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Financing Health Care Expenditure in the OECD Countries: Evidence from a Heterogeneous, Cross-Sectional Dependent Panel

Summary: This paper analyses the relationship between health expenditure and the way it is financed in a panel of 30 OECD countries observed annually from 1990 to 2009. The nonstationarity and cointegration properties between health care spending and its sources of funding, income, and non-income variables are studied. This is performed in a panel data context controlling for both cross section dependence and unobserved heterogeneity. The findings suggest that when health care expenditure is mainly financed by government it becomes independent of an individual's income, controlling for dependency rates for old and young age structure and technological progress.

Key words: Health expenditure, Drivers of health expenditure, Panel unit root tests, Panel cointegration, Cross section dependence model.

JEL: C33, H51, I10.

Despite years of concern and attempts to contain costs, health spending per person in real terms increased on average around 4.0% per year between 1990 and 2009, according to the latest data from the OECD (Organisation for Economic Co-operation and Development - OECD 2011). In almost all countries, public expenditure accounts for the majority of health care spending. It has increased from an average of 12% of total government spending in 1990 to a record of 16% in 2010. OECD has cited technological change, population expectations, and ageing populations as the main drivers of the rise of health care expenditure.

Using annual data on 30 OECD countries from 1990 to 2009, we investigate the non stationarity and cointegration properties between health care spending and a set of regressors including the shares of health care expenditure financed privately and by the government, medication, income *per capita*, and the dependency rates for old and young age structures. We also study the relationship between technological progress and health care expenditure using infant mortality as a proxy for changes in medical care technology. The dynamics of health expenditure and this set of regressors (as well as their relationship) are investigated by estimating a heterogenous pan-

el model with cross-sectional correlated errors. A factor structure is included in the econometric specification with the intent to synthesize the effects of shocks that may hit health spending such as advances in medical care technology, policy shifts, new diseases, and shifts in preferences and expectations of users of health services. The factor structure can capture any contemporaneous correlation that arises from the common response of countries to such unanticipated events.

This paper contributes to the literature on the determinants of health care expenditure in several ways. Firstly, we extend the sample to cover the recent period. Secondly, we account for the way health care expenditure is financed, i.e. by the government or privately, and we examine expenditures on medications. We also account for the fact that health care expenditures are driven not only by income but also by technological progress and by dependency rates of the population. Finally, the empirical methods applied are more comprehensive and recent developments in the field of panel cointegration are taken into account.

The remainder of this paper is organized as follows. Section 1 reviews related literatures. In Section 2, an empirical model specification is presented and the time series properties of the data analysed through several panel data unit root tests. Section 3 provides the empirical results for panel cointegration tests. Section 4 discusses the long-run relationship, and Section 5 concludes.

1. Related Literature

Empirical research on the causes for the increase of health care expenditures indicates that income is one of the most important drivers of health expenditures. Joseph P. Newhouse (1977), Jennifer Roberts (1999), Ulf-G Gerdtham and Mickael Löthgren (2002), Albert A. Okunade and Vasudeva N. R. Murthy (2002), and Donald G. Freeman (2003) have found an income elasticity greater than 1, indicating that health care is a luxury good, while Åke G. Blomqvist and Richard A. L. Carter (1997), and Badi H. Baltagi and Francesco Moscone (2010) have estimated an income elasticity less than 1, interpreting health care as a necessity. The discussion over health being a luxury *versus* a necessity good has important policy implications, because if health is a necessity it should be the object of public intervention and public funding (Anthony J. Culyer 1988; Livio Di-Matteo 2003). This debate receives additional attention with the pressure for the reduction of government budget and for guaranteeing debt sustainability (Roel van Elk, Esther Mot, and Philip H. Franses 2009).

Newhouse (1977) regressed *per capita* medical expenditures on GDP *per capita* for 13 countries for 1970 and found income elasticity for health care spending greater than 1, ranging from 1.15 to 1.31, and concluded that medical care was a luxury good. Gerdtham et al. (1992) used a single cross section of 19 OECD countries in 1987 and reported *per capita* income, urbanization, and the share of public financing to total health expenditure as positive and significant variables with the income elasticity reported at 1.33. Gerdtham et al. (1998) used a pooled time-series cross section analysis for 22 countries over the period 1970-1991 and found the income elasticity of health expenditure to be around 0.8. In a national-level regional study Di-Matteo and Rosanna Di-Matteo (1998) used a pooled time-series cross section approach to

estimate and examine the determinants of Canadian provincial government health spending over the period 1965-1991. Their results show that the estimated income elasticity of real *per capita* provincial government health care expenditures is 0.77, suggesting that over this time period provincial government health expenditures were not a luxury good. More recently, Van Elk, Mot, and Franses (2009) found that income is an important driver of health care expenditures for some European countries. The income elasticity took values of 0.93 and 0.96 for the periods 1970-2003 and 1980-2003, respectively.

