care, pharmaceuticals, and specialised care)[32] and (ii) a second one in which we group together wages, purchases of goods and services and spending to reimburse private hospitals to proxy overall public spending for hospital services.

Given the estimates for each expenditure category we can recover aggregate regional 'waste levels'. Assuming that each expenditure item *h* presents a relationship as in (5) and using the same set of regressors, i.e. $\mathrm{E}\left[c_{it}^{h}\right] = e^{\mathbf{x}'_{it}\beta^{h}+\alpha^{h}+\alpha_i^{h}}; h = 1,\ldots,H$ (*H* being the total number of expenditure items), we have that:

$$(6) \qquad e^{\mathbf{x}'_{it}\beta+\alpha+\alpha_i} = \sum_{h=1}^{H} e^{\mathbf{x}'_{it}\beta^{h}+\alpha^{h}+\alpha_i^{h}} .$$

From which it follows that:

$$(7) \qquad \underbrace{e^{\alpha_i-\alpha_{i\,\min}}}_{\xi_i} = \sum_{h=1}^{H} \underbrace{\frac{e^{\mathbf{x}'_{it}\beta^{h}+\alpha^{h}}}{e^{\mathbf{x}'_{it}\beta+\alpha}}}_{s_i^h} \underbrace{\frac{e^{\alpha_i^h}}{e^{\alpha_{i\,\min}}}}_{\tilde{\xi}_i^h}$$

The distance to the minimum cost for each region *i* can be represented as a weighted average of the inefficiency scores for each expenditure item $(\tilde{\xi}_i^h)$, with the latter normalised with respect to the minimum total regional effect. Estimated fixed effects obtained by aggregating the results for the expenditure items are in line with those obtained estimating aggregate expenditure.[33] Figure 4 shows for each region the contribution of each expenditure item to the difference between its own inefficiency score and the minimum one $(\xi_i - \xi_{\min})$.[34]

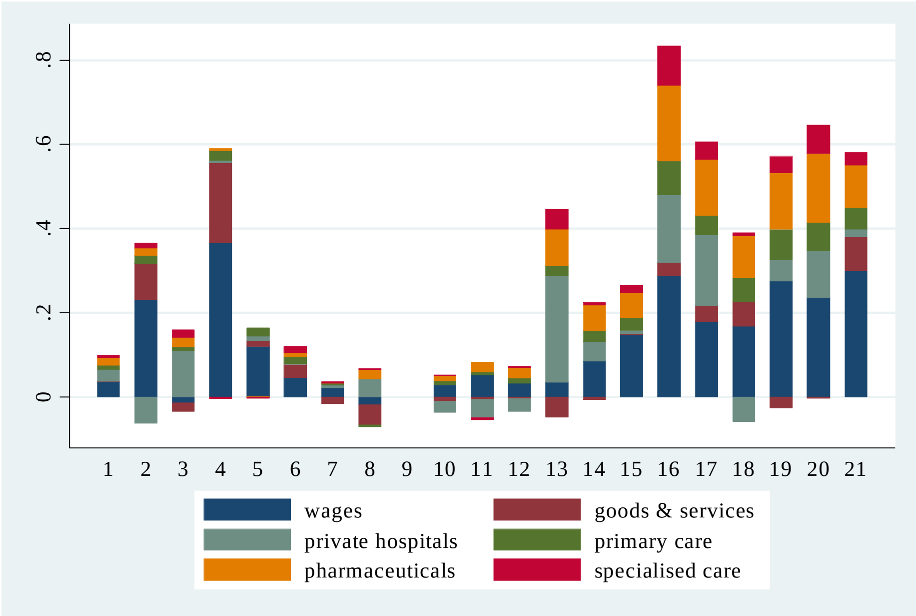
[32] As to the magnitude of the expenditure categories considered, it should be noted that in 2005 for the Italian average, wages accounted for 33 per cent of total expenditure, the purchase of goods and services for 27 per cent, primary care for 6 per cent, pharmaceuticals for 13 per cent, private hospital care for 9 per cent, and specialised care for 4 per cent.

[33] Given (7), regional effects can be obtained by aggregating the results of the estimation of the expenditure items equations as: $\hat{\alpha}_{i\,disag} = \ln\left[\sum_{h=1}^{H} s_i^h e^{\hat{\alpha}_i^h}\right]$. The correlation between $\hat{\alpha}_i$ and $\hat{\alpha}_{i\,disag}$ is 0.99 using both the expenditure breakdowns described above.

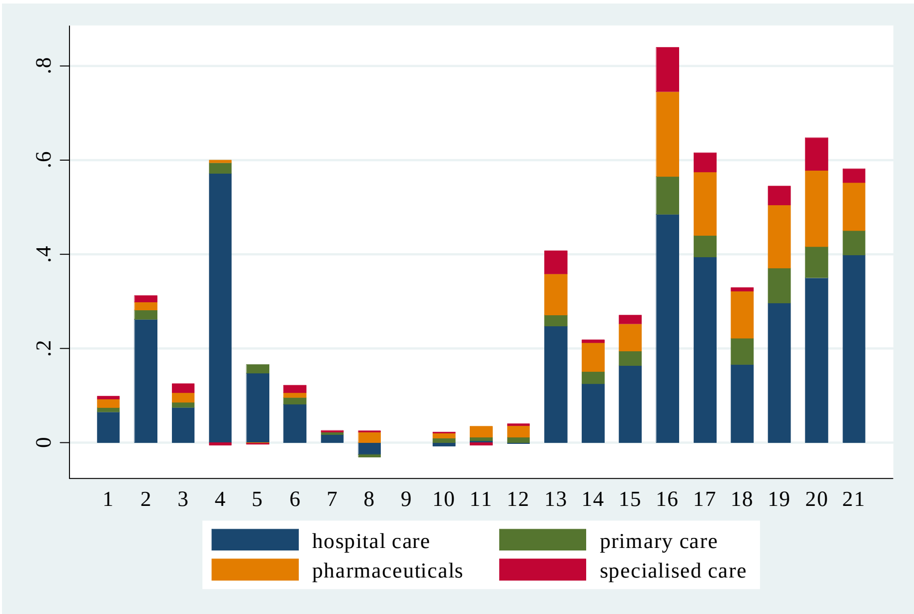
[34] The difference can be decomposed as follows:

Figure 4
Regional fixed effects: breakdown of deviation with respect to the region with lowest unexplained expenditure

Breakdown (i)



Breakdown (ii)



