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HEALTH EXPENDITURE IN ITALY: A REGIONAL ANALYSIS OF THE PUBLIC-PRIVATE MIX

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HEALTH EXPENDITURE IN ITALY: A REGIONAL ANALYSIS OF THE PUBLIC-PRIVATE MIX

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Abstract

In latest years there has been a growing interest on factors explaining health expenditure at a regional level. Indeed, in the case of Italy, even though the health care system was initially designed as a centralized one, the government has progressively undertaken a decentralization process up to the point of modifying the Constitution in order to appoint regions with exclusive health care responsibilities. Starting from 1992, a set of reforms was specifically designed to increase the autonomy of Regional Health Authorities in both the financing and delivery of health care. Regions have thus carried out differentiated policies, which have exacerbated rather than shorten interregional inequalities. Unlike previous studies, in this paper we intend to investigate the impact of institutional and non institutional variables on the public-private mix in health care expenditure. Using pooled time-series cross-section observations over the period 1990-2003, different models for the ratio of public to total health expenditure as well as for private health spending are estimated at a regional level. Among the other findings, there is evidence that public expenditure is not sufficiently able to mitigate regional differences in income levels.

JEL classification: H7, H51, I18

Keywords: Public–private health expenditure; decentralization

1. INTRODUCTION

During the last decade, many Western European countries have made the concept of decentralization a cornerstone of their health policy agenda. Italy is not an exception to this tendency. Although the Italian health care system was initially designed as a centralized one, the government has progressively undertaken a set of reforms whereby an increasing number of key decisions on health care spending and finance has been devolved to regional levels.

Health care decentralization presents arguments both in favour and against. The economic rationales for decentralizing mainly rely on the assumption that health care is rather a 'local good' for which the traditional fiscal federalism theory applies. A decentralized provision of health services is therefore expected to result in allocative efficiency gains as long as sub-national governments have access to better information about local circumstances

than central authorities and can use it to tailor services and spending patterns to citizens' needs. Gains in allocative efficiency are further enhanced by the increase in competition among local governments (a mechanism known as "yardstick competition") and by the subsequent mobility of citizens to reside in the jurisdiction that provides the best mix of taxes and services (as in the Tiebout "voting by feet" model[1]). At the same time, this competition is also likely to contribute to minimize the waste of scarce economic resources (productive efficiency) as a result of the greater experimentation and innovation in the production of public goods and services. Finally, additional arguments underline the advantages that smaller and less bureaucratic local governments might bring about.

Not surprisingly, the arguments for health care decentralization actually become arguments against it (and *vice versa*) when viewed from an alternative disciplinary perspective. Therefore, scholars who are against political decentralization point out the potential negative aspects of a lack of uniformity. The focus here is on the inequity that comes from variation in health service provision: if different local governments rely on different budgetary revenues and/or have different standards of services, then citizens in the same relative health conditions would receive better or worse services depending on their place of residence. Other criticisms to decentralization regard welfare losses resulting from the inefficiency and duplication of multiple small service providers.

The debate on decentralization has deeply influenced the literature on health expenditure. Over the last few years, an increasing body of studies has begun to analyse the main determinants of regional health expenditure, trying to answer on whether: 1) health expenditure decisions are region-specific and heterogeneous; 2) decentralization reforms have eventually worsen pre-existing health care interregional inequalities; 3) political variables - such as political affinity between central and local governments - play a key role in explaining regional health expenditure disparities; 4) expenditure in one region is affected by the expenditure spillovers from neighbouring regions. Nevertheless, in all these studies the attention has been focused on public health expenditure, ignoring the role of private expenditure in explaining the growth of total health expenditure and the relationship existing between public and private spending. Indeed, in the case of Italy, the regional governments autonomy to implement and finance their own model of health care system could in theory result in different levels of public-private expenditure mix, reflecting either different ideologies towards the public–private health care debate (an equity problem) or different abilities by each of these models to provide health services that are appropriate to the population needs (a problem of both efficiency and equity).

This paper intends to contribute to the literature by investigating the impact of the institutional and non-institutional variables separately on the ratio of public to total health expenditure and on the private component of it. Unlike Di Matteo (2000), pooled regional time-series and cross-section data over the period 1990-2003 are employed to estimate different models. The results are important in terms of policy implications since they can induce central government and regions to take account of the existing interdependency between the two health expenditure components when either designing or implementing the decentralization structure of the health care system.

The remainder of the paper is organized as follows. Section 2 provides a basic description of the Italian health care system, its structure, expenditure trends and regional divergences. The existing body of literature on the determinants of health expenditure is briefly reviewed in section 3, where international comparisons are analysed separately from national-level regional studies. In Section 4, we describe the data set and explain the

[1] See Tiebout, 1956.

econometric methodology while in the subsequent section we estimate health expenditure functions and report the empirical results. Some conclusions are drawn in the final section.

2. AN OVERVIEW OF THE ITALIAN HEALTH CARE SYSTEM

The Italian National Health Service (*Servizio Sanitario Nazionale*, SSN) was established in 1978 to guarantee a uniform provision of comprehensive care to all citizens and legal residents. It was structured into a three tier system of government: central (Ministry of Health), regional (20 Regional Health Authorities, RHAs) and local (659 local health agencies, *Unità Sanitarie Locali*, USL). The SSN was initially funded through an earmarked payroll tax, general taxation and co-payments by users. The first two sources went to make up the so-called National Health Fund (*Fondo Sanitario Nazionale*, FSN), which was annually distributed to RHAs and, in turn, to USL[2].

During this period, the lack of financial responsibilities by regional and local governments together with their right to autonomously decide expenditure levels caused frequent and marked deviations from the agreed allocated budgets. The resulting deficits were covered *ex-post* by the central government, without imposing any credible sanction to the overspending actors (a "soft-budget constraint" problem)[3]. This situation brought about two main consequences. Firstly, in contrast with the declared aim of the SSN, the already existing interregional disparities in the quality and efficiency of health care provision widened, especially between the more developed North and the less developed South. Secondly, the growth of public health expenditure went out of any control.

Alike other countries (e.g. Spain), decentralization was considered a possible solution to the above mentioned problems, under the assumption that by bringing accountability for local expenditure closer to local people, both local preferences will be respected and inefficiency will be discouraged[4]. Starting from 1992, a set of reforms (the so-called "reform of the reform") was specifically designed to improve the SSN *value for money*. The aim of these reforms was twofold: to implement an "internal" market for health services which allowed for a partial purchasing/providing split and to increase the autonomy of RHAs in both the financing and delivery of health care. Thus, with the Legislative Decrees 502/1992 and 517/1993, RHAs were mainly prompted to: 1) assign the status of public enterprises together with considerable managerial autonomy to major hospitals and to previous USL (hence, *Aziende Sanitarie Locale, ASL*); 2) reduce drastically the number of ASL (180 today); 3) introduce a per-case payment system (based on Diagnosis Related Groups, DRGs) for inpatient hospital services.

The regionalization process formally began with the Law 59/1997, which devolved some new management powers to the regional governments, and proceeded with the Legislative Decree 229/1999 (the so-called "third reform")[5]. In 2001, an amendment was made to the Constitution, redefining the balance of powers between central and regional

[2] The allocation formula to RHAs was based on a mix of population size, average age, mortality rates and past expenditure levels while that to USL implied the use of a weighted capitation system.

[3] For an analysis of the effects of soft-budget constraints on regional financial behaviours in Italy, see Bordignon and Turati (2003) and Levaggi and Zanola (2003).

[4] A formal analysis of the desirability of devolution for NHS countries can be found in Petretto (2000). The advantages and disadvantages of decentralization in different countries have been recently discussed by Levaggi and Smith (2005) and Mosca (2006).

[5] The 1999 reform deepened the regional devolution process, enlarged the autonomy of accredited public hospitals, defined constraints and incentives for physicians working in public hospitals, established a new structure of primary care services and promoted the diffusion of non-profit supplementary health plans.

governments: the state has exclusive competences in defining the basic health benefit package (*Livelli Essenziali di Assistenza*, LEA), which must be uniformly provided throughout the country; regions are fully responsible for organizing and administering the health care system in relation to population needs[6].

On the financing side, the Legislative Decrees 446/1997 and 56/2000 made regional governments accountable for any health deficit they incur and allowed them to cover such deficits by raising local taxes (to a limited extent) and by introducing cost-sharing on drugs. Starting from 2001, the FSN is formally abolished and regional funds come from a portion of central income taxes (*Imposta Personale sul Reddito*, IRPEF), regionally collected taxes on firms' value added (*Imposta Regionale sulle Attività Produttive*, IRAP) and a set amount of the per litre petrol excise. In line with the reform, a fiscal horizontal equalisation mechanism (Fondo di Perequazione Nazionale, FPN), financed by a fixed proportion of the national VAT revenue, had to be developed to transfer funds to those regions unable to raise sufficient resources to meet population health care needs[7]. Since then, there have been many changes in the allocation formulas to both RHAs and ASLs. Although, to illustrate them is beyond the scope of this paper, the tendency has been to reconcile equity and efficiency objectives, by taking account of both population needs and fiscal capacity indicators[8].

As a result of these reforms, regions have used their autonomy to introduce different models of health care regulation, ranging from systems with minimal regulation and a complete purchaser-provider separation (e.g. Lombardia) to those where regional health services continued to be highly regulated and directly managed by the central regional government (e.g. Emilia Romagna, Toscana). Moreover, the increased decentralization and reliance on regional sources of finance has even exacerbated the interregional divergences in both funding and spending on health care.

Besides the SSN, Italy is characterized by a considerable presence of the private health sector which in some areas of the country covers more than 50 percent of the overall health care supply (mainly, hospital, specialist and ambulatory services). There are two main types of out-of-pocket payments: 1) co-payments for diagnostic procedures, pharmaceuticals and specialist consultations; 2) direct payments by users for the purchase of private health care services and over-the-counter drugs. In 2003, these payments represented 20.7% of total health care expenditure and about 83% of all private health care expenditure, with the remaining 17% including mutual fund contributions and private insurance premiums (OECD Health Data, 2006).

The public-private health care debate has a long and consolidated history in the literature. Briefly speaking, it has been traditionally framed either as a public economics problem or a more ideological issue (Di Matteo, 2000). From the first point of view, the theoretical case for or against a public provision of health services mainly relies on the existence of market failures and the following consequences in terms of efficiency. From an ideological perspective, proponents of a libertarian market view oppose to those who advocate an egalitarian non-market view. In both cases, however, it is made clear that at the core of the debate is not whether health care should be provided entirely publicly or privately but rather in which mixed combination (Besley and Gouveia, 1994). A mixed health care

[6] A overview of the Italian health care system and the actual debate on the level of regional responsibilities is provided by France *et al.* (2005).

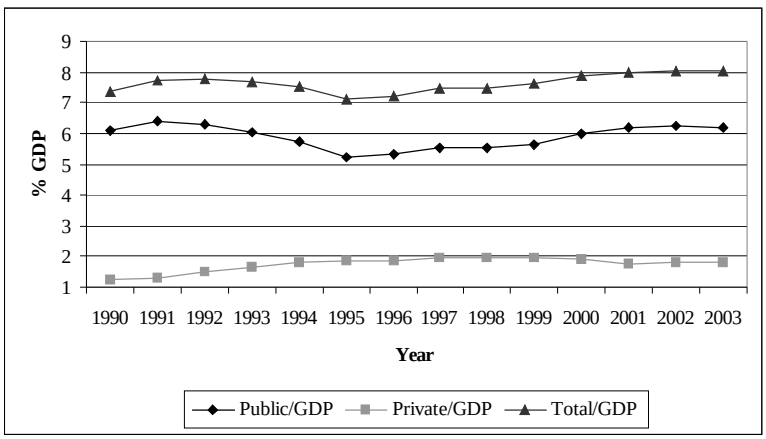
[7] The amount of funds transferred to or received from the FPN had to be determined according to a complex formula, allowing for the fiscal capacity of a region, its population size and age composition, its historic expenditure on health care, the size and the specific characteristics of its territory.

