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ORIGINAL PAPER

Decomposing the determinants of health care expenditure: the case of Spain

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Abstract The aim of this paper is to analyze the determinants of regional health-care expenditure in Spain. The coexistence of several models concerning the degree of spending power decentralization and financing systems makes Spain a singular case. It also allows us to draw conclusions relevant to other countries in decentralizing their health-care systems, and to understand cross-country differences with estimated parameters. Using data from the Spanish regions for the period 1992–2005, we show that the estimated health public expenditure income elasticity does change depending on the omission of relevant variables, econometric specifications and techniques, and institutional arrangements. Moreover, while demographic structure is a very relevant factor when explaining health-care expenditure dynamics, multicollinearity biases econometric parameter estimates.

Keywords Fiscal federalism · Regional health expenditure · Regional inequalities

JEL Classification · I18 · I38 · H73

Introduction

The Spanish case is very interesting for studying the determinants of per capita health care expenditure because of the diversity within its institutional framework. In particular, since the early eighties, different degrees of decentralization in both expenditure and revenues were applied to different groups of Spanish regions or Autonomous Communities (ACs henceforth). Hence, the analysis of results may be particularly relevant for those countries in early stages of health care decentralization.

The Spanish case also serves to illustrate the relevance of a number of pitfalls affecting previous empirical works in the field, especially when regional data is used and, as is usually the case, per capita income and demographic structure are included as explicative variables. In fact, research has most often focused on estimating income elasticities and the effect of aging. Because the reliability of parameter estimates becomes a key issue, a number of caveats should be taken into account when estimating and interpreting results.

First, income elasticities should not be estimated using income as the only regressor. The correct interpretation of income elasticity is the percentage change in health expenditure in response to a given percentage change in income, everything else held constant. Health care expenditure may grow because of aging, technological change, and so on. If those factors are positively correlated with income (as they often are), bivariate regressions will produce upwardly biased estimates of income elasticity.

Second, regions are not countries. In the case of the latter, public revenues rely on national gross domestic product (GDP). The governmental budget constraint tightly binds revenues and expenditure. In the case of regions things may be significantly different. If the responsibility for health care is not decentralized, regional income is irrelevant. And the same may be true if fiscal equalization is strong and/or public health expenditure is financed by specific grants from the central government. Let us imagine

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one country composed of two identical regions, A and B, with the responsibility of managing public health. An asymmetrical regional shock create a gap in annual GDP growth rates: 4% in region A and 0% in region B (national economic growth is then 2%). With full fiscal equalization, a unitary income elasticity at the country level (a growth rate of public health expenditure of 2%) is compatible with a null correlation between income and health expenditure at the regional level. While regional GDP growth rates are very different, the growth of the latter is equalized at 2%. In sum, the more the fiscal interdependence of regions, the lower the regional income elasticity of public health expenditure. Therefore, the institutional framework matters.

Third, if changes in the structure of the population are slow and/or the time span of the sample is short, the within-variation of some population brackets may be very low. This becomes a problem if individual effects are included in the estimates and if those effects are correlated with regressors. In this case, the fixed effects specification is preferable to random effects, but then the coefficients of variables with little within-variation are imprecisely estimated.

Finally, the correlation between population brackets may also be high, producing multicollinearity if several brackets are simultaneously included into estimates. For instance, the proportion of population aged 0–4 usually is negatively correlated with the proportion aged 65 and over; or, the proportion of population aged 65–74 tends to be positively correlated with that aged 75 and over.

In the European Union, several studies have examined those effects [22] However, only limited empirical evidence has been reported on the effect of determinants of health care expenditure at the regional level [14, 17, 18, 20] In this manner, some research has been conducted in Spain to disentangle the potential factors in the generation of health care expenditure [9, 11, 12], but some of their results are subject to revision because of methodological and econometric flaws.