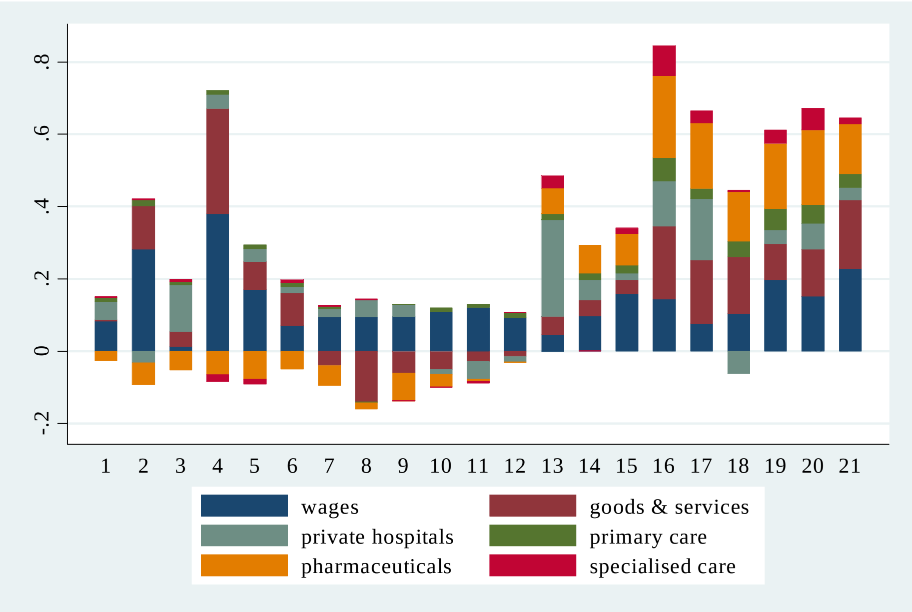
$$\Delta_i = \xi_i - \xi_{\min} = \sum_{h=1}^{H} (\kappa_i^h - \kappa_{i\,\min}^h) = \sum_{h=1}^{H} \Delta_i^h$$

where $\kappa_i^h = s_i^h \tilde{\xi}_i^h$ are the contributions of each expenditure item and variables with the subscipt *min* refer to the region with the lowest α_i. Values shown in Figure 4 are computed considering the average values of s_i^h over the estimated period.

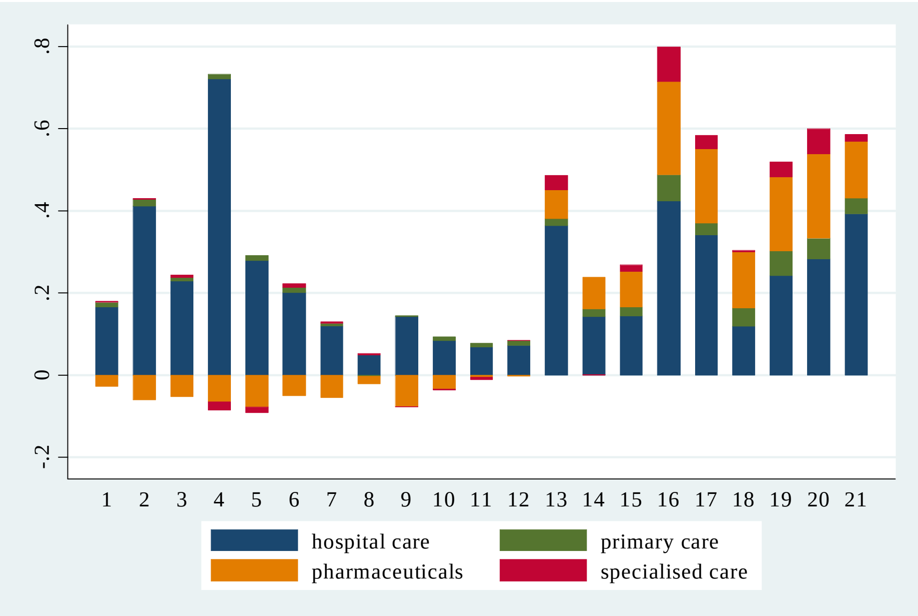
Figure 5 instead shows the contribution of each expenditure item to the difference between the actual inefficiency score and the score that would have occurred in region *i* had all the $\tilde{\xi}_i^h$ been equal to 1.[35]

Figure 5
Regional fixed effects: breakdown of deviation with respect to reference expenditure levels and composition

Breakdown (i)



Breakdown (ii)



[35] If $\tilde{\xi}_i^h = 1 \, \forall h$ (the term of comparison this time is the case in which inefficiency is uniformly distributed among the expenditure items and equal to aggregate minimum $\alpha_{i\,\min}$) then $\kappa_i^h = s_i^h$. It follows that the described difference can be decomposed as: $\Delta_i = \xi_i - \xi_{i\,ref} = \sum_{h=1}^{H} (\kappa_i^h - s_i^h) = \sum_{h=1}^{H} \tilde{\Delta}_i^h$.

This decomposition allows us to point out some interesting patterns. Low levels of unexplained expenditure (characterised by Δ_i equal or close to 0) seem compatible with different choices as regards spending composition. Furthermore, in regions with higher spending the distribution of inefficiency among expenditure items does not seem to be uniform. In particular, in the regions with a positive total fixed effect (meaning, *ceteris paribus*, higher than average unexplained expenditure), the management of the outlays which account for relatively smaller shares of the budget seems in need of particularly careful monitoring. This is evident if we consider the distribution of the inefficiency among expenditure items computing $\vartheta_i^h = \frac{\tilde{\Delta}_i^h}{\Delta_i} - s_i^h$, an indicator that compares the share of the deviation from minimum spending due to a given expenditure item and the reference share of that same item in total outlays (Figure 6).[36] For the regions with a positive total fixed effect located in the South of Italy the distortion in spending on pharmaceuticals is particularly large, while the weight of the inefficiency in hospital spending is less pronounced than implied by their reference share of total spending.[37] This might reflect several features, such as national guidelines and the application of national labour contracts for the employees of the SSN. The breakdown of hospital spending suggests that in some regions, in particular Lazio, the level of distortion in reimbursements for services provided by private hospitals plays a non-negligible role in overall spending overruns. For the northern regions with higher than average unexplained expenditure (Valle d'Aosta and the autonomous province of