[8] For further details on the Italian health care financing system, see Bordignon *et al.* (2002). Turati (2003) provides an overview of the evolution of public health care financing and expenditure.

system is essentially a compromise between efficiency and equity objectives. The models of public-private mix chosen by different countries and, in the Italian case, by different regions may be better captured by examining the total health expenditure composition both at national and regional level. A rising issue is that of the nature of the relationship between public and private health expenditure. Few papers have afforded it by assuming that public and private health care can be shown to be imperfect substitutes[9]. However, one could argue that a certain degree of complementarity may exist, at least between some categories of services provided by the public sector and others by the private one. Although important for the resulting policy implications, defining the nature of the relationship between public and private expenditure is not trivial from a methodological point of view. Indeed, this relationship seems to depend on many factors, above all the structure of the health care supply. The joint analysis of the dynamics of public and private expenditures may offer some insights about it, though partial and not univocal.

Figure 1 presents total, public and private health care expenditures as proportions of GDP in Italy from 1990 to 2003. The share of total health care expenditure on national income has steadily increased from 6.6% in 1978, when the SSN was firstly established, to 7.8% in 1992, when the first set of health care reforms was introduced. After that, the share has slowly declined, reaching its minimum peak of 7.1% in 1995, when the central government made the maximum effort for reducing public deficit in order to comply with Maastricht criteria. Since its entrance in the European Monetary Union, the upward trend has recovered, with total health expenditure exceeding the 8% of GDP in both 2002 and 2003. The dynamics of public health expenditure follows exactly the same path as that of total health expenditure both in percentage of GDP and in per capita real terms (Fig. 2). In 2003, the share of health expenditures accounted for by the public sector was 6.2% (the average values for the EU and the OECD countries were respectively 6.7% and 6.3%). Household expenditures for health care have increased during the early '90s, fluctuating around 2% of GDP afterwards and declining down to 1.8% in 2003 (respectively, 2.3% and 2.5% the average values for EU and OECD countries). On the contrary, real per capita private health expenditures rose rapidly and continuously by 74% over the period 1990-2003.

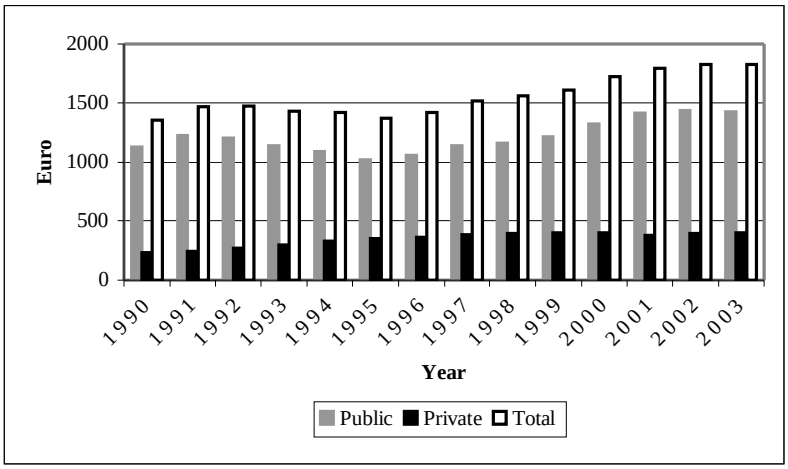
Fig. 1. Health expenditures in Italy as percentages of GDP



Source: SANITEIA and ISTAT.

[9] See, Gouveia (1996 and 1997), Levaggi (2000) and Levaggi and Zanola (2003).

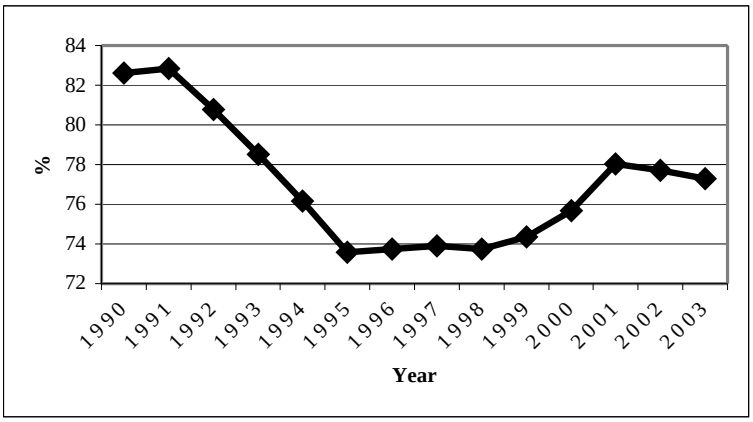
Fig. 2. Real per capita health expenditures in Italy (€, 2003 prices)



Source: SANITEIA and ISTAT.

With regard to the dynamics of the public sector share of health expenditure, three different phases can be identified. From 1991 to 1995, the central government attempts to increase financial accountability and to reduce inefficiency in the public health care system have led to a rapid decrease in the share of public expenditure, which shifted from 83% to 73% of total health expenditure. In the period 1995-2001, the public sector share has been mainly fuelled by the rise of public expenditure, which allowed recouping half out of the ten percentage points lost during the previous five years. Since 2001, the public sector share has started to decline again due to both a slowing down of the public expenditure growth rate and a slight increase in private expenditure trend.

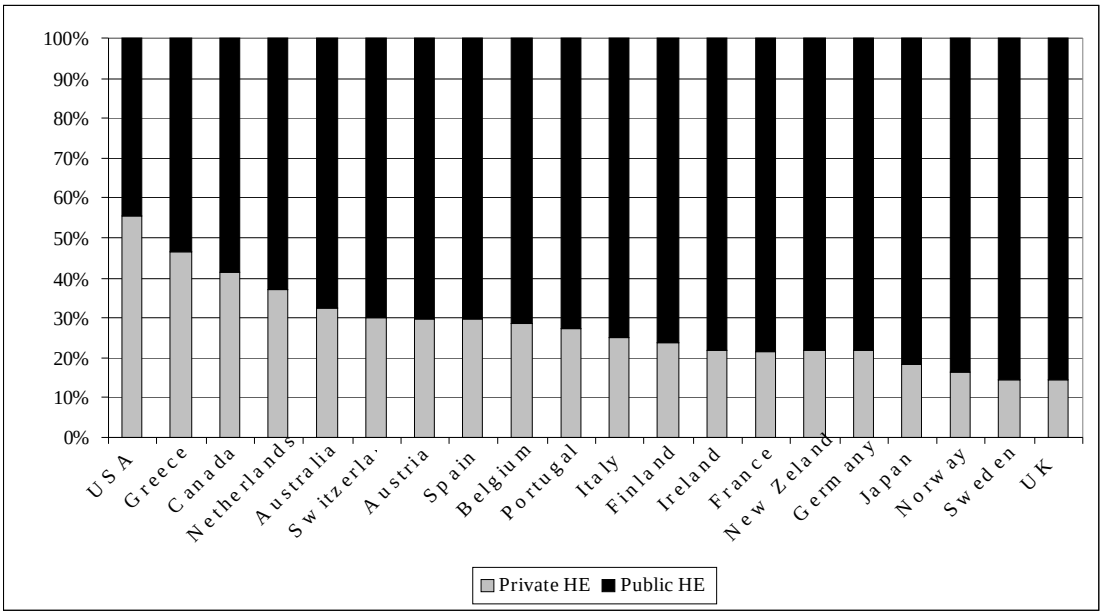
Fig. 3. Public sector share of health expenditure in Italy



Source: SANITEIA and ISTAT.

Comparing the composition of total health expenditure across different OECD countries, figure 4 indicates that Italy with its 25% share of private health expenditure ranks almost in the middle but well below the average of 32.8%. The range of the private expenditure share values in the 20 selected countries is quite big, with the maximum value (55.4%) belonging to the USA and the minimum one (14.6%) to the UK.

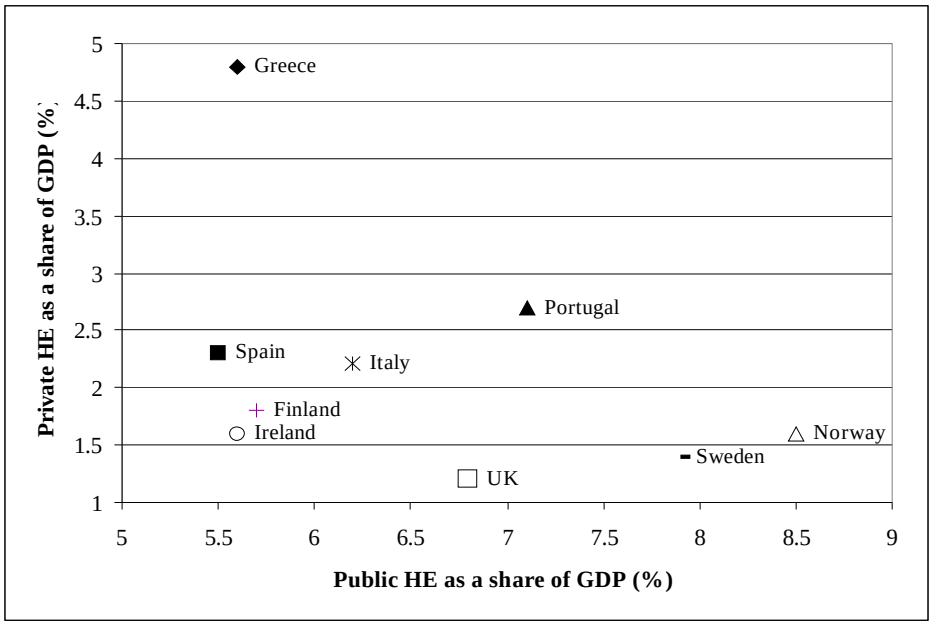
Fig. 4. Public and private shares of total health expenditure in some OECD countries – 2003



Source: OECD Health Data, 2006.

In view of the fact that crude shares of public and private expenditures can hide important cross-country differences in the finance and delivery of health care, figure 5 restricts the analysis to countries with a national health system, by plotting public and private health expenditures as percentage of GDP in the year 2003. Italy shows the fourth highest share of GDP devolved to private health expenditure (2.2%), after Greece (4.8%), Portugal (2.7%) and Spain (2.3%). Contrary to these countries, however, the share of public expenditure is almost on average (6.2% against an average value of 6.5%).

Fig. 5. Public and private health expenditures as percentages of GDP in NHS countries - 2003



Source: OECD Health Data, 2006.

More interesting is the analysis of the regional variability of the single health expenditure components and their dynamics over time. Although, we are not controlling here for the effects of income and other relevant variables (e.g. aging composition of the population) which may affect the regional findings, some worthy of note tendencies can be observed. Table 1 shows the evolution of regional per capita public and private health expenditures in real terms. In all the 20 regions, both the two expenditure components have been increasing during the period 1990-2003, although at very differentiated regional growth rates. The private component of health expenditure has generally raised faster than the public one. Compared to the average national growth rate of 27% for public expenditure and 73.5% for private expenditure, the increases were less pronounced in the Southern regions (on average respectively, 28% and 61%) than in the Northern ones (on average respectively, 31% and 84%). In 1990, before the decentralization reforms, the range of interregional differences was around €416 for public expenditure (standard deviation, SD, 110) and €138 for private expenditure (SD 39). In 2003, the range increased respectively to €568 for the public component (SD 130) and to €278 for the private one (SD 86). On average, also the gap between the richer North and the poorer South of Italy has halved in this period, shifting from €193 to €207 for public expenditure and from €68 to €170 for private expenditure. Overall, regional disparities were therefore greater for the private than for the public component of health care expenditure. The position of each region with respect to the national mean is also shown in table 1.