Using data from the Spanish regions for the period 1992–2005, this paper shows that the health public expenditure income elasticity estimate does change depending on the omission of relevant variables, econometric specifications and techniques, and institutional arrangements. Second, while demographic structure is a more relevant factor when explaining health care expenditure dynamics, multicollinearity biases econometric parameter estimates.

The structure of the paper is as follows. In the second section, we briefly present the main characteristics of the Spanish National Health Service. In the third section, previous empirical studies are reviewed. In the fourth section, an analysis of data is carried out and the econometric specifications are presented. In the fifth section, the main econometric results are shown. Finally, the paper ends with conclusions.

The Spanish National health service: a brief description

The Spanish National Health Service (NHS) is characterized by two main features: universal access to health care for all Spanish citizens and a rapid asymmetric decentralization of health care to the Spanish regions since the early eighties [9]. The population, even illegal immigrants, has the right of free access to services and benefits are quite comprehensive, although minimal for long-term care and dental services and some regional diversity exists in some services. Health care expenditure is $2,255 PPP (purchasing power parity) per capita and accounts for 8.2% of GDP in 2005. Approximately three-quarters (5.8) of this spending corresponds to public expenditure and a quarter (2.4) to private expenditure.

The devolution process of public health care began in 1981, according to the three models distinguished among ACs:

a) Ten regions (approximately half of the population) had no health care responsibilities until 2002. Before this date, the central government carried all responsibility for health care in those regions.
b) Five regions (Catalonia, Galicia, the Canary Islands, Community of Valencia, and Andalusia) kept health care expenditure responsibilities, but with actual fiscal responsibility limited, in the sense that they were held politically more than fiscally accountable. Therefore, most resources devoted to health care in those regions came from specific grants, with self-financing strongly constrained and playing a minor role.
c) A third group of two AC with special status (*foral* ACs). Navarre and the Basque Country are both fiscally and politically accountable for the running of almost all public service provision within their boundaries. While they were granted autonomy in financing health care, they also enjoyed a high level of tax autonomy.

Since 2002, the process of decentralizing health care and financing in Spain has extended to all ACs. Moreover, the new effective system departs from the previous model of specific financing of health care, by integrating it into the general financing system of ACs. Health care financing is now covered by regions basically through three types of resources, as any other service offered by regional governments: regional taxes, shared (totally or partially) taxes and block-grants from the central government. User co-payments play a minor role. Finally, as Table 1 shows, global inequality in terms of per capita expenditure has not

Table 1 Evolution of regional per capita public health care expenditure in Spain (1992–2005) (euros)

Autonomous communities	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Andalusia	449	503	527	543	567	583	618	680	766	791	837	903	973	1,020
Aragon	529	521	559	569	622	628	684	776	824	899	955	1,069	1,168	1,209
Asturias	521	535	564	576	613	612	664	757	810	872	946	1,061	1,136	1,205
Balearic Islands	427	420	460	470	506	526	552	614	637	677	800	908	950	1,121
Canary Islands	479	498	520	550	579	587	613	770	820	840	910	1,000	1,046	1,147
Cantabria	508	528	562	576	584	631	672	773	833	921	1,014	1,073	1,243	1,331
Castilla y León	467	464	500	513	548	565	611	726	787	840	898	1,029	1,093	1,177
Castilla La Mancha	433	447	487	501	557	560	588	675	721	774	879	936	923	1,157
Catalonia	455	487	525	547	576	591	642	722	777	817	869	958	998	1,058
Community of Valencia	462	497	536	540	573	585	616	689	750	790	846	934	989	1,029
Extremadura	470	487	504	526	581	588	630	725	786	826	969	1,026	1,122	1,199
Galicia	402	437	479	511	566	585	623	754	797	864	902	980	1,088	1,122
Madrid	528	522	590	570	598	598	633	725	752	788	815	870	980	1,026
Murcia	441	450	466	504	576	589	606	709	768	806	861	951	1,037	1,114
Navarre	420	424	437	483	542	570	615	878	933	961	1,014	1,089	1,167	1,204
Basque Country	459	467	513	539	576	589	613	791	836	894	957	1,028	1,095	1,195
La Rioja	444	451	501	515	514	549	585	720	791	834	910	994	1,112	1,228
Total	465	488	526	540	574	587	624	721	776	818	874	954	1.023	1,191
Var. Coef. (%)	8.36	7.63	8.04	6.09	4.78	4.32	5.10	5.80	5.04	5.58	5.77	6.23	6.58	6.87