[36] Taken a region *i*, values of $\left|\vartheta_i^h\right|$ that are close to zero for every *h* suggest that in region *i* the level of inefficiency is similar among the various expenditure items. A large value of ϑ_i^h for a given *h* implies a particularly high value of $\tilde{\xi}_i^h$ for that item with respect to the others. We can in fact rewrite ϑ_i^h as follows:

$$\theta_i^h = \frac{s_i^h \tilde{\xi}_i^h - s_i^h}{\xi_i - \xi_{i\,ref}} - s_i^h \text{ or } \theta_i^h = s_i^h \frac{\tilde{\xi}_i^h - \xi_i}{\xi_i - \xi_{i\,ref}}$$

When $\tilde{\xi}_i^h = \xi_i \;\; \forall h$ then $\theta_i^h = 0 \;\; \forall h$. All the items have the same level of inefficiency. The distortion might be very big but it is uniformly distributed among the expenditure items. On the other hand, consider a case in which all the first *h*-1 items are characterised by 'full efficiency' so that $\tilde{\xi}_i^h = 1 \;\; \forall h = 1,\ldots,H-1$. In this case with $\xi_{i\,ref} = \sum_{h=1}^{H} s_i^h = 1$, we will have $\theta_i^h = -s_i^h \;\; \forall h = 1,\ldots,H-1$ while the overall inefficiency will reflect the distortion in the last expenditure item: θ_i^H will be $> 0 > \theta_i^h \;\; \forall h = 1,\ldots,H-1$. Given (7) we will in fact have that: $\xi_i = \left(\sum_{h=1}^{H-1} s_i^h\right) + s_i^H \tilde{\xi}_i^H$. Finally it should be noted that for items characterised by $\tilde{\xi}_i^h > \xi_i$, θ_i^h will be positive, while for $\tilde{\xi}_i^h < \xi_i$, θ_i^h will be negative. This means that a large distortion in a relatively small spending item might be compensated by a relatively smaller distortion in a spending item that accounts for a large fraction of total outlays.

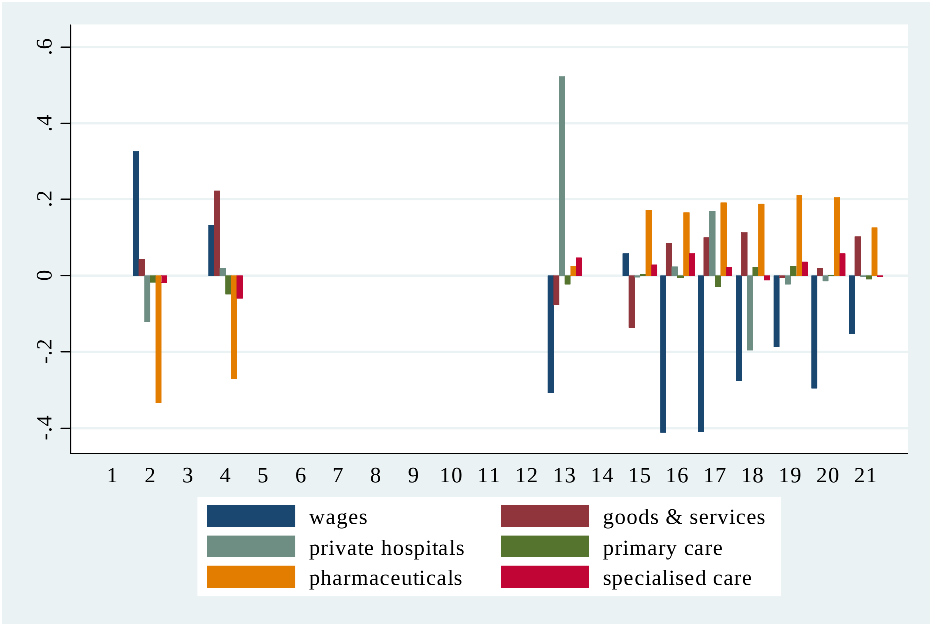
[37] This means that for the regions under consideration the inefficiency level for this item, although large, is less pronounced than the inefficiency in other spending categories.

Bolzano) the situation is different, with most of the distortion being attributable to hospital spending.

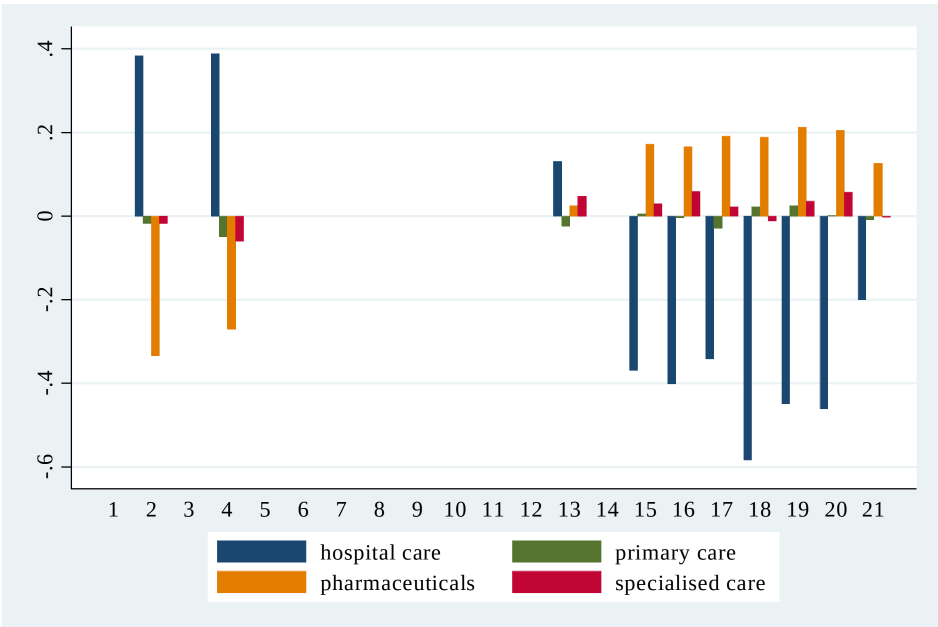
Figure 6
θ_i^h: share of the deviation from minimum spending due to a given expenditure item (*h*) minus its weight on total outlays

Regions with positive fixed effects (higher than average unexplained expenditure)

Breakdown (i)



Breakdown (ii)



The particular geographic characteristics of these regions, both located in the Alps, might play a role. As regards the distortion in the purchases of goods and services, it seems in line with average inefficiency levels in each of the regions. For this item the large impact on overall unexplained spending (Figure 5) seems to reflect mainly its large incidence on total expenditure.

It has to be noted, however, that regions with lower health spending seem to have been particularly effective in containing outlays in this category.