Table 1. The evolution of regional health care expenditure in Italy (€, 2003 prices)

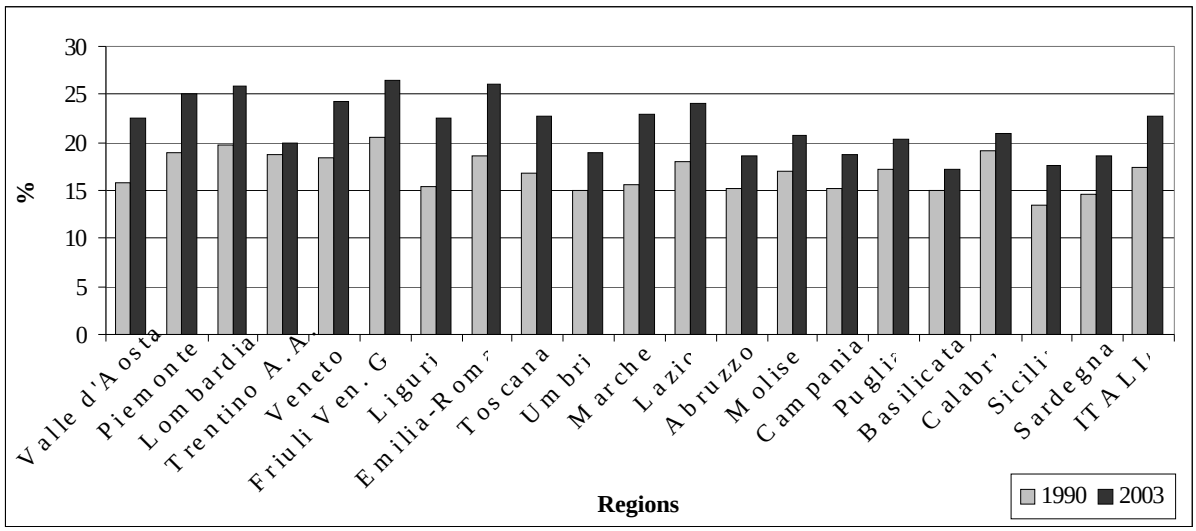
Regions	**1990**				**2003**			
	Per capita public HE		*Per capita private HE*		*Per capita public HE*		*Per capita private HE*	
	Euro	**Italy = 100**	**Euro**	**Italy = 100**	**Euro**	**Italy = 100**	**Euro**	**Italy = 100**
Valle d'Aosta	1,165	103	218	95	1,610	113	466	117
Piemonte	1,065	95	249	109	1,470	103	493	124
Lombardia	1,096	97	271	118	1,392	98	488	122
Trentino A.A.	1,124	100	260	113	1,778	125	440	110
Veneto	1,153	102	258	112	1,412	99	451	113
F.V. Giulia	1,130	100	292	127	1,472	103	528	132
Liguria	1,303	116	237	103	1,567	110	454	114
E. Romagna	1,323	117	303	132	1,498	105	530	133
Toscana	1,219	108	245	107	1,459	102	427	107
Umbria	1,183	105	209	91	1,473	103	343	86
Marche	1,287	114	237	103	1,393	98	413	103
Lazio	1,216	108	267	116	1,463	103	464	116
Abruzzo	1,118	99	200	87	1,416	99	322	81
Molise	1,048	93	213	93	1,404	98	366	92
Campania	1,069	95	192	84	1,333	93	307	77
Puglia	1,036	92	215	94	1,278	90	325	81
Basilicata	932	83	164	72	1,210	85	251	63
Calabria	907	80	214	93	1,262	88	332	83
Sicilia	1,082	96	168	73	1,308	92	277	69
Sardegna	1,072	95	182	79	1,335	94	306	77
NORTH	*1,170*	*104*	*261*	*114*	*1,525*	*107*	*481*	*121*
CENTRE	*1,226*	*109*	*239*	*104*	*1,447*	*101*	*412*	*103*
SOUTH	*1,033*	*92*	*193*	*84*	*1,318*	*92*	*311*	*78*
ITALY	***1,126***	***100***	***230***	***100***	***1,427***	***100***	***399***	***100***

Source: SANITEIA and ISTAT.

In figure 6, the private shares of total health care expenditures in 1990 and 2003 are compared for each region. A definite increase in the private share across all regions is

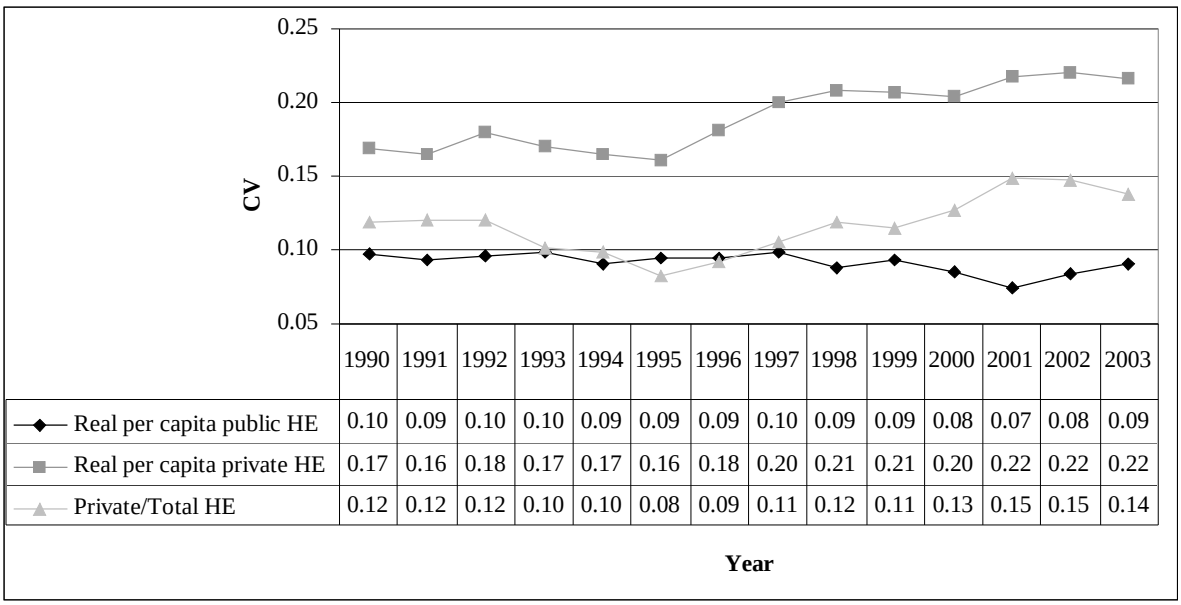
noticeable. Once again, the results by region suggest that there are deep geographical divergences in the growth rates. With the exception of Trentino A.A. and Umbria, all regions in the northern and central part of Italy and none of those in the south experienced growth rates above the national average of 31%. Therefore, in 2003 the private share of health expenditure reached a mean value of 24% in the North, 22% in the Centre and 19% in the South, with an overall SD of about 3. The highest private share was that of Friuli V.G. (26.4%) while the lowest belonged to Basilicata (17.2%).

Fig. 6. Private shares of total health care expenditures by region in Italy (1990 and 2003)



Source: SANITEIA and ISTAT

Fig. 7. Coefficients of variation for regional health expenditures in Italy (1990-2003)



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Real per capita public HE	0.10	0.09	0.10	0.10	0.09	0.09	0.09	0.10	0.09	0.09	0.08	0.07	0.08	0.09
Real per capita private HE	0.17	0.16	0.18	0.17	0.17	0.16	0.18	0.20	0.21	0.21	0.20	0.22	0.22	0.22
Private/Total HE	0.12	0.12	0.12	0.10	0.10	0.08	0.09	0.11	0.12	0.11	0.13	0.15	0.15	0.14

Source: Own elaboration based on data from SANITEIA and ISTAT

Finally, figure 7 shows the Italian evolution of regional health expenditure disparities in terms of yearly coefficients of variation (CV) over the period 1990-2003. Since 1995, the CV dynamics for real per capita public expenditure has moved towards a direction opposite to that of private expenditure: whenever the former was increasing, the latter was decreasing and *vice*

versa. Therefore, during the last three years of the period considered, regional disparities in the public expenditure components were widening while those in the private one were shortening. With regard to the private share of total expenditure, the interregional inequalities were increasing during the second wave of reforms while decreasing from 2001 and afterwards.

3. EMPIRICAL LITERATURE ON THE DETERMINANTS OF HEALTH EXPENDITURE

Over the last three decades empirical investigations on the determinants of health expenditure have become popular as long as many countries have experienced significant increases in the amount of resources and in the share of GDP devoted to health care. The existing body of literature has followed two main approaches. Early studies have focused on comparisons of aggregate health expenditure across different countries. However, they were not able to appropriately deal with heterogeneity across countries attributable to differences in the extent of health coverage and internal system design. Most recently, a similar determinant approach has been applied not to international comparisons but to the national level. Both these two types of studies will be reviewed in this paragraph, even though the following econometric analysis will fall within the second category.

3.1. Comparisons of aggregate health expenditure across different countries

International studies have tried to explain the substantial differences existing in health expenditure across countries (mainly, OECD ones) by examining which variables have a significant impact on it. Nevertheless, from a methodological point of view they cannot be regarded as a homogeneous group. Following the classification given by Gerdtham and Jönsson (2000), the first generation of these studies has used cross-section regressions - initially bivariate (Newhouse 1977) and later multivariate (Leu 1986, Parkin *et al*. 1987, Gerdtham *et al*. 1992a) - for a single year or selected years; the second generation (among them, Hitiris and Posnett, 1992; Gerdtham *et al.* 1992b; Gerdtham *et al*. 1998) has relied on pooled cross-section and time-series data to partially overcome the small-sample shortcomings[10].

Cross-section studies have emphasized the importance of national income in explaining the rise in health expenditure. In his pioneering paper, Newhouse (1977) regresses per capita medical care expenditure on per capita GDP for 13 developed countries, using 1971 data. The estimation yields to the following strong results:

1. aggregate income is by itself able to explain almost 92 percent of the variance in the level of health expenditure between countries, leading to the conclusion that factors other than income (e.g. the price paid by the consumer and the method of reimbursing physicians) should not be included in the analysis since they are of marginal significance;
2. income elasticity is greater than one, suggesting that health is technically a *luxury* good.

[10] Amongst the advantages of using panel data sets there is the possibility to test a more extensive range of hypotheses, to analyse dynamic properties of the relationships, to relax the assumption of homogeneous relationships across countries and to control for country and time-invariant variables.

To overcome the criticisms of misspecification, some researchers have widened the number of explanatory variables and functional forms employed in their analyses but the results did not clash with Newhouse's findings. Using national data for 19 OECD countries in 1974, Leu (1986), for example, includes as regressors a set of exogenous variables (i.e. the share of population under 15 and over 65 and the degree of urbanization[11]) together with an additional variable to reflect the extent of public provision of health services and dummies for the presence of a National Health Service and direct democracy[12]. He gets income elasticity higher than one and confirms the predominant effect of the income variable, though some institutional and non-institutional variables are found significant and with the expected signs. In their cross-section analysis on 18 OECD countries, Parkin *et al.* (1987) replicate Newhouse (1977) but using different functional forms and different conversion factors[13]. Their results indicate that income elasticities are not indifferent to the choice of the functional form and are around unity in cross-sections when PPP conversion factors, rather than exchange rates, are employed. Gerdtham *et al.* (1992a) extends the cross-section analysis to 19 OECD countries and demonstrate the most appropriate functional form being a log-linear model where health expenditure is a function of per capita GDP, public financing, in-patient care expenditure, urbanization and a dummy variable for countries with fee-for-service (FFS) payments to doctors. The results indicate that income elasticity is 1.33, significantly different from one.