Source Authors' calculation based on Ministry of Health (Spain)

significantly increased with decentralization. Health care is the foremost policy responsibility of the ACs. In conjunction with education, these social expenditure items account for 60–70% of total public funds in the hands of ACs.

The determinants of regional health care expenditure: a survey

Health care expenditure growth and its determinants is one striking issue for western economies [21–23]. After some seminal papers [24, 26], the examination of the determinants of health care expenditure has been a matter of extensive debate. The increasing availability of international data on health care has led to the development of studies disentangling the underlying factors that determine health care expenditure, such as income, aging, time effects, availability of factors and even technological progress [27]. However, most studies are based on cross-country data, to unravel the extent to which income and other determinants, such as demographics (demand side variables) and heterogeneity of health care inputs (supply side variables), explain differences in health expenditure [31].

Most cross-country studies find that per capita income is the most important determinant of per capita health expenditure. Furthermore, there is no agreement in the literature about whether health care expenditure is a luxury or a normal good [3, 4, 7, 8, 10, 15, 17, 30]. Another important element is the consideration of the regional dimension within national health care expenditure, because there may be an aggregation fallacy in estimating the income elasticity of health care expenditure.

In light of the long-lasting debate on whether health care is a luxury and what are the determinants of this expenditure, Di Matteo and Di Matteo [16] found that key determinants of health care expenditure were real provincial per capita income, the proportion of the provincial population over age 65 and real provincial per capita federal transfer revenues. Also, an income elasticity of 0.77 implied that health care is not a luxury good.

Ariste and Carr [2] use error correction and cointegration techniques on Canadian provincial health care expenditure data (1966–1998). They find an income elasticity of 0.88 and conclude the same as Di Matteo and Di Matteo [16]. Similarly, Giannoni and Hitiris [20] attempt to examine the determinants of regional health expenditure in Italy and find significant regional-specific effects.

The principal findings of Freeman [19] are that health care expenditures and incomes within the US states for the years 1966–1998 are nonstationary and cointegrated. Dynamic OLS cointegrating regressions of the pooled state time-series estimate the income elasticity of health care at 0.817–0.844.

In the study by Di Matteo [17], parametric and nonparametric estimation techniques are compared in estimating the relationship between income and health expenditures with implications for the reliability of past estimates of health expenditure income elasticity. The results for three time-series cross-sectional data sets (the US state and Canadian province-level data and national level data for 16 OECD countries) confirm that income elasticity does vary by level of analysis, with international income elasticities generally larger than national or regional studies.

The aim of Cantarero [9] was to analyze the determinants of regional health care expenditure in Spain because important differences exist among regions. Results show that the most important determinant in explaining the volume of regional health care expenditure is the aging population, while other factors like the regional income and the relative structural characteristics of the supply variables have less importance.

In the study by Di Matteo [18], the determinants of real per capita health expenditure in the United States and Canada are examined. Aging population distributions and income explain a relatively small portion of health care expenditures when the impact of time effects, a partial proxy for technological change, is controlled.

In the study by Crivelli et al. [14], income does not have any influence on the level of health care expenditures. This result might be considered surprising, but in reality it shows that one of the main objectives of the Swiss health care system has been reached (horizontal equity).