An overall glance at the results highlights a clear geographical pattern:[38] the regions which present positive unexplained differentials are all located in the South of the country, apart from Valle d'Aosta and the autonomous province of Bolzano in the North and Lazio in the Centre. Also in light of the identification problem discussed above, before moving on to disentangle some of the characteristics that might be related to the regional fixed effects, it is worth checking whether the differentials isolated in our first step reflect differences in the quality of services provided to the public. To do that we consider two types of indicators: a) the mobility of patients between regions; b) declared patients' satisfaction.

If we look at patients' mobility between regions[39] (Figure 7) as an indirect indicator of the quality of health services (or at least of the degree of quality 'perceived' by patients), we observe that patients consistently tend to move from the South towards the Centre and North of Italy. The correlation between the regional fixed effects and the average attraction index observed over the period considered is highly negative (-0.64) and significant so that the higher the 'perceived' quality, the lower the 'unexplained' spending.

Similarly, indicators that take into account declared patient satisfaction[40] for hospital services display a clear North-South pattern with patients being more satisfied with hospital services in the North. In particular, the correlation between average patient satisfaction indexes for nurses, physicians and sanitary services and the estimated regional effects vary between -0.48 and -0.31.

Finally, the complexity of the treatments is also on average higher in the regions with lower regional effects.[41]

In brief, the higher spending in the southern regions with respect to the Centre and North does not seem to be ascribable to perceived or reported higher quality. So, what causes the difference? Are there any factors that policy makers could control for in order to cut spending without reducing the amount of services provided?

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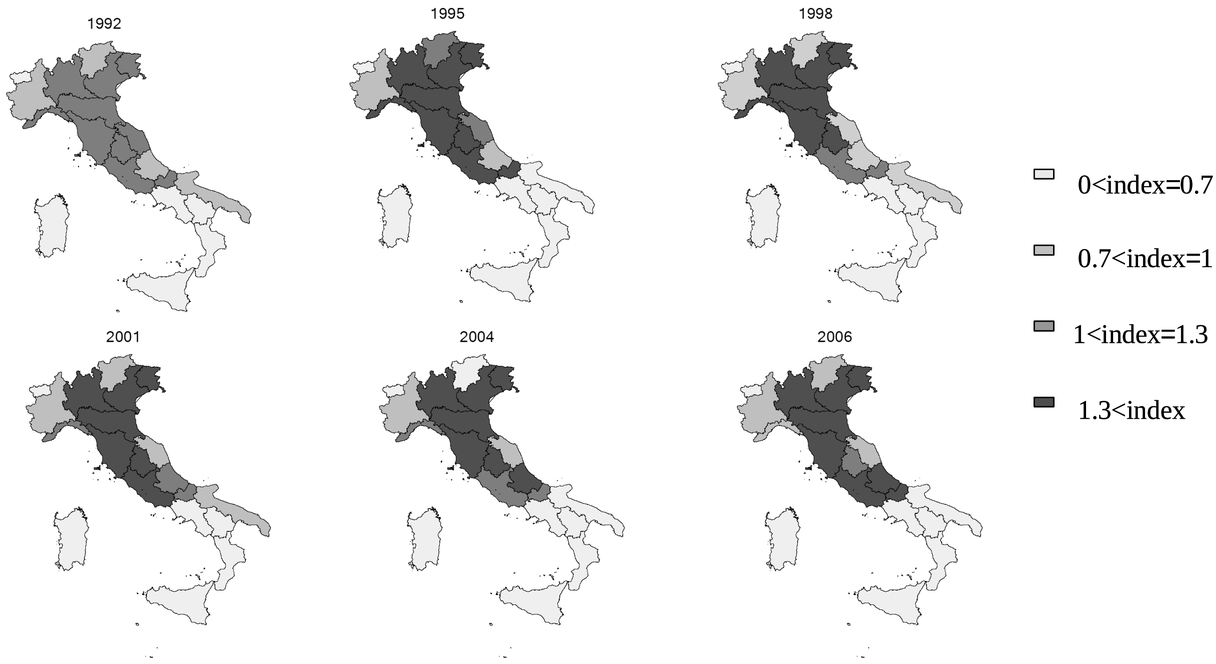
[38] This result is in line with other studies that have addressed the analysis of health spending differentials. See for example Pammolli, Papa and Salerno (2009).

[39] In particular, we consider the attraction index, measured as the ratio between the inflow and outflow of patients into a given region. An index value > 1 means that the inflow of patients from other regions is greater than the outflow to other regions, and hence the region attracts patients from other areas of the country.

[40] The satisfaction with hospital services is drawn from surveys included in the *Indagine multiscopo* regularly performed by Istat. The data considered here refer to the period 1998-2007.

[41] The correlation between the average case mix (measured as the standard hospital stay*the normalised applicable DRG) over the observed period and regional fixed effects is -0.89.

Figure 7 Attraction Index(*)
(Net mobility)



(*) A value greater than 1 means that the inflow of patients from other regions is greater than the outflow of residents towards other regions.
Source: our computations based on Ministero della Salute, *Rapporto sull'attività di ricovero ospedaliero*, and Istat, *Statistiche sulla sanità*, various years. Data up to 1995 refer to all hospital admissions. For the following years they refer to ordinary admissions, escluding longterm care and 1 day hospital admissions.

3.5 The empirical analysis – second step: the drivers of regional differentials

The second step of our analysis tries to address this issue. In particular, we investigate the correlation between regional effects and some supply factors and regional characteristics which could influence the unexplained variability observed in spending levels.

The analysis exploits the result of the expenditure levels estimation in step one. In particular, we consider the covariates of the regional fixed effects estimating the following linear model:[42]

$$(8) \qquad \alpha_i = \mathbf{q}_i'\delta + \zeta_i \qquad i = 1,...,N$$

where ζ_i is the standard i.i.d. error term and $\mathbf{q}_i$ is a vector of *j* regressors and includes indicators for the following categories: 1) appropriateness of treatments;[43] 2) supply structure characteristics;[44] 3) quality in public administration;[45] and 4) social capital.[46]

[42] This is consistent with the assumption of regional effects being time invariant. As seen above, the time invariant component estimated using time varying frontier models or fixed effects gives equivalent results. Apart from the common impact due to the decaying factor, estimated waste levels are strongly correlated using the four estimation procedures discussed in Appendix B.
[43] The indicators considered under this category are the average over the observed period of the incidence of Caesarian sections and of the incidence of patients discharged by a surgical ward with a medical DRG.
[44] In this category we considered the averages of the incidence of SSN employees on residents; composition of employees (ratio of medical staff over total employees); incidences of public hospital beds on residents; incidences

Given the small number of observations, we started by considering one (or at most two) regressor for each category: the index for Caesarean sections, the index for total employment and its composition; the indicator for general practitioners with a large number of patients; the ratio between the number of beds in private and public hospitals; the share of the use of generic pharmaceuticals and proxies for social capital (Table 5 shows the results of the estimation). To check the robustness of the results, we also considered each category at a time and substituted the proxy/ies included in the estimated specification. Table 5 also shows the results of a SURE model having as dependent variables the regional effects for the categories of hospital spending, primary care, outlays for pharmaceuticals and specialised care.[47]

The appropriateness index turns out to be significantly related to unexplained spending differentials (even when we substitute Caesarean sections with the surgical ward discharge index[48]). The higher the inappropriateness of treatments the higher the regional effects.