Second-generation studies have used panel data to investigate the relationship between health expenditures and their determinants. The earliest of these analyses (Gerdtham, 1992; Gerdtham *et al.*, 1992b; Hitiris and Posnett, 1992; Hitiris 1997 and 1998; Gerdtham *et al.*, 1998) did not concern about the presence of several non-stationary variables (e.g. health expenditure and GDP), which could lead to spurious results[14]. On the contrary, the later ones did look at the problems of non-stationarity and cointegration between these variables (Hansen and King, 1996; Blomqvist and Carter, 1997; McCoskey and Selden, 1998; Roberts, 2000).

One of the issues mostly debated in early international panel analyses has been the ways of modelling possible country and time-specific error components. Traditional econometric approach requires to firstly compute a Lagrange Multiplier (LM) test[15] for detecting the

[11] While health expenditures for population under 15 and over 65 are commonly assumed to be above average, the effect of urbanization is theoretically not so clear. A negative relationship is expected since there is a higher risk of contagion in more densely populated areas. However, urbanization could even have a positive effect by reducing travel costs to reach the population. Furthermore, access to vital health information is better and preventative health education is easier to provide. Therefore, in the literature Leu (1986) finds a positive sign, whereas the same effect in Gerdtham *et al.* (1992a) is negative.

[12] Following the public choice theory, Leu argues that an increase in the size of the public share would increase health expenditure due to two reasons: (1) bureaucrats in public or private non-profit hospitals would maximize budgets to increase their own utility (a Niskanen approach); (2) less intensive competition in the public sector would give rise to higher unit costs (X-inefficiency). The rational for the inclusion of the two types of dummies is that restraining health expenditure would be easier in countries where health provision and financing is centralized and voters have greater direct control over government choice and tax levels.

[13] A methodological problem of international comparisons is how to convert national expenditure and income data to a common currency unit. Newhouse (1977) uses market exchange rates which, by reflecting the relative prices of internationally traded commodities, are in general highly variable and attach little weight to non-marketed commodities. The possibility to translate national currencies into more stable PPPs, expressed in US dollars, has brought the issue of conversion factors into the literature on health expenditure (Gerdtham and Jönsson, 1991a,b; Milne and Molana, 1991).

[14] Time series data are stationary if the mean, variance and covariance do not change over time. Regressions involving non-stationary variables show apparently significant relationships even if the variables are generated independently. Non-stationary variables may be cointegrated if a linear combination of them is itself stationary (Gerdtham and Jönsson, 2000).

[15] For further details, see Breusch and Pagan (1980).

presence of an error component (either fixed or random) and to successively carry out a Hausman test (Hausman, 1978) of fixed against random effects models. For example, Gerdtham (1992) applies simple OLS as well as one-way and two-way fixed and random effects models to panel data for 22 OECD countries over the period 1972-1987. Using a reduced number of explanatory variables, the author finds that country and time-period effects are able to influence health expenditure. The fixed effect specification is however to be preferred since tests reject random effect models. Most recently, Gerdtham and Jönsson (2000) propose to choose between fixed and random effects models on the basis of *a priori* conceptual issues rather than of statistical tests. In this sense, the fixed-effects model appears to be more appropriate when the sample constitutes all or most of the population of interest (such as in the case of OECD countries), while random-effects would be more appropriate if the sample is drawn from a substantially larger population.

Among the other second-generation studies, Hitiris and Posnett (1992) replicate the models of Newhouse (1977) and Leu (1986), using a sample of 560 panel observations for 20 OECD countries over the period 1960-1987. They conclude that - apart from GDP - the demographic structure of the population matters. Gerdtham *et al.* (1992b) shows that two variables in addition to the five of their previous cross-section study (Gerdtham *et al.*, 1992a) were statistically significant: the proportion of population aged above 64 and the number of physicians per capita, which - contrary to expectations - is found to have a weakly negative impact on health expenditure. In two different papers, Hitiris (1997 and 1999) focuses on different methods of estimation which may be applied to analyse the determinants of health care expenditure respectively for 10 member states of the European Union and for the G7 industrial countries. In the latter paper, the author justifies his preference for a log-linear rather than a linear functional form by observing that: (a) when many of the explanatory variables are expressed as percentages it is inappropriate to convert them to logs; (b) expenditure on health care is one of the components of total national expenditure and thus it should satisfy the 'adding up' constraint.

The effects of different sorts of institutional arrangements on health expenditure are examined by Gerdtham *et al.* (1998), who provide the most comprehensive international panel study of 22 OECD countries over the period 1970-1991. Many results appear to be reasonably strong. Public reimbursement systems are the least expensive, with public integrated ones about as costly as public contract systems. Countries with primary physicians acting as gatekeepers for in-patient care as well as those where the patient first pays the provider and then seeks reimbursement have lower expenditure than the others. The method of remunerating physicians in the ambulatory care sector also appears to influence health expenditure: capitation systems tend to lead to lower expenditure on average than FFS systems. The ratio of in-patient expenditure to total health expenditure and the presence of budget ceilings on inpatient care are positively related to health expenditure. There is some evidence that public sector provision of health services is associated with lower health expenditure. Finally, the total supply of doctors may have a positive effect on health expenditure. Amongst the non-institutional variables, only GDP and tobacco consumption show a significant impact on health expenditure: the former elasticity is lower than unity (0.74) while the latter elasticity indicates that health expenditure would increase by about 1.3 percent if tobacco consumption increased by 10 percent. Nevertheless, it has been noticed (Gerdtham and Jönsson, 2000) that some of these results must be taken with caveats, since the distinctions between institutional arrangements of different countries are not usually as simple and clear-cut as implied by the use of dummy variables.

As previously mentioned, within the stream of second-generation analyses some studies raise the issue of stationarity (or rather the lack of) in the data sets. Hansen and King (1996)

survey 20 OECD countries for the period 1960-1987 by applying the typical methodologies wherein real per capita health care expenditure is predicted as a function of GDP and other demographic and institutional variables. Using individual country-by-country Augmented Dickey-Fuller (ADF) unit root and the Engle-Granger cointegration tests[16], they get non-stationarity in approximately two thirds of the variables tested and no country possesses a data set that is entirely stationary in levels. In addition, they find practically no evidence of cointegrating relationships for any country. A battery of alternative econometric tests by Blomqvist and Carter (1997), Roberts (1999 and 2000) and Gerdtham and Lothgren (2000) reaches almost the same conclusions concerning the presence of unit roots for health expenditure and GDP but either rejects the no-cointegration hypothesis or finds no conclusive evidence. However, the support for Hansen and King's results is not unanimous. Thus, McCoskey and Selden (1998) and, more recently, Jewell *et al.* (2003) and Carrion-i-Silvestre (2005) apply panel data techniques to assess the stochastic properties of health expenditure and GDP, obtaining that both these variables are stationary. As part of an ongoing debate, these latter results have been met with claim and counter claim, making a definitive judgment difficult[17]. Overall, two basic lessons can be drawn by the literature on stationarity and cointegration (Atella and Marini, 2005). Firstly, panel tests should be preferred to time series (country-by-country) ones given that the former enable to mitigate the lack of power that the latter show, especially when time series are not very long but similar data may be available across a cross-section of units. Secondly, cointegration seems to be strongly affected by the power of the available tests: as far as tests are developed continuously, results on cointegration will be affected consequently.

3.2. National-level regional studies on health expenditure

International comparisons of health care expenditures are marked by a number of acknowledged problems. Among them, there are the lack of an internationally standardized definition of what constitutes health care expenditures, the difficulties in constructing exchange rate conversions for national data and the possible correlation of input prices with the level of national income (Di Matteo, 2003). Furthermore, the financing, organizational and political contexts in which health care decisions are taken are often heterogeneous across countries and cannot be easily and fully included in cross-country analyses. From this point of view, restricting analysis to one country with multiple sub-governments that reduces the impact of price variations, institutions and labour market differences on the estimates may prove to be an improvement in the attempt to overcome the aforementioned problems. Following this direction, recent papers have examined the determinants of health expenditure in single countries with either a federal system (e.g. Canada and Switzerland) or multiple autonomous jurisdictions (e.g. Spain and Italy). In the latter cases, the interest towards this approach has proceeded together with the debate on the opportunity to decentralize health care responsibilities at lower levels of government. From a methodological point of view, national-level regional studies have benefited from the estimation techniques developed in the previous international comparisons, though they have to adapt the explanatory variables employed in the analyses to the characteristics of each country.

[16] See Dickey and Fuller (1981) and Engle and Granger (1987).

[17] Hansen and King (1998) argue that the conflicting results found by McCoskey and Selden (1998) are mainly due to the omission of a structural break in the unit roots test. However, stationarity tests used in Jewell *et al.* (2003) and Carrion-i-Silvestre (2005) allow for the presence respectively of two or more structural breaks.

The first attempt to investigate health expenditure at a sub-national level regards the Canadian context. Di Matteo and Di Matteo (1998) use a pooled time-series cross-section approach to analyze the determinants of real per-capita provincial government expenditures on health care over the period 1965-1991. Applying the Kmenta pooling technique[18], they show that the key determinants of health expenditures are real per capita provincial income, the proportion of the population over age 65 and real per capita provincial federal transfers. Although the issue of stationarity is not fully addressed, an estimated income elasticity of 0.77 is reported, therefore suggesting that health expenditures are more a necessary rather than a luxury good[19].

With regard to the Italian context, Giannoni and Hitiris (2002) develop an econometric panel model for 20 regions over the period 1980-1995. To take account of deep regional economic divergences and of a series of administrative reforms which may have affected the regional patterns of health care expenditure, they decide to apply a three-stage estimation procedure. In the *first stage*, a parsimonious fixed-effects model is used in which real per capita public health care expenditure is regressed against: per capita real GDP; ageing population; structural characteristics of the health care supply such as (a) the number of beds per hospital (as a measure of the presence of scale economies) and (b) the number of personnel per hospital (as a measure of productivity improvement)[20]. The relative emphasis on the supply-side determinants is justified by the fact that in countries where there exists a public insurance, individual demand for health care is not limited by price or ability to pay considerations. In such cases, only supply constraints would determine the size of public health care expenditure. In the *second* and *third stages* of the estimation process, regional clusters and time-specific dummy variables are progressively included in the model. The results show that all factors considered in the analysis are relevant for explaining regional differences in the levels of per capita public health expenditure.

One drawback of this prior body of studies is that they do not account for political characteristics, which arguably stand at the forefront of the health care decision-making in countries where the mainstream health insurer is the public sector. Using a soft-budget constraint framework, Bordignon and Turati (2003) build a simple model of bailing out to interpret the evolution of regional health care spending and funding in Italy during the period 1990-99. Besides the traditional structural variables of health expenditure, additional variables are also introduced to capture budgetary pressures coming from the constraints imposed by the Maastricht Treaty, to catch the strength of central government to credibly enforce reforms, to measure the reduction of vertical imbalance across regions, to pick up the potential effect of scale on regions' expectations of bailing out and to control for *political affinity* between central and local governments. The main finding suggests that financing by regions is influenced by political variables that may be interpreted as capturing changes in bailing out expectations. "Expected" funding has the expected positive relationship with expenditure, even when central government decreased financing to regions. Moreover, the analysis

[18] The Kmenta or Parks-Kmenta approach is also technically known as cross-sectionally heteroskedastic and timewise autoregerssive model (Kmenta, 1986).

[19] Di Matteo (2003) observes that the magnitude of income elasticity is highly dependent on the level of analysis, with international income elasticities being generally larger than national or regional study ones. He also argues that existing estimates of health care elasticity may be unreliable because of the use of parametric techniques that assume a specific functional form, usually a linear one. As an alternative, non-parametric or "distribution-free" methods could be used, which not only can be applied to samples that come from populations having any of a wide class of distributions but are also better suited to deal with inadequacies of the data with respect to outliers.