Lopez-i-Casasnovas and Saez [25] apply a multilevel hierarchical model, using data for 110 regions in eight countries in 1997 (including Spain). Two sources of random variation (within countries and between countries) are identified. Variability between countries amounts to (SD) 0.5433 and just 13% of that can be attributed to income elasticity, with the remaining 87% to autonomous health expenditure. Within countries, variability amounts to (SD) 1.0249 and the intra-class correlation is 0.5300. They conclude that it is necessary to take into account the degree of fiscal decentralization within countries in estimating income elasticity of health expenditure. Two reasons justify this: where there is decentralization to regions, policies aimed at emulating diversity tend to increase national health care expenditure; and without fiscal decentralization, central monitoring of finance tends to reduce regional diversity and therefore decrease national health expenditure. The results do seem to validate both these points.

Also, Costa-Font and Pons-Novell [11] show that Spanish regions exhibit significant heterogeneity as a result of increasing decentralization and region-specific political factors, along with different uses of health care inputs, economic dimensions and spatial interactions. A potential limitation of these studies lies in the fact that no evidence of Spanish private health expenditure is available at the regional level.

Finally, Costa-Font and Moscone [12] use a spatial panel specification for all Spanish regions. They show some degree of interdependence in expenditure decisions between neighboring regions. Similar results appear in Costa-Font, Gemmill, and Rubert [13] when they test the health care luxury good hypothesis.

Table 2 summarizes all the above studies. In short, most of them find a positive income elasticity for regional public health expenditure, but below unity. Moreover, the demographic structure is another key variable. Both factors are analyzed in depth in the next sections of this paper.

Econometric specification and data

As endogenous variable, the logarithm of per capita health care expenditure (*Loggspc*) is used. The list of exogenous variables includes per capita income (*Logy*), demographic structure (*Pop*), and a number of control variables: several physical indicators and a proxy for technological change. In particular, we have considered consumption of medical services through the number of general practitioners per 1,000 population (*Ph*) and acute care beds per 1,000 population (*Ch*). With respect to technological change, empirical literature has given it little attention. An exception is the study by Di Matteo [18]. While it is often accepted that innovations in medical care boost the cost of health services, there are no aggregated statistical indexes to measure it. As in the literature on economic growth, a time trend (*Trend*) or a set of time fixed effects may be used as proxy. Di Matteo [18] chooses the second option, finding that time accounts for approximately two-thirds of health expenditure increases in the US and Canada. In this paper, both alternatives are explored.

Information is available for the period 1992–2005 on 17 Spanish regions, which yields 238 observations. The list of variables, definitions, and data sources are shown in Table 3 and basic descriptive statistics in Table 4.

The basic econometric specification is the following:

$$\begin{aligned} Loggspc_{it} = {} & \alpha_i + \beta_1 Logy_{it} + \beta_2 Ch_{it} + \beta_3 Ph_{it} \\ & + \beta_4 Trend + \sum_j \gamma_j Pop_{jit} + \varepsilon_{it} \end{aligned} \tag{1}$$

where i indicates region and t indicates year. Different numbers (j) of population brackets are used in each estimate. Logarithms are only used in the case of health care expenditure and income because the remaining variables are expressed in percentages; taking logarithms of percentages makes no sense [20].

In order to test differences in the effect on income, several groups or clusters of observations are defined. Observations in cluster 1 are those combining expenditure

Table 2 Summary of previous studies. Dependent variable: regional health care expenditure