As to supply indicators, a higher number of employees is related to higher spending, as expected. Instead, the coefficient of the proxy for the composition of the staff is not significant.

The workload of general practitioners is significant;[49] in particular, the share of practitioners with a very large number of patients is related to higher spending (the same happens when considering the average number of patients for general practitioners). The workload of primary care doctors has a strong positive impact on hospital and pharmaceutical spending as well as spending for primary care. This suggests that too many patients to follow might make it more difficult for general practitioners to avoid unnecessary access to hospital services and use of pharmaceuticals.

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of private hospital beds; ratio between number of beds in private to public hospitals; share of expenditure for care provided by private hospitals; average stay in public hospitals; average stay in private hospitals; number of general praticitioners; number of patients per general praticitioner; number of general praticitioners with more than 1500 patients.

[45] To proxy the quality of administration we consider indicators of some practices that aim to reduce the resources absorbed by pharmaceutical outlays without reducing the quantity provided or the effectiveness of the treatments: the share of pharmaceutical expenditure for generic (off-patent) pharmaceuticals and the share of expenditure for pharmaceuticals delivered directly by the SSN in total pharmaceutical expenditure. We also considered an indicator for the use of IT in other Italian local governments in each region; in particular, we use a municipality IT index, which is given by the share of municipalities whose general registry office has been computerised.

[46] In particular, we consider several proxies for social capital commonly used in the literature: incidence of blood donors per 1000 residents; incidence of recyclable waste collection (we thank Marco Casiraghi for providing these indicators); average turnout at referenda; interest in politics and morality. The indicators for solidarity/'morality' and participation/'interest in politics' are drawn from Giordano et al. (2009). In particular, solidarity/'morality' is a composite index summarising self-reported pro-social attitudes and objective measures of altruistic behaviour (such as blood donation); similarly, interest in politics is built from self-reported answers and more objective measures (such as referendum participation).

[47] All the estimated models exclude the constant term. In fact, the mean value of the fixed effects is zero by construction. To check for this, however, we also replicate the estimation including the constant term, which turns out to be not significant. Moreover, neither the sign nor the magnitute of the estimated coefficients are affected by including/excluding the constant.

[48] In this case, however, it interferes with the significance of the number of employees indicator.

[49] In Italy, general practioners are paid on a capitation basis.

Table 5 Step 2 – Drivers of regional effects

	Regional fixed effect (1) total expenditure		Regional fixed effect (2) hospital expenditure		Regional fixed effect (2) primary care		Regional fixed effect (2) pharmaceuticals		Regional fixed effect (2) specialised care	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
% Caesarian sections	0.01793 ***	0.000	0.01025 ***	0.000	0.00170 ***	0.000	0.00334 ***	0.000	0.00101 **	0.027
Incidence of SSN employees on residents	0.04854 ***	0.002	0.04889 ***	0.000	0.00508 ***	0.000	0.00461 *	0.061	-0.00070	0.731
Composition of employees (medical staff/employees)	-0.00657	0.232	0.00427	0.252	-0.00003	0.954	0.00174 *	0.092	0.00009	0.918
General pratictioners with more than 1500 patients	0.00877 ***	0.000	0.00758 ***	0.000	0.00044 ***	0.003	0.00055 **	0.035	0.00014	0.504
# beds in private/# bed in public hospitals	0.00214	0.137	0.00161 *	0.095	0.00034 **	0.020	0.00059 **	0.029	0.00034	0.124
% generic (off patent) pharmaceuticals	-0.05452 ***	0.004	-0.03993 ***	0.001	-0.00166	0.316	-0.00615 **	0.044	-0.00243	0.334
Interest in politics	-0.01551 ***	0.001	-0.01143 ***	0.000	-0.00140 ***	0.000	-0.00269 ***	0.000	-0.00080	0.156
Solidarity	0.00805 **	0.018	0.00791 ***	0.000	0.00053 *	0.100	0.00117 **	0.048	0.00094 *	0.058
No. Observations	21		21		21		21		21	
F(8, 13)	22.07		559.14		184.66		244.2		20.15	
Prob > F	0.0000		0.0000		0.0000		0.0000		0.0000	
ρ2 y,ŷ	0.9332		0.9971		0.9913		0.9934		0.9254	

Correlation matrix of residuals:

	Hospital	Primary care	Pharma	Specialised care
Hospital	1.00			
Primary care	0.27	1.00		
Pharma	0.49	0.58	1.00	
Specialised care	0.53	0.34	0.62	1.00

Breush-Pagan test (independence)

chi(6)	30.262
Pr	0.0000

*, **, *** significance at respectively 10, 5 and 1 per cent level

(1) Ordinary least square.

(2) Maximum likelihood seemingly unrelated regression. Small sample statistics are computed.

Proxies (either the ratio of beds in private to public hospitals or the share of spending for private hospitals in total spending) for the relevance of the private sector display a positive but not significant coefficient in the regression for aggregate regional effects; the coefficient is significant, however, in the estimation of spending categories, in particular hospitals, primary care and pharmaceuticals. The impact of a larger role for the private sector could be relevant, but our aggregate analysis is not able to highlight it. This could be due to the relation that characterises the relevance of the private sector and some of the other control variables.[50]

As expected, proxies for good practices (we considered alternatively the index for the use of generics or for direct delivery of pharmaceuticals) do display a negative relation to unexplained spending.

Finally, we also included in our model proxies for informal rules and habits that might play a role in the performances of different public administrations. The economic literature often highlights the impact of history and economic institutions on the development of different regions. Institutions also include informal rules and constraints which are often summarised in the concept of social capital.[51] In this context, social capital captures the level of trust and habits of cooperation shared among members of a local community. As to our results, social capital indicators turn out to be significant when splitting the two aspects of solidarity/'morality' and participation/'interest in politics', the first one being positively related to spending – probably reflecting a higher propensity to share fundamental services – the second one being negatively related to regional effects – suggesting that the more public attention is given to policy makers' activity the stronger their incentive to manage the available resources efficiently.