[20] According to the authors, other things being equal, more beds per hospital should imply bigger hospitals and therefore lower expenditure. On the contrary, the more the staff per hospital, the higher the expected expenditure.

demonstrates that there exists an "alignment effect" which works in two directions: on the one hand, the central government increases financing to "friendly" regions; on the other hand, "friendly" regional governments support central government by reducing health expenditure.

Using a sample of cross-sectional and time-series observations covering the 20 Italian regions over the period 1989-1993, Levaggi and Zanola (2003) estimate the hypothesis of an asymmetry in the response to intergovernmental grants: local expenditure is highly responsive to increases in grants-in-aid from central government, but it is relatively insensitive to grants reduction (a "flypaper effect"). Two different models are estimated based on different budget balance rules. The first one assumes the presence of a stringent budget constraint ("hard-budget hypothesis") and includes as explanatory variables not only per capita GDP, the percentage of population aged 65 and over, private health care expenditure and intergovernmental grants but also a dummy variable which allows controlling for the presence of non-decreasing grants. The second model enables regions to incur in some deficit by adding a specific variable to the previous determinants. The existence of a standard and a super flypaper effects in both models are empirically demonstrated. The introduction of the soft-budget constraint hypothesis results in a stronger effect of grants and a lower response of own resources which shows that, before reducing expenditure, regional governments prefer to incur in some deficit.

Amongst the others national-level regional studies, Crivelli *et al.* (2003) investigate the differences in health care expenditures between Swiss cantons over the years 1996-2000. The income elasticity is found not to be significant but the other major variables carry the expected sign and are significant; the most important factors explaining health expenditures are physicians' density and the density of acute beds, the age structure of the population, and the unemployment rate. Di Matteo (2004) uses data for a 25-year period in order to assess the impact of income, time, and the distribution of population by age on Canadian provincial government health expenditures. The results suggest that real per capita provincial expenditure on health is related positively and significantly to income, federal transfers, time, and the aging of the population (especially, those aged 75 or more), and negatively and significantly to the share of private expenditure on health. Expenditure is also related positively to the number of physicians per capita and to the share of provincial spending on health. Di Matteo (2005) investigates the same hypotheses as the previous paper but using American state-level data for the period 1980–1998 and Canadian province-level data for the period 1975–2000. As dependent variables, real per capita US personal health state expenditures and real per capita Canadian provincial health expenditures are considered. The author finds that ageing population distributions and income explain a relatively small portion of health expenditures when the impact of time is controlled for. On the contrary, time effects can explain approximately two-thirds of the increase in real per capita health expenditures, supporting the Newhouse conjecture that technological change accounts for the bulk of health expenditure increases[21]. Using the same approach as Giannoni and Hitiris (2002), Cantarero (2005) analyses the determinants of regional health expenditure in Spain over the period 1993-99. It turns out that the most important determinant in explaining the volume of regional health care expenditure is the ageing population while other factors such as the regional income and the relative structural characteristics of the supply variables have a minor impact.

Finally, a recent paper by Costa-Font and Pons-Novell (2005) analyses the determinants of public health expenditure within 17 Spanish Autonomous Communities over the period 1992-98. The main study objective is to investigate whether public expenditure in one jurisdiction is affected by the expenditure spillovers from neighbouring jurisdictions.

[21] The author notes that while time effects can be interpreted as a proxy for technological change, they may also be the result of policy shifts, the effect of other variables as well as preference and expectations shifts.

Using the Lagrange Multiplier estimation method of serial error dependence (ML-SER), they reject the null hypothesis of absence of spatial interactions and find evidence suggesting that the decentralization and political ideology - in a context characterized by some inter-jurisdictional competition – might foster mechanisms leading towards the expansion of health care expenditure.

4. EMPIRICAL METHODOLOGY AND DATA

As already mentioned, the aim of this paper is to identify factors influencing the public-private mix in health care expenditure. The attention here is on the Italian context where regional responsibilities in financing and delivering health care have been progressively increasing over time. In the previous paragraph it has been shown that empirical studies on the determinants of health expenditure have only focused on expenditure levels (total or public), whereas the relationship between private and public expenditure has been considered as one of partial substitutability[22].

Indeed, these two health expenditure components could theoretically respond to different considerations. In a recent paper, Clemente *et al.* (2004) show that when making international comparisons, it is not appropriate to jointly deal with public and private health expenditure, since the trend of the former is driven by mechanisms that are partly different from those of the latter. In fact, the trend of private expenditure is mainly determined by households at a decentralized level. However, it seems difficult to disregard the fact that the decisions taken to control health expenditure, which depend on the level of transfers, do not influence household private expenditure, especially in institutionally homogeneous contexts. This type of problems is more emphasized in international comparisons, given the influence of institutional factors and structural breaks which can affect single countries (Carrion-i-Silvestre, 2005). On the contrary, they appear to be less serious in national-level regional studies because of the existence of a sufficiently homogeneous institutional context.

In a seminal paper, Di Matteo (2000) contributes to the debate on whether health care should be provided publicly, privately or in some combination, by investigating factors influencing the public-private mix in Canadian health care expenditures during the years 1975-1996. Health expenditures are examined as total and sub-expenditure categories such as hospital, physician and drug spending. The major determinants of the public-private mix at a national level are found to be per capita income, the share of individual income held by the top quintile of the income distribution and federal health transfers, though there are differences in impacts across expenditure categories. The empirical evidence shows that income has a negative and statistically significant relationship with the public-private share both in total health expenditure and in most sub-expenditure categories. This would suggest that private health expenditures have higher income elasticity than public health expenditures and, thus, as per capita income rises, there would be some substitution of private for public health. Moreover, income has a stronger impact on the public-private split in areas where a variety of choices exists between public and private health services (e.g. expenditures on drugs or other professionals).

As to the objectives of our analysis, the approach of Di Matteo (2000) shows many interesting features. Firstly, the investigation of the factors influencing the public-private mix in health care expenditure, in spite of its importance in the political agenda, has yet received little attention in the literature. Secondly, the object of this analysis is particularly noteworthy

[22] See, Di Matteo (2004), Levaggi and Zanola (2003) and the aforecited literature.

in Italy, where a debate on the degree of autonomy to be granted to regions, without compromising the NHS principle of universality, has taken place for over a decade. The heterogeneity of local preferences and the different levels of efficiency could indeed lead to highly different expenditure mixes across regions. From this point of view, understanding the influence of different factors on the expenditure mix can help the regulator to better define the consequences of decentralization policies. Lastly, the time series approach followed by Di Matteo (2000) is very simple and mainly descriptive, laying itself open to be empirically analysed at a regional level.

Our analysis differs from the approach followed by Di Matteo (2000) in a number of ways. He focuses the attention on public expenditure in a federal system, which is endowed with a high degree of financial autonomy at the provincial level. However, the Italian institutional system cannot be easily compared with the Canadian federal system, although the Italian regions enjoy a high degree of autonomy. Moreover, the author adopts a time series approach that aims at testing the elasticity of the public-private expenditure mix, considering different components of health expenditure without controlling for heterogeneity at the provincial level.

Table 2. Definition and summary statistics of the variables employed in the analysis

Variable	*Meaning*	*Data source(s)*	*Mean*		*Standard deviation*	*Minimum*	*Maximum*
RPHCE	The ratio of public to total health care expenditure	SANITEIA and ISTAT (Regional Accounts)	*Overall*	0.78	0.04	0.70	0.87
			Between		0.02	0.74	0.82
			Within		0.03	0.73	0.86
PHCE	Real per capita private (household) health care expenditure	ISTAT (Regional Accounts)	*Overall*	345.09	89.34	164.47	536.03
			Between		65.88	227.65	443.07
			Within		62.00	177.16	442.81
PGDP	Real per capita GDP	ISTAT, Regional Accounts	*Overall*	20,001.80	5,239.47	10,752.85	29,829.26
			Between		5,146.71	12,455.16	27,693.99
			Within		1,482.44	17,078.32	23,345.68
AGE	Percentage of population aged 65 and over	ISTAT, Regional Accounts	*Overall*	17.85	3.14	10.82	26.18
			Between		2.91	12.83	23.60
			Within		1.33	15.25	20.47
FTRA	Real per capita national transfers to regions	SANITEIA and ISTAT (Regional Accounts)	*Overall*	1,131.29	190.54	753.36	1,777.64
			Between		80.21	1,011.35	1,278.19
			Within		173.70	711.45	1,630.74
HB	Number of beds per hospital	ISTAT, Italian Statistical Yearbook	*Overall*	214.25	80.49	110.24	628.00
			Between		77.58	144.68	498.14
			Within		27.22	131.50	344.11
HS	Number of medical and non medical staff per hospital	ISTAT, Italian Statistical Yearbook	*Overall*	264.02	135.58	102.16	756.00
			Between		125.66	151.57	728.79
			Within		57.67	118.15	463.69

Note: all monetary values are expressed in euros, at 2003 prices.

As graphically illustrated in paragraph 2, both public and private components of health expenditure in Italy have clearly different patterns. Hence, the need for a separate analysis of the effects of each component arises. Consequently, two different models have been estimated. The first model examines the determinants of regional private health expenditure

while the second one focuses on those of the public-private mix. Following Di Matteo (2000), the mix of health expenditure has been computed as the ratio of public to total health expenditure.

The main problem in applying the same detailed level of analysis as Di Matteo (2000) to the Italian context has been the lack of qualitative statistical data. In particular, regional data on both private health expenditure by separate categories and the share of individual income held by the quintiles of the income distribution, though interesting, were not available at the time the analysis was carried out. Therefore, the following data set consists of a sample of cross-sectional and time series observations for the 20 Italian administrative regions. Data comes from several sources and covers the period 1990-2003, thus resulting in 280 observations.

The explanatory variables employed in the analysis are summarized in table 2. With regard to private health expenditure and per capita income, descriptive statistics convey an interesting result. Namely, the variability of private health expenditure between and within regions shows almost the same size, whereas a similar thing cannot be said for per capita income. This result may suggest that the levels of per capita private health expenditure, although similar between regions, are sustained by different levels of per capita income. Accordingly, it becomes interesting to analyse the determinants of regional private health expenditure and its interaction with the public component of health spending.

In our approach, per capita private expenditure and the ratio of public to total health expenditure are assumed to be a function of real per capita regional income, regional proportion of population aged 65 and over and real per capita national transfer revenues to regions. Following previous literature[23], other two variables (the number of medical and non medical staff per hospital and the number of beds per hospital) whose impact has been found to be significant on the Italian SSN expenditure are also considered. Finally, a standard linear time trend variable was included. Thus, the estimated models are:

$$RPHCE_{it} = \beta_1 + \beta_2 PGDP_{it} + \beta_3 AGE_{it} + \beta_4 FTRA_{it} + \beta_5 HB_{it} + \beta_6 HS_{it} + u_{it} \quad [1]$$

$$PHCE_{it} = \beta_1 + \beta_2 PGDP_{it} + \beta_3 AGE_{it} + \beta_4 FTRA_{it} + \beta_5 HB_{it} + \beta_6 HS_{it} + u_{it} \quad [2]$$

where the subscript *it* refers to region *i* ($i = 1,\ldots,20$) in year *t* ($t = 1990,\ldots,2003$).

The inclusion of both per capita income and aged population is standard in studies of health care expenditure determinants and hence does not require further explanations. Interpreting the signs of the income variable is however not straightforward. Given the mutual relationships existing between the two dependent variables, attention will be paid only to the sign of the income variable in the private expenditure model (model [2]). In fact, the sign of the income variable in the ratio model (model [1]) mostly depends on the income elasticities of both public and private expenditure. Hence, a negative sign is expected if public health expenditure is less income elastic than private health expenditure and *vice versa*.