Reference	Countries studied	Period	Model description	Main results
Di Matteo and Di Matteo [16]	Canadian provincial government health expenditure	1965–1991	Pooled time-series cross-sectional regression analysis	Key determinants: real provincial per capita income, the proportion of the provincial population over age 65 and real provincial per capita federal transfer revenues. Income elasticity: 0.77 (health care is not a luxury good)
Ariste and Carr [2]	Canadian provincial government health expenditure	1966–1998	Error correction and cointegration techniques	Income elasticity: 0.88 (health care is not a luxury good)
Gionannoni and Hitiris [20]	Italy's regions	1980–1995	Pooled regional time-series cross-sectional data	The most important determinant is regional income. Among the factors of lesser importance are: (i) the aging population; and (ii) structural characteristics, relating to economies of scale and productivity.
Freeman [19]	American state-level data	1966–1998	Dynamic Ordinary Least Squares cointegrating regressions	Income elasticity: 0.817–0.844 (health care is a necessity good)
Di Matteo [17]	American state-level data, Canadian province-level data and national level data for 16 OECD countries	1980–1997 (US), 1965–2000 (Canada) and 1960–1997 (16 OECD countries)	Ordinary Least Squares (OLS) regression model	Income elasticity does vary by level of analysis with international income elasticities being generally larger than national or regional studies.
Cantarero [9]	Spanish regions	1993–1999	Panel data	The most important determinant is the aging population, while other factors such as income differences and structural characteristics of the supply variables (the physician and bed density) have less importance
Di Matteo [18]	American state-level data and Canadian province-level data	1980–1998 (US) and 1975–2000 (Canada)	Multivariate analysis	Key factors: Income and population over 65 years, and time effect (proxy for technological change).
Crivelli et al. [14]	Swiss cantons	1996–2001	Panel data	Key factors: the physician density, the percentage of over 75 in the population, the percentage of under 5 in the population and the unemployment rate. Income does not have any influence on health expenditures.
López-i-Casasnovas and Saez [25]	110 regions in Australia, Canada, France, Germany, Italy, Spain, Sweden and United Kingdom	1997	Multilevel hierarchical model	Key determinants: Income and population over 65 years and over.
Costa-Font and Pons-Novell [11]	Spanish regions	1992–1998	Ordinary Least Squares and the Lagrange multipliers methods (ML-SER)	Key Determinants: Income, number of doctors, beds, and stays per population, health care responsibilities and political variables. Income elasticity: 0.98 and 0.66 (health care is not a luxury good)
Costa-Font, Gemmill and Rubert [13]	Income elasticity estimates derived from aggregate datasets and published in social science journals	167 comparable elasticity estimates from a set of 48 published studies up until 2006	Meta-regression model	Publication bias exists. The corrected income elasticity estimates range from 0.4–0.8, which cast serious doubt on the validity of luxury good hypothesis. Nonetheless, due to the importance of aggregation, we cannot reject the luxury good hypothesis for aggregate time-series data.

Source Authors' elaboration

Table 3 Variable definitions and data sources

Variable	Definition	Data source
Loggspc	Logarithm of health care expenditure per capita	Spanish Ministry of Health
Logy	Logarithm of real per capita income	Spanish National Institute of Statistics
Ch	Acute care beds per 1,000 population	Spanish National Institute of Statistics
Ph	General practitioners (density per 1,000 population)	Spanish National Institute of Statistics
Pop4	Population with age below 4	Spanish National Institute of Statistics
Pop75	Population with age over 75	Spanish National Institute of Statistics
Pop6575	Population with age between 65 and 75	Spanish National Institute of Statistics
Trend	Time trend	
CLUSTER1	Dummy variable. It is coded 1 for observations corresponding to regions with responsibilities on public health care and a high tax autonomy (Basque Country and Navarre) and 0 otherwise	
CLUSTER2	Dummy variable. It is coded 1 for observations corresponding to regions with responsibilities on public health care but a low tax autonomy, and 0 otherwise	

Table 4 Descriptive statistics

Variable	Mean	*SD*	*SD*	*SD*	*Min.*	*Max.*
Loggspc	6.54	0.30	0.05	0.30	6.00	7.19
Logy	7.19	0.32	0.20	0.26	6.47	7.91
Ch	3.83	0.63	0.60	0.24	2.51	4.97
Ph	2.82	0.91	0.35	0.84	1.65	6.00
Pop4	4.65	0.80	0.78	0.26	3.03	6.40
Pop75	7.24	1.63	1.47	0.78	4.00	11.10
Pop6575	9.80	1.43	1.41	0.41	5.94	12.35
CLUSTER1	0.12	0.32	0.33	0.00	0	1
CLUSTER2	0.41	0.49	0.37	0.33	0	1