Although the second step of the empirical analysis is based on a small sample size, the correlations we detect are sufficiently robust to derive some general policy considerations. Regional spending differentials seem to be related both to persistent (sticky?) regional features (such as social capital) and characteristics which in the medium term can be controlled by policy makers (such as the appropriateness of health treatments, the workload of general practitioners or the use of generics). Spreading administrative best practices and enhancing the degree of appropriateness of treatments would be an effective way of reducing spending differentials and increasing efficiency in the use of public funds. Even relatively limited improvements could turn into substantial savings: given our results, an increase in the appropriateness level or in the use of

[50] For example, the correlation between our regressor for inappropriateness (Caesarean sections) and the ratio between the number of beds in private and public hospitals is positive (0.43). Furthermore, a more prominent role of the private sector is also reflected *ceteris paribus* in a lower number of employees in the public sector.

[51] See Putnam (1993), de Blasio and Nuzzo (2006), Nuzzo (2006).

generics by 1 percentage point[52] implies on average a reduction of respectively 1.8 and 5.3 per cent in total expenditure (€20.9 and €62.3 per capita).

4. Concluding remarks

Several studies have documented the presence of regional differentials in public health spending in Italy. The aim of this work is to contribute to this discussion by analysing the determinants of per capita health expenditure focusing on identifying the drivers of inefficiency for the panel of Italian regions and the existence of potential room for savings. The paper presents an empirical analysis of per capita expenditure levels that takes into account the regional differences in the need for health services. The remaining differences in spending (the "unexplained differentials") are then studied in relation to structural characteristics and policy variables.

First, the results confirm the existence of potential margins for savings which are related at least in part to differences in the effectiveness of public administration. However, with respect to previous studies, our methodology not only allows us to evaluate the overall inefficiency level for every region, but also to estimate the contribution of each spending item (e.g. wages, pharmaceuticals, etc.) to that inefficiency. For all the regions, the analysis further breaks it down into two factors: the first accounts for the budget share of each spending category, the second captures its relative inefficiency. In our framework it is thus possible to single out the categories which need careful monitoring in the regions with poorer performances, such as outlays for pharmaceuticals.

The second step of the study suggests that there are policy tools (e.g. the use of generic drugs or the workload of general practitioners) that might help to keep inefficiency under control. Moreover, some supply structure indicators and proxies for good practices seem to be particularly important for certain spending categories.

Appendix A: The impact of different hypotheses on the financing mechanisms

A.1 Ex post bail-out

Let us consider a one period economy with N regions. Each region has a given income level (and tax base) a_i, so that $\sum_{i=1}^{N} a_i = Y$ is the total income in the economy (and the overall tax base).

[52] These computations use the result of the estimation of Model 1a in Table 4 and the coefficents reported in the first column of Table 5. Values are computed using variable averages over the regions and the years 1993-2006.

Healthcare is financed via transfers received from the central government (CG) and using regional resources. Each region can decide on the level of a local tax $v_i \geq 0$. Regions want to produce the optimal level of healthcare demanded by the population (x_i*) and choose the local tax rate accordingly. They also want to minimise the tax burden on the citizens living in their constituency and know that: (1) the CG will choose a level of general taxation (t) and a vector of transfers to each region (T_i) taking into account the revenue collected through local taxes; (2) the CG's mandate is to provide homogeneous healthcare coverage and ensure that every citizen has access to comprehensive healthcare services (i.e. CG wants each region to have enough resources to produce x_i*). The CG (as well as the regions) observes spending levels but does not distinguish waste from efficient costs.

The CG will then choose t so that total resources would be sufficient to pay for the production of the optimal level of healthcare in each region:

$$\text{(A.1)} \quad \sum_{i=1}^{N}(t+v_i)a_i = \sum_{i=1}^{N} S_i^* \text{ where } S_i^* = C(x_i^*) + w_i \text{ and } t\sum_{i=1}^{N} a_i = \sum_{i=1}^{N} T_i$$

The tax rate set by the CG will then be:

$$\text{(A.2)} \quad t = \frac{\sum_{i=1}^{N} S_i^*}{\sum_{i=1}^{N} a_i} - \frac{\sum_{i=1}^{N} v_i a_i}{\sum_{i=1}^{N} a_i} = \frac{N\overline{S}}{Y} - \frac{LR}{Y}$$

where LR is the revenue collected at the local level and $\overline{S}$ the average regional spending.

Given (A.2), regions' optimal behaviour would be to set $v_i = 0 \ \forall i$. In equilibrium each region will be able to produce the optimal quantity and spending will be financed through transfers from the central budget, with tax revenue collected in rich regions used to finance spending in poor ones as well. All the regions will have as low as possible local taxation. Tax rates at local level would be correlated with neither the degree of efficiency in the production of healthcare nor the magnitude of income differentials.

A.2 Fiscal decentralisation

Assume now that a minimum local tax rate is mandated by law. Healthcare financing will then be split between revenue from a tax set by the CG (t), revenue from the mandatory local tax (μ) and revenue from an optional local tax (v_i).

The CG distributes flat transfers to the regions. The transfer is a fraction of average regional spending:

$$(A.3)\quad \tilde{S} = b\bar{S} \qquad b < 1$$

and μ is set by the CG so that the own mandatorily collected resources and the transfer are sufficient to finance $S_{\min}$:

$$(A.4)\quad \mu a_{S_{\min}} + b\bar{S} = S_{\min}$$

($S_{\min}$ is the minimum level of expenditure among regions and $a_{S\min}$ is the income in the region with the minimum level of expenditure).

In this scenario, the CG will set the tax rate so that:

$$(A.5)\quad t = \frac{N\bar{S}}{Y} - \frac{\sum_{i=1}^{N} v_i a_i}{Y} - \mu$$

Now suppose that regional governments have different beliefs with regard to the commitment of the CG to limit the transfer to $\tilde{S}$, i.e. some of the regions believe that the budget constraint is 'soft' (J regions of type j) others that it is 'tight' (Z regions of type z, with J+Z=N).

Regions of type j will set the optional local tax rate at the minimum (v_j =0), while regions of type z will put it equal to:

$$(A.6)\quad v_z = \frac{S_i^* - b\bar{S}}{a_z} - \mu$$

The tax rate set at the central level will then be:

$$(A.7)\quad t = \frac{N\bar{S}}{Y} - \frac{\sum_{z=1}^{Z}(S_z - b\bar{S})}{Y} - \mu\left(1 - \frac{Y_z}{Y}\right)$$

higher than if all the regions had believed the commitment of the government to transfer $\tilde{S}$ to each region. The maximum level of t would occur if none of the regions believed the government commitment, as in the ex post bail-out case with μ =0.