According to the existing literature, a positive sign should be expected for the variable measuring the effect of per capita income in model [2]. However, given that in a country with a national health system the volume of private expenditure depends on the NHS ability to offer a wide range of good quality services, public expenditure could in theory crowd-out private expenditure. In addition, it is not clear enough whether private health expenditure is a substitute or a complement for public health expenditure. Finally, the geographical differences between regions could imply different roles of private expenditure in each

[23] See, Giannoni and Hitiris (2002) for Italy and Cantarero (2005) for Spain.

regional context. In regions with higher public health care supply, private expenditure may show a good degree of complementarity, whereas in regions with lower public health care supply, private expenditure may be a substitute for public expenditure.

With regard to the aged population variable, a positive effect is expected in model [2] due to the low care paid by the SSN to the elderly, who therefore have to pay out of pockets for some categories of health services. Given this result and all other things being equal, an increase in the proportion of population aged 65 and over is likely to determine a decrease in the share of public health expenditure.

The other explanatory variables deserve some additional comments. The inclusion of per capita national transfers to regions is expected to capture the effects of different containment policies on the public-private mix in health expenditure[24]. According to our previous considerations, the impact of this variable on private health expenditure should be negative. Therefore, the adoption of policies aiming at containing public health expenditure should result in an increase of private health expenditure, even because these policy measures are in general introduced together with forms of co-payments by users.

Lastly, the number of staff per hospital is employed as a measure of productivity improvement (other things being equal, more staff per hospital implies higher public expenditure and *vice versa*) while the number of beds per hospital is used in an attempt to control for different levels of efficiency due to the presence of scale economies (other things being equal, more beds per hospital imply bigger hospitals and hence lower public expenditure and *vice versa*). As for private expenditure, the signs of these two variables mainly depend on their relationship with public expenditure, as already described. Moreover, with respect to private expenditure, these two variables could be interpreted as proxies, respectively: 1) hospital beds for morbidity (more beds imply higher morbidity), which may involve higher costs for households; 2) hospital staff for the presence of waiting-lists in the public sector (more hospital staff imply lower waiting lists), which should in theory decrease private costs.

Several other points must be discussed regarding the above estimation models. First, the choice of the appropriate functional form is a quite controversial issue. For example, Di Matteo (2000) opts for a log-log functional form, which allows for direct estimates of elasticities. However, under a general view, there are no explicit reasons to prefer a logarithmic variable transformation, even if variables are measured as percentages (Wooldridge, 2003 p. 189). Indeed, previous studies on Italian regional expenditure have employed linear functional forms[25]. On the other hand, the use of a logarithmic transformation enables to straightforwardly compare the results with those found by Di Matteo (2000). In any case, the RESET test for the functional form has yielded the log-log specification as the best one for both models. Secondly, the choice of the estimation method represents a further problem. In the literature, the use of regional data on expenditure is generally considered as an obstacle to the adoption of random-effects models[26], thus making fixed-effects models preferable. In this context, the standard technique is provided by Parks (1967) and it is further developed by Kmenta (1986) for data that is cross-sectionally heteroscedastic and time-wise autoregressive. Nevertheless, this approach should be preferred whenever data are mostly time series rather than cross-sectional. Other techniques, such as OLS, GLS random effects, and fixed effects models must be adopted if the dataset is

[24] Over the period covered by this paper, there exists evidence that funding from central government to regions was constantly under-estimated. Moreover, the allocation formula also underwent a series of changes which deeply influenced regional transfers (Bordignon, Mapelli e Turati 2002).
[25] See, Giannoni and Hitiris (2002), Levaggi e Zanola (2003) and Bordignon e Turati (2003).
[26] An exception can be found in Crivelli *et al.* (2006).

essentially cross-sectionally. In the following analysis all these methodological approaches are used[27].

5. RESULTS

Tables 3 and 4 illustrate the regression results for different specifications of the two estimated models. All the models are in a log-log form. Therefore, the coefficients can be directly interpreted as elasticities. The specifications basically differ for the inclusion or not of regional effects. The results obtained are preliminary and clearly require further refinements. However, some interesting aspects are already evident.

Both the estimated models show a high degree of sensitivity to regional effects, especially with reference to per capita income. Comparing the OLS models with and without regional dummies, the presence of regional variables determines a change in the sign of the income variable. A similar effect can also be found when a model controlling for the fact that the pooled set of regional data is cross-sectionally correlated and time-wise autoregressive is estimated (Kmenta regions model)[28].

As suggested by Giannoni and Hitiris (2002), a more parsimonious model including regional clusters was also estimated to control for the effects of regional variables on private health expenditure. Besides the considerations on the estimator's efficiency offered by the two authors, the use of regional clusters enables to capture the different characteristics of private health expenditure demand coming from different regions rather than simply the regional administrative boundaries. Five clusters were obtained by following the same methodology as that of Giannoni and Hitiris (2002). Table 5 shows the composition of the clusters. The fourth columns of tables 3 and 4 illustrate the estimates obtained using regional clusters (Kmenta cluster model). Once more, the sign of the income variable does not change with respect to both the OLS with regional dummies and the Kmenta regions model. However, considering the prevalently panel nature of the dataset and the results of both the Breush-Pagan and the Hausman tests, the most efficient model seems to be the one with fixed effects (Greene, 2003).

Independently from the estimation technique employed in the analysis, many results appear to be quite stable. Therefore, the following discussion will focus only on the sign and relative size of the coefficients estimated in the Kmenta and fixed effects models. Nevertheless, the fitness of each of the models included in tables 3 and 4 is quite high.

[27] Other important aspects of our analysis are the presence of cointegration and data poolability. The time span considered (t=14) does not allow us to run an efficient test of cointegration. Notwithstanding this, the effects of both stationarity and cointegration are still an open issue in the literature. In the case of panel data, prevalent literature suggests that stationarity may not be a serious problem if one uses panel-level tests (McCoskey and Seldon, 1998). Regarding data poolability, the standard procedure is to assume it when one deals with regional data. Although in the regional contest this issue may seem reasonable, we note that this might be a problem. In fact, the rejection of poolability gives up one of the prime advantages of panel data: the increase in degrees of freedom obtained by repeating cross-sectional observations over time (Hsiao, 2003). However, at this early stage of analysis it has been decided to follow the prevalent literature on regional health expenditure which assumes "poolability" of the data.

[28] In the literature, the inclusion of regional dummy variables in cross-sectionally correlated and time-wise autoregressive models is controversial. Nevertheless, the bulk of papers controls for regional effects (Di Matteo and Di Matteo, 1998; Di Matteo, 2004; Giannoni and Hitiris, 2002).

Table 3. Estimation results for ratio of public to total health care expenditure (RPHCE)

Independent variable: ratio of public to total health care expenditure (RPHCE)
Functional form: log–log
Estimation range: 1990 – 2003
Standard errors are reported in parentheses

Variable	OLS (1) [(1)]	OLS (2) [(1)]	Kmenta regions	Kmenta cluster	GLS Random effects	Fixed effects (within)
PGDP	-0.12247***	0.33326***	0.38098***	0.17385***	-0.04186	0.33326***
	(0.01226)	(0.06681)	(0.05857)	(0.03579)	(0.02561)	(0.05584)
FTRA	0.23830***	0.22168***	0.13482***	0.11805***	0.22921***	0.22168***
	(0.02087)	(0.01902)	(0.01566)	(0.01483)	(0.01795)	(0.01719)
AGE	-0.03442**	0.02002	-0.19064**	-0.06677***	-0.06270*	0.02002
	(0.01402)	(0.09534)	(0.09237)	(0.02522)	(0.03790)	(0.08462)
HS	0.02865**	0.02109	-0.00658	-0.01105	0.02968**	0.02109*
	(0.01390)	(0.01324)	(0.00928)	(0.00807)	(0.01277)	(0.01213)
HB	-0.02749*	-0.07723***	-0.04961***	-0.01206	-0.07143***	-0.07723***
	(0.01615)	(0.01550)	(0.01483)	(0.01209)	(0.01686)	(0.01649)
TIME	-0.00985***	-0.01867***	-0.01171***	-0.00971***	-0.01110***	-0.01867***
	(0.00099)	(0.00217)	(0.00209)	(0.00104)	(0.00110)	(0.00207)
Regional dummies	No	Yes	Yes	No	No	No
Regional clusters	No	No	No	Yes	No	No
Observations	280	280	280	280	280	280
Number of regions	20	20	20	20	20	20
Number of years	14	14	14	14	14	14
F test for regional effects		16.84***				13.92***
F test for cluster effects				9.40***		
Breusch-Pagan LM[(2)]					170.86***	
Hausman test[(3)]					$\chi^2(6) = 68.67$***	
Log likelihood			697.5312	710.0045		
R^2	0.5127	0.7646				
Buse- R^2			0.8887	0.8624		

(1) Robust standard errors are reported in parentheses.
(2) Breusch-Pagan = Breusch-Pagan test OLS vs random effects.
(3) Hausman = Hausman test random vs. fixed effects.
***, ** and * denote significance at 1, 5 and 10 per cent levels, respectively.

Table 4. Estimation results for private expenditure

Independent variable: Real 2003 euro per capita private health expenditures
Functional form: log–log
Estimation range: 1990 – 2003
Standard errors are reported in parentheses.

Variable	OLS (1) [(1)]	OLS (2) [(1)]	Kmenta regions	Kmenta cluster	GLS Random effects	Fixed effects (within)
PGDP	0.71833***	-1.03345***	-1.08896***	-0.47113***	0.17742*	-1.03347***
	(0.04187)	(0.20778)	(0.16941)	(0.11654)	(0.10217)	(0.15909)
FTRA	-0.42286***	-0.40290***	-0.18996***	-0.11617***	-0.40870***	-0.40290***
	(0.07815)	(0.05651)	(0.04438)	(0.04073)	(0.05425)	(0.04897)
AGE	0.11862**	-0.15276	0.35938	0.29513***	0.29483*	-0.15277
	(0.05687)	(0.28274)	(0.26322)	(0.08990)	(0.15380)	(0.24111)
HS	-0.09662*	-0.10977***	-0.02675	-0.00392	-0.12642***	-0.10974***
	(0.04943)	(0.03597)	(0.02513)	(0.02113)	(0.03886)	(0.03457)
HB	0.03540	0.27420***	0.17172***	0.04278	0.27867***	0.27417***
	(0.06166)	(0.04676)	(0.04146)	(0.03426)	(0.05198)	(0.04697)
TIME	0.04220***	0.08085***	0.06192***	0.04890***	0.05237***	0.08085***
	(0.00373)	(0.00680)	(0.00596)	(0.00321)	(0.00387)	(0.00590)
Regional dummies	No	Yes	Yes	No	No	No
Regional clusters	No	No	No	Yes	No	No
Observations	280	280	280	280	280	280
Number of regions	20	20	20	20	20	20
Number of years	14	14	14	14	14	14
F test for regional effects		29.87***				31.50***
F test for cluster effects				9.80***		
Breusch-Pagan LM[(2)]					158.47***	
Hausman test[(3)]					$\chi^2(6) = 83.20$***	
Log likelihood			410.4341	428.2084		
R^2	0.7718	0.9320				
Buse- R^2			0.9999	0.9757		

(1) Robust standard errors are reported in parentheses.
(2) Breusch-Pagan = Breusch-Pagan test OLS vs random effects.
(3) Hausman = Hausman test random vs. fixed effects.
***, ** and * denote significance at 1, 5 and 10 per cent levels, respectively.