Source Authors' calculation

decentralization with high tax autonomy (*foral* ACs). Observations in cluster 2 are characterized by expenditure decentralization but low tax autonomy (five ACs until to 2002, and 15 since then). Cluster 3 includes observations without expenditure decentralization (10 ACs until 2002). In order to avoid perfect multicollinearity, only two dummy variables *CLUSTER1* and *CLUSTER2* are included. Interactions between both variables and *Logy* are then included into the basic specification. Hence, the coefficient on *Logy* is $\beta_1 + \beta_5$ for cluster 1, $\beta_1 + \beta_6$ for cluster 2, and β_1 for the reference category (cluster 3):

$$\begin{aligned} Loggspc_{it} = & \alpha_i + \beta_1 Logy_{it} + \beta_2 Ch_{it} + \beta_3 Ph_{it} + \beta_4 Trend \\ & + \sum_j \gamma_j Pop_{jit} + \beta_5 Logy_{it} CLUSTER1_{it} \\ & + \beta_6 Logy_{it} CLUSTER2_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

Econometric results

For some regressors, within-variation is clearly lower than between-variation (see Table 5). This is so for of *Pop6575* (within-variation is 3.4 times lower than between-variation), *Pop4* (3 times) and *Ch* (2.5 times). Collinearity with individual fixed effects may be troublesome when using fixed effects is necessary. Unfortunately, this is the case. Econometric results show that individual effects significantly increase the goodness of fit (column 1 vs. column 5 and column 2 vs. column 6). A simple *F*-test formally verified the null hypothesis that the constant terms are equal. Moreover, correlation between individual effects and regressors is high, indicating that fixed effects is a better choice than random effects. According to the Hausman test applied on column 5, the hypothesis of uncorrelation should be discarded (p-value $= 0.005$).

As expected, the inclusion of individual effects into the estimates changes the estimated coefficients for variables with a low within-variation. This is the case of variable *Pop4*. In column 2, its coefficient is positive and significant at 10% level. However, it becomes negative and marginally significant when individual effects are included (column 6).

The negative sign of acute care beds for each 1,000 inhabitants is explained because this variable follows a falling trend in all the Autonomous Communities. In fact, the between-groups correlation between ch and loggspc provides a positive coefficient with a $p = 0.17$: spending is higher in those regions with more acute care beds. In Spain,

Table 5 Econometric estimates of Eqs. 1 and 2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9) §	(10)
Intercept	1.33***	2.66***	3.14***	2.35***	−1.57***	3.93***	4.38***	6.08***	6.46***	6.11***
	(0.29)	(0.04)	(0.32)	(0.25)	(0.15)	(0.50)	(0.10)	(0.14)	(0.11)	(0.15)
Logy	0.72***	0.47***	0.44***	0.49***	1.13***	0.47***	0.17***	−0.01	0.04	−0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.06)	(0.05)	(0.08)	(0.04)	(0.05)
Ch		−0.03*	−0.06***	−0.03		−0.22***	−0.21***	−0.12***	−0.04	−0.12***
		(0.02)	(0.02)	(0.02)		(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Ph		0.12***	0.10***	0.15***		0.06***	0.04***	0.02**	0.02	0.02*
		(0.02)	(0.02)	(0.02)		(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Pop4		0.01				−0.07***				
		(0.02)				(0.02)				
Pop75		0.04***	0.07***			0.12***	0.23***	0.07***	0.05*	0.06***
		(0.01)	(0.02)			(0.01)	(0.02)	(0.02)	(0.03)	(0.02)
Pop6575			−0.03*	0.04***						
			(0.02)	(0.01)						
Trend								0.06***		0.06***
								(0.01)		(0.01)
*Logy*CLUSTER1*										0.14*
										(0.08)
*Logy*CLUSTER2*										0.0033
										(0.0024)
$\hat{\rho}$							0.74	0.64	0.73	0.62
R^2	0.584	0.779	0.782	0.768	0.932	0.955	0.759	0.885	0.889	0.900
Observations	238	238	238	238	238	238	221	221	221	221
Method	OLS	OLS	OLS	OLS	Xtreg, fe	Xtreg, fe	Xtregar, fe	Xtregar, fe	Xtregar, fe	Xtregar, fe