In this scenario each region is again able to finance the preferred level of spending ($S_i^* = C(x_i^*) + w_i$).

Local tax rates would in any case be differentiated between regions, with $v_j = 0$ for the regions that did not believe the CG commitment and a positive optional local taxation in the regions that believed to have a tight budget constraint, except for the region with minimum spending if it happened to be of type z.

No optional local tax would then reflect either a soft budget constraint belief, or a combination of healthcare demand, inefficiency and income levels so that:

$$\text{(A.8)} \quad \frac{C(x_z^*) + w_z - b\overline{S}}{a_z} - \frac{S_{\min} - b\overline{S}}{a_{S_{\min}}} = 0$$

Zero optional local taxes would not necessarily reflect a high level of efficiency. If the region believes in the central government's commitment, this result could be due to low demand (for example due to a favourable health status of the population).

Similarly, for the other regions of type *z* the ranking according to optional local tax rates would not necessarily reflect the ranking in terms of efficiency levels. Demand and income levels also play a role.

Finally, in this set-up regions that overspend with respect to the resources drawn through mandatory local taxes and the flat transfer set by the CG are not necessarily the most inefficient ones. Overspending which is ex post financed by the CG could be a signal of the region's belief in the commitment of the CG to limit its transfers.

The inability of the CG to infer efficiency levels from regional spending and tax levels reflects the impossibility of observing regions' beliefs, imperfect knowledge about the healthcare production function and the ultimate objective of the CG of financing the production of optimal levels of healthcare in all the regions.

Given this framework, which outlines the financing of the healthcare sector over recent decades, we assume that regions are able to finance their preferred level of health services.

Appendix B – Robustness checks

To check the robustness of our estimates, we perform a series of exercises described in Table B.1.

First, we re-estimate the three specifications discussed above using different indices for computing real values for per capita health expenditure and GDP.[53] All of them give very similar results (Figure B.1).[54]

Second, we estimate model *1a* using alternative estimation techniques. We start by considering a stochastic frontier model[55] of the type:

$$\text{(B.1)} \quad c_{it} = f(x_{it})\xi_{it}$$

where $\xi_{it} = 1$ for the best unit in the sample and $\xi_{it} > 1$ for the others.

[53] Specifically, we consider three indices: GDP deflator, CPI, HICP for health product indices. The combinations considered are described in Table B.1.
[54] In particular, the correlation between the estimated regional effects ranges from 0.81 to 1.00.
[55] A drawback of this approach, however, is that using stochastic frontiers requires explicit assumptions in terms of the distributions involved.

Table B.1 – Step 1 – Robustness checks

Dependent variable	Population used to compute per capita values	Index used to compute real values (for health expenditure)	Index used to compute real values (for GDP)	
Total expenditure (corrected to take into account patient mobillity)	Population	GDP Deflator	GDP Deflator	Model 1a (Table 4)
	Equivalent population (using weights for hospital services)	GDP Deflator	GDP Deflator	Model 2a (Table 4)
	Equivalent population (using weights for pharmaceuticals)	GDP Deflator	GDP Deflator	Model 3a (Table 4)
Outcome	Regional fixed effects		**Years**	1993-2006
Robustness:				
Across estimation techniques	A) panel fixed effects; B) stochastic frontier (time invariant); C) time varying stocahastic frontier; D) time varying fixed effect (Table 6)			
Across indices used for computing real values				Model
		GDP deflator	GDP deflator	a
		CPI index	GDP deflator	b
			CPI index	c
		HICP for health products	GDP deflator	d
			CPI index	e

We specify the efficient expenditure function as

$$\text{(B.2)} \quad f(x_{it}) = e^{cons+\mathbf{x}'_{it}\beta}$$

and hence we can write the estimating equation as

$$\text{(B.3)} \quad \ln c_{it} = cons + \mathbf{x}'_{it}\beta + u_{it} + v_{it}$$

where v_{it} iid $N(0,\sigma_v^2)$ is the error term and u_{it} iid $N^+(\mu,\sigma_u^2)$ captures each region's distance with respect to the efficient frontier:[56]

$$\text{(B.4)} \quad \xi_{it} = e^{u_{it}}$$

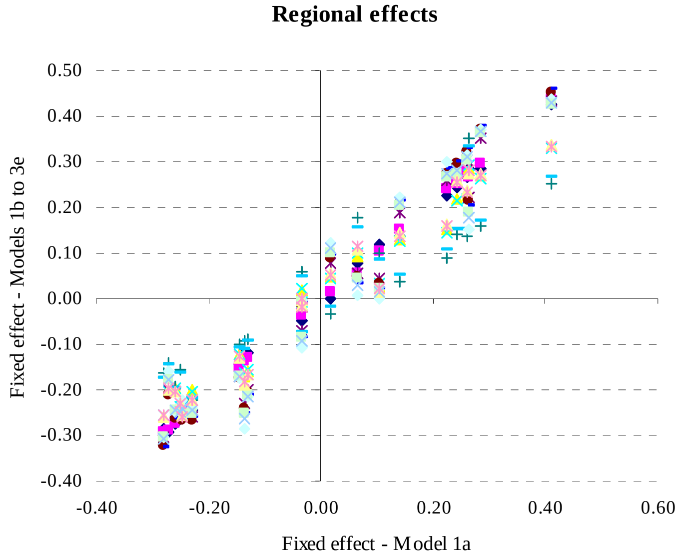
[56] In general, model (B.3) can be related to model (5). In particular, rearranging the estimating equation for model (5) with regional fixed effects we have that:

$$\ln(rexp\_pc_{it}) = [\alpha + \min(\alpha_i)] + [\alpha_i - \min(\alpha_i)] + \mathbf{x}_{it}'\beta + \varepsilon_{it}$$

with $0 \le \alpha_i - \min(\alpha_i) = \alpha_{i\,norm} \le +\infty$, which can be directly compared to (B.3) where $0 \le u_{it} \le +\infty$ captures the inefficiency levels.