Table 5. Cluster of regions for private expenditure

Cluster	Categories	Regions
AREA1	Cluster of regions with minima private expenditure	Basilicata, Sicilia, Campania, Puglia
AREA2	Cluster of regions with less that average private expenditure	Sardegna, Molise, Calabria Abruzzo
AREA3	Cluster of regions with average private expenditure	Umbria, Marche, Liguria, Toscana
AREA4	Cluster of regions with more that average private expenditure	Friuli Venezia Giulia, Veneto, Valle D'Aosta, Piemonte, Lazio
AREA5	Cluster of regions with maximum private expenditure	Emilia Romagna, Lombardia, Trentino A.A

On the basis of the previous discussion, a positive and significant sign of the income variable in the ratio model would mean a public expenditure elasticity higher than the private one, regardless of time and regional differences. In other words, regions with higher income enjoy a higher share of public health expenditure, all other things being equal. This result is quite surprising since it would imply the inability of SSN to adequately equalize expenditure with respect to regional income differences. To better appraise it, the effect of the income variable on private health expenditure must be considered. Table 4 highlights that, when controlling for regional effects, the income elasticity of private expenditure is negative and significant, thus implying that private expenditure tends to be higher in those regions where income is lower. This finding is somewhat unexpected and requires further discussion[29]. Different explanations may be provided for it. Firstly, a bias may exist in the way in which household health expenditure data are collected by the National Institute of Statistics (ISTAT). Secondly, the static nature of the analysis could have contributed to confound the effect of income on the two dependent variables. Thirdly, this finding could be the sign of the presence of a significant crowding-out effect between public and private health expenditures. In short, a higher public health expenditure in the highest income regions could reduce the need for private expenditures by households. Another possible explanation may be related to the level of the analysis. Indeed, this is the hypothesis suggested by Gentzen (2000) with regard to the income elasticity of health care expenditure. Finally, it has to be noted that a negative, though non significant, value for the coefficient of the income variable has been also found by Crivelli *et al.* (2006) with reference to the cantonal socialized health expenditure in Switzerland. The authors justify the result by observing that this type of health expenditure represents the minimum package for each canton, independently from their income level. A similar hypothesis could be made for private health expenditure in Italy. Indeed, services which are not covered by the SSN are quite homogeneous across the Italian territory (e.g. dental services, some elderly care and pharmaceutical services, etc.) and form a package of irreducible size which is paid out of pocket by households, quite independently from the differences in average regional income levels[30].

Among the other variables included in the above models, national transfers and aged population variables are worthy of note. In the ratio model (table 3), the variable measuring

[29] For each region, both the ratio and the private health expenditure models have also been estimated, thus resulting in 20 different time series regressions. In the majority of cases, the income variable showed a sign coherent with that found in the estimates with regional effects. This result suggests that the sign of the income variable does not depend on the panel nature of the dataset but it is embedded within it.

[30] Clearly, the negative income elasticity of private health expenditure could also be the result of a spurious correlation.

national transfers to regions has a positive and significant sign. Moreover, this variable's elasticity is generally lower than income elasticity, in absolute value terms. As expected, the effect of national transfers revenues on private health expenditure is negative.

Regarding the effect of the aged population variable on the expenditure ratio, it does not appear stable in different model specifications but its coefficient is prevalently negative. As for the influence of this variable on the private component of health expenditure, in the Kmenta cluster model the result is negative and significantly different from zero, suggesting that the share of public health expenditure is not affected by this variable and that the Italian expenditure equalization systems do not work properly. Once more, it seems useful to look at private expenditure to better interpret this finding. As expected, private expenditure elasticity with respect to the share of aged population has a positive and significant sign, thus confirming the incapacity of public expenditure to appropriately satisfy the health care needs of this population group.

Finally, the number of both staff and beds per hospital report the expected signs, even though not always significant. The presence of more staff has a negative effect on private health expenditure, which can be interpreted in terms of shorter waiting-lists in the public sector and, therefore, less need for private expenditure. On the contrary, the number of beds per hospital has a positive effect on private health expenditure, due to a longer hospitalization, and, thus, higher costs of post hospitalization which are usually paid out of pocket by patients. Given these results and considering the fact that previous literature suggests that the two variables affect public expenditure (respectively, the number of staff per hospital positively and the number of beds per hospital negatively), a negative sign for HB and a positive sign for HS are expected in the ratio model. Results in table 3 are in line with this expectation.

A last consideration regards the inclusion of a time trend variable. This variable is usually adopted in the literature in order to capture the effect of technological progress, and more generally rising costs, in driving health expenditure. However, the most appropriate way to account for technological changes is still an open discussion (Di Matteo, 2005). In this preliminary analysis, the standard methodological procedure which requires to consider a linear time trend was employed. A future improvement would be to adopt a non linear trend or a two way fixed-effects model. Nonetheless, in all the estimated models, the time trend variable is found statistically significant. In particular, it has a positive sign with respect to private expenditure, which is not surprising given that the dynamics of private expenditure has shown an upward trend from 1990 to 2001. In consequence, during the same period, the share of public expenditure has decreased, resulting in a negative sign for the time trend variable in table 3.

6. CONCLUSION

This paper represents a first attempt to analyse the determinants of both private health expenditure and the public-private mix at a decentralized level in Italy, where there exist important differences among geographical areas and regions enjoy a high degree of autonomy. In theory, decentralization policies should help to improve the degree of vertical equity in the Italian health care system, by making public health expenditure more responsive to local needs. However, the risk exists that the lack of an adequate national financial equalization system could exacerbate rather than relieve regional health care disparities. In such a context, understanding the relationship between public and private health expenditures may contribute to better evaluate the consequences of different regional policies.

The empirical results, although preliminary and worthy of further improvement, show that regardless of the employed estimation methodology, per capita income, national transfers to regions and aged population influence the public-private mix in health care expenditure. In particular, other things being equal, increases in regional per capita income are associated with more public health care expenditure relative to private one, thus suggesting that the former is not sufficiently able to mitigate regional differences in income levels. As a direct consequence of this inability, higher costs have to be paid directly by households who reside in regions with an income level below the average. This finding could be explained by the specificities of the Italian system, in particular its regional disparities. Theoretically, in a country with a national health system, the size of regional private health expenditure depends on the NHS capacity to provide services with an equivalent high quality all over its territory. If this is not the case, where the NHS is able to provide better quality services, public health expenditure tends to crowd-out the private one. On the contrary, where service quality is worse, private health expenditure fills the gaps left by the public sector. In the case of Italy, differences existing within regions could therefore result in a dual role covered by private expenditure: as complement of public expenditure in higher income regions; as a substitute of public expenditure in lower income regions.

Among the other findings of this analysis, real per capita national transfers to regions are related positively to the public share of health expenditure and negatively to private health spending. Hence, policies aiming at containing the public component of health expenditure are expected to raise household health expenditures, thus increasing the already existing regional inequities.

Further developments of this paper should look at more sophisticated dynamic models which allow to describe with a higher accuracy many features of the employed variables and to better understand complex relationships. Moreover, though the focus of this paper was on the interaction between public and private health expenditures, a straight empirical model for the former was not estimated. Therefore, it could be useful to comprise also this expenditure component among the other dependent variables in order to evaluate the size of the marginal effects of the explanatory variables. Since one limitation of our analysis is the fact of not sufficiently taking into account health expenditure outcomes and differences in efficiency levels across regions, health outcome indicators could be also included as additional explanatory variables. Finally, our paper has not considered private and public health expenditure by separate categories, given the lack of regional data. In this sense, a future and appealing extension of this analysis could account for such data so as to investigate whether different expenditure categories (either private or public) react differently to the same determinants and to evaluate the implications of sectorial policy measures for health care.

APPENDIX A

International literature on health expenditure – first generation studies

	Data source	*Year(s)*	*Type of analysis*	*Methodology*	*Variables*	*Income elasticity*
Newhouse (1977)	13 developed countries	1971	Cross-section	Linear form	GDP	(>1)
Leu (1986)	19 OECD	1974	Cross-section	Double-log form	GDP, share of population <15 and >65, urbanization, public provision and financing, share of public HE, dummies for NHS and direct democracy	(>1)
Parkin *et al.* (1987)	18 OECD	1980	Cross-section	Linear, semi-log, exponential, double-log forms	GDP	Around 1 with PPP conversion factors
Gerdtham *et al.* (1992a)	19 OECD	1987	Cross-section	Double-log form	GDP, relative prices, number of physicians, share of population >64, share of public financing, share of in-patient expenditure, urbanization, dummies for countries with FFS payments and global budgeting caps.	1.33
Gbesemete and Gerdtham (1992)	30 African countries	1984	Cross-section	Double-log form	GNP, percentage of births attended by health staff, share of population <15, urbanization rate, crude birth rates, per capita foreign aid	Around 1

International literature on health expenditure – second generation studies

	Data source	*Year(s)*	*Type of analysis*	*Methodology*	*Variables*	*Income elasticity*
Gerdtham (1992)	22 OECD	1972-87	Panel	Double-log form. OLS and one-way and two-way fixed and random effects models	GDP, inflation, share of public financing, share of population >65	0.74 (in static equilibrium models)
Hitiris and Posnett (1992)	20 OECD	1960-87	Panel	Linear and double-log forms	GDP, share of population >65, crude mortality rates	1.026 (exchange rate) 1.160 (PPP)
Gerdtham *et al.* (1992b)	19 OECD	1974 1980 1987	Panel	Double-log form	GDP, relative prices, number of physicians, share of population >64, share of public financing, share of in-patient care expenditure, urbanization, dummies for countries with FFS payments and global budgeting caps.	1.27
Hitiris (1997)	10 EC	1960-91	Panel	Double-log	GDP, dependency rate, inflation rate, share of health expenditure	1.165
Hitiris (1999)	G7	1960-94	Panel	Linear form. Fixed effects model	GDP, share of population >65, share of public expenditure on GDP	1.07 and 1.09
Gerdtham *et al.* (1998)	22 OECD	1970-91	Panel	Double-log form	GDP, share of population >74 and <5, female labour force participation ratio, unemployment rate, alcohol and tobacco consumption, share of in-patient care expenditure and other institutional variables	0.74
Hansen and King (1996)	20 OECD	1960-87	Time series	Double-log form Nonstationarity. Cointegration	GDP, share of population <15 and >65, share of public financing, relative price of healthcare	No long-run relationship between HE and GDP
Blomqvist and Carter (1997),	18 OECD	1960-91	Cross-section Time-series Pooled	Double-log form. Static and dynamic models. Nonstationarity. Cointegration	GDP, share of population >65	0.976 (pooled estimation)
McCoskey and Selden (1998)	20 OECD	1960-87	Panel	Double-log. Nonstationarity and cointegration (panel unit roots tests)	GDP	Reject the unit root hypothesis for both HE and GDP time series.
Roberts (1999)	20 OECD	1960-93	Panel	Double-log form Static and dynamic models.	GDP, share of public financing, share of population >65, relative price of health care.	1.875
Roberts (2000)	10 EU	1960-93	Panel	Double-log form	GDP, dependency rate, inflation rate, share of health expenditure, time trend	1.212
Gerdtham and Lothgren (2000)	21 OECD	1960-97	Panel	Double-log. Nonstationarity and cointegration (panel unit root tests)	GDP	[Long-run cointegrating relationship between HE and GDP]
Jewell *et al.* (2003)	20 OECD	1960-97	Panel	Double-log. Nonstationarity and cointegration (panel unit root test with two structural breaks)	GDP	[HE and GDP are stationary around one or two breaks]
Carrion-i-Silvestre (2005)	20 OECD	1960-97	Panel	Double-log. Nonstationarity and cointegration (panel unit root test with multiple structural breaks}	GDP	[Evidence of stationarity of both the HE and GDP]