Standard errors appear in parenthesis; § Includes time fixed effects. * Significant at 10%. ** Significant at 5%. *** Significant at 1%

like in many developed countries, the figure of acute care beds has gone falling during the last 20 years. This slope goes together with the reduction in the average duration of the stay and the growth of the surgery that it does not require hospitalization.

As expected again, correlation between the different population brackets are high. Multicollinearity is then a serious concern when some combinations of brackets are simultaneously used. For instance, when both *Pop6575* and *Pop75* ($r = 0.86$) are included, the coefficient for the first is negative (column 2). But it becomes positive when *Pop75* is removed (column 3). Some of the results given in the study by Di Matteo [18] concerning the effect of the structure of population on health care expenditure could be explained by this reason.

As an alternative to the standard within-estimator, the three-stage estimator proposed by Plumpër et al. [28, 29] was used. This estimator, called *xtfevd*, allows simultaneous inclusion of time-invariant variables and individual fixed effects. Moreover, according to Monte Carlo simulations, *xtfevd* performs better than the fixed-effect model when the between-variation clearly exceeds the within-variation (by at least a factor of 2.5). Results, not reported in Table 5, confirmed the positive sign of variable *Pop4*. Finally, correcting for cross-sectional heteroscedasticity and contemporaneous cross-correlation following the methodology proposed by [6] did not significantly change results.

All in all, estimates in columns 1–6 may suffer from biases due to serial autocorrelation. The modified Bhargava et al. Durbin-Watson statistic was computed for estimates in column 6. It yielded the value of 0.90. According to critical values calculated by Bhargava et al. [7], the hypothesis $\rho = 1$ may be rejected. Estimates in columns 7–10 includes control variables for this problem. With this aim, the Baltagi and Wu [5] estimator for cross-sectional time-series regression models with first-order autoregressive disturbance terms (*xtregar*) was used.[1]

A time trend is included in columns 8 and 10. In column 9, the time trend is replaced by time fixed effects. While results using a common time trend or time fixed effects are similar, there are significant differences in estimates where the effect of time is not controlled.

The income elasticity of public health care expenditure significantly changes depending on the inclusion of other

[1] The Arellano-Bond dynamic panel estimator (*xtabond*) [1] was also used as an alternative in preliminary estimates, including two lags of the dependent variable in the model in order to reject the null hypothesis of no second-order serial correlation in the residuals. Basic results were the same.

variables, specifications, and econometric techniques. In columns 1 and 5, *Logy* is the only regressor. Because the model specification in column 5 is better than that in column 1 (individual effects are included), one should conclude that health services is a luxury good: elasticity is over unity (1.13). However, once other regressors are included, elasticity dramatically drops to 0.47 (column 6). Moreover, when serial correlation is controlled for, elasticity becomes just 0.17 (column 7). Finally, income is not significant when the time trend (column 8) or time fixed effects (column 9) are included. While this last result may be partially explained by collinearity between income and time trend or time effects, our main conclusion is that income elasticity is (at most) very low once omitted variable bias and econometric problems are corrected.