Figure B.1 Regional fixed effects

Comparison between the estimated specifications 1a to 3e



Initially, we assume that the stochastic frontier is invariant over time (Table B.2 – column B).[57]

We then consider a time varying version à la Battese and Coelli (1992):[58]

$$\text{(B.5)}\quad u_{it} = e^{-\eta(t-T)} u_i \qquad \text{with} \qquad u_{it} \text{ iid } N^{+}(\mu, \sigma_u^2)$$

where the distance from minimum cost can be decomposed into two factors, a given level of inefficiency u_i characterising each region and a time varying component, which is a function of time and a decay factor η (Table B.2 – column C).

We also estimate a fixed effect model with time varying regional effects. In particular, we derive an estimating equation equivalent to the time varying stochastic frontier described above (cf. B.5). In this case the expenditure equation becomes:[59]

$$\text{(B.6)}\quad \ln c_{it} = \mathbf{x}'_{it}\beta + e^{-\eta t}\varphi_i + \varepsilon_{it} \quad \text{with} \qquad \varphi_i = [e^{\eta T}\alpha_i]$$

Using the approximation

$$\text{(B.7)}\quad e^{-\eta t} \cong 1 - \eta t + \eta^2 \frac{t^2}{2}$$

we derive the following estimating equation:[60]

[57] So that in terms of model (5) and rearrangenging the time invariant fixed effects, the estimation of α_i - min(α_i) is analogous to the estimation of u_i.
[58] See Greene (2008) for a discussion of the available approaches to the analysis of economic efficiency.
[59] In terms of rearranging model (5) it is like writing:

$$\alpha_{it\,norm} = e^{-\eta(t-T)}\alpha_{i\,norm} = e^{-\eta(t-T)}\alpha_i - e^{-\eta(t-T)}(\min(\alpha_i))$$

with $\alpha_{i\,norm} = 0$ for the best unit in the sample.
[60] This specification is analagous to those discussed in Cornwell et al. (1990) and Kumbhakar (1990), where the authors suggest substituting a constant inefficiency parameter with a quadratic specification as in (B.8).

$$\text{(B.8)} \qquad \ln c_{it} = \mathbf{x}'_{it}\beta + \varphi_i - \eta t \varphi_i + \eta^2 \frac{t^2 \varphi_i}{2} + \varepsilon_{it}$$

From the estimates of (B.8) we can recover the parameters we are interested in: the regional (time invariant) effects α_i and the decay factor η (Table B.2 – column D). In both time varying models (C and D) the estimated decay factor is negative and significant. This might reflect a common increasing pattern in health expenditure which could be due to the impact of technological developments in the production of healthcare, in the organisation at national level of the health system or in the structure of preferences.

Table B.2 Step 1 – Comparison: fixed effect and stochastic frontier estimation
(standard errors robust to heteroskedasticity and autocorrelation)

	(A)		(B)		(C)		(D)	
	Panel fixed effect		Stochastic frontier		Time varying stochastic frontier		Time varying fixed effect (1)	
	Real total expenditure (corrected to take into account patient mobility)		Real total expenditure (corrected to take into account patient mobility)		Real total expenditure (corrected to take into account patient mobility)		Real total expenditure (corrected to take into account patient mobility)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
Per capita GDP	0.00001	0.248	0.00001 **	0.038	0.00001 **	0.015	0.00000	0.328
Dependency ratio for children (0-4)	-0.00645	0.279	-0.00255	0.456	0.00944 ***	0.003	-0.00038	0.915
Dependency ratio for elderly (75+)	0.04337 ***	0.010	0.03767 ***	0.000	0.04600 ***	0.000	0.03284 ***	0.000
Life expectancy (female)	0.04133 ***	0.003	0.05330 ***	0.000	0.03874 ***	0.000	0.02896 ***	0.009
Bad habit	0.02172 **	0.015	0.01806 **	0.024	0.02762 ***	0.000	0.03260 ***	0.000
Health status	0.01763 ***	0.008	0.01625 ***	0.004	0.00350	0.490	0.00530	0.412
Participation rate (female)	0.00154	0.703	0.00001	0.995	-0.00298	0.105	-0.00007	0.977
Tertiary education	0.00317	0.575	0.00504	0.358	0.00559	0.218	-0.01000	0.109
Share of employed in agriculture (%)	-0.00678 *	0.089	-0.00720 ***	0.005	-0.00466 **	0.018	-0.00451 *	0.079
Share of employed in manufacturing (%)	0.00127	0.254	0.00102	0.314	0.00176 **	0.050	0.00195 *	0.061
Dummy for the years after 1995	-0.11747 ***	0.000	-0.12202 ***	0.000	-0.12103 ***	0.000	-0.12715 ***	0.000
Constant	3.11231 ***	0.003	1.96360 ***	0.006	2.89818 ***	0.000		
No. Observations	294		294		294		294	
F(11, 20)	115.76							
Prob > F	0.0000							
R-squared	0.9304						1.0000	
Adj R-squared	0.9222						1.0000	
Root MSE	0.0453						0.0435	
Wald chi2(11)			2672.1000		1027.9300			
Prob > chi2			0.0000		0.0000			
Log likelihood			443.1939		482.0209			
η					-0.0458 ***	0.000	-0.0050 ***	0.000
Regional effects (α_i)								
1 Piemonte	-0.144		-0.051		-0.072		-0.100	
2 Valle d'Aosta	0.065		0.049		0.172		0.113	
3 Lombardia	-0.135		-0.058		-0.079		-0.081	
4 Bolzano	0.263		0.127		0.282		0.226	
5 Trento	-0.034		-0.012		-0.015		-0.018	
6 Veneto	-0.131		-0.058		-0.095		-0.116	
7 Friuli Venezia Giulia	-0.251		-0.099		-0.189		-0.174	
8 Liguria	-0.270		-0.105		-0.210		-0.124	
9 Emilia Romagna	-0.278		-0.107		-0.205		-0.151	
10 Toscana	-0.260		-0.108		-0.208		-0.157	
11 Umbria	-0.245		-0.107		-0.207		-0.142	
12 Marche	-0.227		-0.103		-0.208		-0.143	
13 Lazio	0.104		0.046		0.156		0.160	
14 Abruzzo	-0.034		-0.023		-0.057		-0.028	
15 Molise	0.017		0.001		-0.036		-0.003	
16 Campania	0.412		0.170		0.284		0.221	
17 Puglia	0.259		0.097		0.132		0.099	
18 Basilicata	0.139		0.050		0.032		0.012	
19 Calabria	0.223		0.082		0.111		0.103	
20 Sicilia	0.285		0.112		0.158		0.149	
21 Sardegna	0.243		0.098		0.257		0.155	

*, **, *** significance at respectively 10, 5 and 1 per cent level
(1) Estimates by non-linear least square.

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