National-level regional studies on health expenditure

	Data source	*Year(s)*	*Type of analysis*	*Methodology*	*Variables*	*Income elasticity*
Di Matteo and Di Matteo (1998)	10 Canadian provinces	1965-91	Panel	Double-log form Kmenta model	GDP, share of population >65, federal transfer revenues	0.77
Giannoni and Hitiris (2002)	20 Italian regions	1980-95	Panel	Linear form Three-stage estimation Procedure. Fixed-effects models	GDP, aging population, n. of beds per hospital, n. of medical and non-medical personnel per hospital, dummies for regional clusters (second stage), regional time-specific dummies (third stage)	0.33 0.35
Bordignon and Turati (2003)	15 Italian ordinary regions	1990-99	Panel	Linear form Fixed effects model	GDP, share of population >65, physicians' density, n. of beds per hospital, expected funding, dummy for political affinity between central and local gov., dummy for 1997 EMU examination, ratio between the Italian and the average EU deficits, dummy for the 1994 voting system change, length of central gov., tax base of regional taxes, dummy for the region's size, dummy for allocation formula	Around 1
Levaggi and Zanola (2003)	20 Italian regions	1989-93	Panel	Linear form	GDP, share of population =65, private consumption of health services, intergovernmental grants, regional current deficit	0.246 0.1443
Crivelli *et al.* (2003)	26 Swiss cantons	1996-2000	Panel	Double-log form OLS and random effects models	GDP, physicians' density, share of population <5 and >75, unemployment rate, density of acute beds in hospitals, dummy variable for physicians selling drugs directly to the patients, time trend	Statistically not significant from zero
Di Matteo (2004)	10 Canadian provinces	1975-2000	Panel	Linear form Kmenta model	GDP, federal cash transfers, population aging, physicians' density, private proportion of total health expenditure, share of provincial government expenditure, time trend, province dummies	(<1)
Di Matteo (2005)	50 US states plus the District of Columbia 10 Canadian provinces	1980-98 (USA) 1975-2000 (Canada)	Panel	Linear form	GDP, aging population, federal cash transfers (only for Canada), province/region-specific dummies, year indicator variables	
Cantarero (2005)	15 Spanish regions	1993-99	Panel	Semi and double-log forms	GDP, dependency rate, n. of beds per hospital, n. of personnel per hospital	0.0815 0.0216
Costa-Font and Pons-Novell (2005)	17 Spanish autonomous communities	1992-98	Panel	Double-log Fixed effects models Spatial interactions (OLS and ML-SER)	GDP, share of population >65, physicians' density, hospital stays, dummies for fiscally accountable and health care responsible communities, dummy for political affinity between regional and central gov., share of left-wing MPs within regional parliament	Between 0.98 and 0.66

REFERENCES

Atella, V., and G. Marini (2005), *Panel data stationarity and cointegration: An application to the determinants of health care expenditure*, unpublished.

Besley T., and M. Gouveia (1994), "Alternative Systems of Health Care Provision", *Economic Policy* 19:199-258.

Blomqvist, A., and R.A.L. Carter (1997), "Is health care really a luxury?", *Journal of Health Economics* 16:207-229.

Bordignon, M., V. Mapelli, and G. Turati (2002), "Fiscal Federalism and National Health Service in the Italian System of Governments" , in: *Annual Report on Monitoring Italy*, ISAE, Roma.

Bordignon, M., and G. Turati (2003), *Bailing Out Expectations and Health Expenditure in Italy*, CESIFO Working Paper n. 1026.

Breusch, T.S., and A.R. Pagan (1980), "The Lagrange multiplier test and its application to model specification in econometrics", *Review of Economic Studies* 47:239-254.

Cantarero, D. (2005), "Decentralization and health care expenditure: the Spanish case", *Applied Economics Letters* 12:963–966.

Carrion-i-Silvestre, J.L. (2005), "Health care expenditure and GDP: Are they broken stationary?", *Journal of Health Economics* 24:839-854.

Casasnovas, G.L., and M. Saez (1998), *A Multilevel Analysis on the Determinants of Regional Health Care Expenditure*, University of Pompeu Fabra, Economics Working Papers, no: 572.

Clemente J. and C. Marcuello and A. Montañés and F. Pueyo "On the international stability of health care expenditure functions: are government and private functions similar?", Journal of Health Economics 23 (2004) 589–613

Costa-Font, J., and J. Pons-Novell (2005), *Public Health Expenditure and Spatial Interactions in a Decentralized National Health System*, Working Paper series, University of Barcelona.

Crivelli, L., M. Filippini and I. Mosca (2003), "Federalismo e spesa sanitaria regionale: analisi empirica per I cantoni svizzeri", in: Franco D. e A. Zanardi (eds.*), I sistemi di welfare fra decentramento regionale ed integrazione europea*, Franco Angeli, Milano.

Crivelli, L., M. Filippini and I. Mosca (2006), "Federalism and regional health care expenditures: an empirical analysis for the Swiss cantons", *Health Economics* 15:535-541.

Dickey, D.A., and W.A. Fuller (1981), "Likelihood-ratio statistics for autoregressive time-series with a unit roots", *Econometrica* 49:1057-1072.

Di Matteo, L., and R. Di Matteo (1998), "Historical evidence on the determinants of Canadian provincial government health expenditure: 1965–1991", Journal of Health Economics 17,211-28.

Di Matteo, L. (2000), "The Determinants of the Public-Private Mix in Canadian Health Care Expenditures: 1975-1996", *Journal of Health Policy*, 52:87-112.

Di Matteo, L. (2003), "The income elasticity of health care spending: A comparison of parametric and nonparametric approaches", *European Journal of Health Economics* 4:20–29.

Di Matteo, L. (2004), What drives provincial health expenditure?"", *Canadian Tax Journal* 52:1102-1120.

Di Matteo, L. (2005), "The macro determinants of health expenditure in the United States and Canada: assessing the impact of income, age distribution and time", *Health Policy* 71:23-42.

Engle, R.F. and C.W.J. Granger (1987), Cointegration and error correction: representation, estimation and testing, *Econometrica* 50:251-276.
France, G., F. Taroni, and A. Donatini (2005), "The Italian health-care system", *Health Economics* 14 (Suppl 1):187-202.
Gbsemete, K., and U.-G. Gerdtham (1992), "The determinants of health expenditure in Africa: a crosssectional study", *World Development* 20:303-308.
Gerdtham, U.-G. (1992), "Pooling international health expenditure data", *Health Economics* 1:217-231.
Gerdtham, U.-G., and B. Jönsson (1991a), "Conversion factor instability in international comparisons of health care expenditure", *Journal of Health Economics* 10:227-234.
Gerdtham, U.-G., and B. Jönsson (1991b), "Price and quantity in international comparisons of health care expenditure", *Applied Economics* 23:1519-1528.
Gerdtham, U.-G., J. Sögaard, F. Andersson and B. Jönsson (1992a), "Econometric analysis of health expenditure: a cross-sectional study of the OECD countries", *Journal of Health Economics* 11:63-84.
Gerdtham, U.-G., J. Sögaard, B. Jönsson and E Andersson (1992b), "A pooled cross-section analysis of the health expenditure of the OECD countries", in: P. Zweifel and H. Frech, eds., *Health Economics Worldwide*, Kluwer Academic Publishers, Dordrecht.
Gerdtham, U.-G., B. Jönsson, M. MacFarlan and H. Oxley (1998), "The determinants of health expenditure in the OECD countries", in: P. Zweifel, eds., *Health, The Medical Profession, and Regulation*, Kluwer Academic Publishers, Dordrecht.
Gerdtham, U.-G., and B. Jönsson, (2000), "International comparisons of health expenditure: theory, data and econometric analysis", in Culyer, A.J. and Newhouse, J.P., eds., *Handbook of Health Economics*, vol. 1a, North-Holland, Elsevier, Amsterdam.
Gerdtham, U.-G, and M. Lothgren (2000), "On stationarity and cointegration of international health expenditure and GDP", *Journal of Health Economics* 19:461-475.
Getzen TE. (2000) "Health care is an individual necessity and a national luxury: applying multilevel decision models to the analysis of health care expenditures." *Journal of Health Economics*, 19(2):259-70.
Gianonni, M., and T. Hittris (2002), "The regional impact of health expenditure: The case of Italy", A*pplied Economics* 34:1829-1836.
Gouveia, M. (1996), "The Public Sector and Health Care", *International Tax and Public Finance* 3:329–349.
Gouveia, M. (1997), "Majority Rule and the Public Provision of Private Goods", *Public Choice* 93:221–244.
Greene, W. (2003), *Econometric Analysis*, Fifth Edition, Prentice Hall, Englewood Cliffs.
Hansen, P., and A. King (1996), "The determinants of health care expenditure: a cointegration approach", *Journal of Health Economics* 15:127-137.
Hansen, P., and A. King (1998), "Health care expenditure and GDP: panel data unit root test results – comment", *Journal of Health Economics* 17:377-381.
Hausman, J. (1978), "Specification tests in econometric", *Econometrica* 46:1251-1271.
Hitiris, T., and J. Posnett (1992), "The determinants and effects of health expenditure in developed countries", *Journal of Health Economics* 11:173-181.
Hitiris, T. (1997), "Health Care Expenditure and integration in the countries of the European Union", *Applied Economics* 29:1-6
Hitiris, T. (1999), *Health Care Expenditure and Cost Containment in G7 Countries*, University of York, discussion papers.
Hsiao C. (2003), *Analysis of Panel Data*, 2nd Edition, Cambridge University Press

Jewell, T., J. Lee, M. Tieslau, and M.C. Strazicich (2003), "Stationarity of Health Expenditures and GDP: Evidence from Panel Unit Root Tests with Heterogeneous Structural Breaks", *Journal of Health Economics* 22:313-323.

Kmenta, J. (1986), *Elements of Econometrics*, 2nd edition, MacMillan, New York.

Leu, R.E. (1986), "The public-private mix and international health care costs", in: A.J. Culyer and B. Jönsson, eds., *Public and Private Health Services*, Basil Blackwell, Oxford.

Levaggi, R. (2000), "Health Care Expenditure Across OECD Countries: A Public Choice Approach," *International Economics* 53:203–219.

Levaggi, R., and R. Zanola (2003), "Flypaper Effect and Sluggishness: Evidence from Regional Health Expenditure in Italy", *International Tax and Public Finance*, 10:535-547.

Levaggi, R, and P.C. Smith (2005), "Decentralization in health care: lessons from public economics", in: P.C. Smith, L. Ginnelly and M. Sculpher, eds., *Health policy and economics: opportunities and challenges*, Open University Press, Maidenhead.

McCoskey, S.K., and T.M. Selden (1998), "Health care expenditure and GDP: Panel data unit root test results", *Journal of Health Economics* 17:369-376.

Milne, R., and H. Molana (1991), "On the effect of income and relative price on demand for health care: EC evidence", *Applied Economics* 23:1221-1226.

Mosca, I. (2006), "Is decentralisation the real solution? A three country study", *Health Policy* 77:113–120.

Newhouse, J.P. (1977), "Medical care expenditure: a cross-national survey", *Journal of Human Resources* 12:115-125.

Parks R.W., (1967), "Efficient Estimation of a System of Regression Equation When Disturbance are Both Serially and Contemporaneously Correlated, *Journal of the American Statistical Associati*on, 62, 500-509

Parkin, D., A. McGuire and B. Yule (1987), "Aggregate health expenditures and national income: is health care a luxury good?", *Journal of Health Economics* 6:109-127.

Roberts, J. (1999), "Sensitivity of Elasticity Estimates for OECD Health Care Spending: Analysis of a Dynamic Heterogeneous Data Field", *Health Economics* 8: 459-472.

Roberts, J. (2000), "Spurious Regression Problems in the determinants of Health Care Expenditure: A comment on Hitiris (1997)", *Applied Economics Letters* 7:279-284.

Tiebout, C. (1956), "A pure theory of local expenditure", *Journal of Political Economy* 64:416-424.

Turati, G. (2003), "L'evoluzione della spesa, del finanziamento, dei disavanzi e degli interventi di ripiano nelle gestioni della sanità regionale italiana", *Politiche Sanitarie*: April-June.

Wooldridge J. , (2003) "Introductory Econometrics: A Modern Approach", 2nd edition, Thomson-South Western