In column 10, the homogeneity of coefficients for the variable *Logy* and the different cluster of observations defined above are tested. The results indicate that variation of GDP per capita would be more influential in the case of foral ACs (*CLUSTER1*). As expected, higher regional GDP growth rates would be translated into more health care expenditure only in foral AC.[2]

In sum, the more reliable estimates are those including both individual and time effects (or a time trend) in columns 8–10. The rest of the estimates are included in Table 5 to show how results change when problems affecting to both specification and econometrics are (or are not) solved.

To understand the results concerning income elasticity, one must take into account that the decisions in health policy in Spain are strongly affected by a model of health care that puts emphasis on the equality of citizens' access. Strong income elasticities of health care expenditure at the national level are compatible with weak regional elasticities. If the central government controls expenditure directly or equalizes per capita regional revenues (reducing tax autonomy and/or giving grants to less developed regions), expenditure and income may be weakly correlated. In this sense, we have shown that income is translated into higher expenditure only in those Spanish regions with particular fiscal arrangements (Navarre and the Basque Country) entailing a higher income and tax autonomy. They enjoy a greater capacity to convert regional income into public health care expenditure.

Discussion and concluding remarks

In this paper, the main determinants of per capita health care expenditure in Spanish regions (autonomous communities) are analyzed. The coexistence of several models regarding the degree of expenditure decentralization and financing systems makes Spain a singular case; it allows interesting conclusions to be drawn for other countries on ways to decentralize their health care system.

According to the literature, our model is based on two main factors: per capita income and demographic structure. As control variables, two physical indicators (acute care beds and general practitioners per 1,000 population) and a proxy for technological change are also included. Nevertheless, multicollinearity is a serious concern when some combinations of variables are simultaneously used.

Finally, the income elasticity of public health expenditure significantly changes depending on the inclusion of other variables, specifications, and econometrics. Moreover, it is worth noting that regional GDP growth would be translated into more health care expenditure in regions enjoying higher tax autonomy, but not in the rest. To understand the results concerning income elasticity, one must take into account that choices on health care in Spain are strongly affected by the fact that the National Health Service puts strong emphasis on the equality of citizens' access and controls the revenues devoted to regional public health care. For that reason, only in regions with high tax autonomy, a positive (although not very strong) relationship between regional income and public expenditure is found.

While regional GDP is not significant once time effects or a time trend is included (columns 8–10), column 7 shows that even excluding then the coefficient is very low (0.17) once serial correlation is corrected. As far as the individual effects are concerned, we have tested whether they are correlated with some observable variables. In particular, we have analyzed simple correlations between fixed effects estimated in column 10 of Table 5, on the one side, and population, surface, and population density, on the other, in order to capture potential economies of scale or extra costs. This procedure is justified by the fact that all of them are invariant or quasi-invariant variables and their inclusion in the main regression as explanatory variables would be troublesome. However, coefficients were under 0.20 in absolute values in all cases, with a very low statistical significance (p-value < 0.40). While additional research should be done on this issue, our hypothesis is that individual fixed effects are reflecting, above all, differences in the amount of resources directly spent (until 2002) or granted by the central government, which are barely grounded on the real cost of provision of health care in each region, but on bilateral bargaining between central and each regional government.

Regarding the consequences for countries who want to decentralize their health care system, it is clear that the relationship between decentralization and interregional inequality is far from evident. A high degree of fiscal

[2] Results hold when only one interaction was included in the econometric specification.

equalization involves decentralization without inequality. On the contrary, if differences among regions in per capita GDP are highly significant and equalization is weak, decentralization does drive to increasing inequalities in per capita regional expenditure and then in public health care services.

Of course, the debate on the consequences of decentralization on the health care expenditure is not limited to the issue of inter-regional inequality. In particular, both richer and poorer regions should be very concerned about the dynamics of revenues devoted to health care. The elasticity of devolved taxes and grants is crucial to avoid a gap between the dynamics of health care expenditure drivers, on the one side, and financial instruments, on the other.

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