The large values obtained for the income elasticity in the macro studies do not find support in the micro evidence. At a micro level, the income elasticity seems to be less than 1 (Gerdtham and Bengt Jönsson 1992; Moscone and Elisa Tosetti 2010). As stated by Thomas E. Getzen (2000), health care is an individual necessity and a national luxury. At the individual level, the existence of health insurance makes the demand for health care independent to a large extent of an individual's income, which means that demand is highly inelastic. At the aggregate level, the situation is different since health care spending depends mainly on the level and composition of government expenditure, which evolves with income (Kamil Dybczak and Bartosz Przywara 2010).

More recently, several empirical studies pointed to the possible non-stationarity properties of health care spending and income data, which in turn cast doubt on earlier inference on income elasticity obtained from spurious regressions (Paul Hansen and Alan King 1996). Todd Jewell et al. (2003), and Josep Lluís Carrion-i-Silvestre (2005) find smaller values for the income elasticity after the introduction of a time trend. Recent literature investigates the non-stationarity in health expenditure and income and their long-run relationship in a panel data framework (Roberts 1999; Gerdtham and Löthgren 2002; Freeman 2003; Jewell et al. 2003; Okunade, Mustafa C. Karakus, and Charles Okeke 2004; Carrion-i-Silvestre 2005; Christian Dreger and Hans-Eggert Reimers 2005; Baltagi and Moscone 2010; Moscone and Tosetti 2010).

Besides income variables, a number of non-income determinants of health care spending have been identified in the literature as important factors in explaining variations of health care expenditure across countries. Evidence indicates that when government expenditure on health, the age structure of the population, and technological progress have been included, the income elasticity is found to be less than 1 (Van Elk, Mot, and Franses 2009).

Technological progress has been proxied by several variables such as time trend, life expectancy, infant mortality, the surgical procedures (Thomas P. Weil 1995), the amount of specific medical equipment (Laurence C. Baker and Susan K. Wheeler 2000), or the number of tomographic scanners (Terkel Christiansen et al. 2006). Newhouse (1992) found that technology accounted for as much as 75% of the increase in health care expenditure. A common finding in these studies is that the trend is positive (Joan O'Connell 1996; Ruolz Ariste and Jeff Carr 2003; Freeman 2003), an outcome that is seen as an indicator of the cost-increasing effect of technology (Dreger and Reimers 2005; Van Elk, Mot, and Franses 2009). Gerdtham et al. (1998) included the number of renal dialyses per million of the population as a proxy for technology and found a positive and significant effect for this variable. Generally,

when including a proxy for technological progress, the income elasticities are found to be less than 1. However, Roberts (1999), and Okunade and Murthy (2002) found income elasticity greater than 1.

The share of the young population (usually, population under 15 years old, or even under 5) and the share of the elderly (above 65) or very old population (above 75) have been used to characterize the dependency rates of the populations. The indicator that has been receiving attention is ageing, but the estimated coefficient has been weak (Michael Grossman 1972; Robert E. Leu 1986; Pierre Moise and Stéphane Jacobzone 1986; Jeff Richardson and Iain Robertson 1986; Culyer 1988, 1990; Gerdtham et al. 1992; Theo Hitiris and John Posnett 1992; Di-Matteo and Di-Matteo 1998; Gerdtham et al. 1998; Peter Zweifel, Stefan Felder, and Markus Meiers 1999; Gerdtham and Jönsson 2000; Jönsson and Ingemar Eckerlund 2003). However, more recent studies have found a significant and positive effect of ageing on health care expenditures (Murthy and Victor Ukpolo 1994; O'Connell 1996; Okunade, Mustafa, and Okeke 2004; Dreger and Reimers 2005; Christiansen et al. 2006). This finding is based on the tendency for health expenditures *per capita* to increase with age (Joaquim Oliveira Martins and Christine de la Maisonneuve 2006; Kosta Josifidis et al. 2011).

Institutional factors are also pointed to as drivers of health expenditure (Gerdtham et al. 1992; Murthy and Ukpolo 1994; O'Connell 1996; Gerdtham et al. 1998; Roberts 1999; Okunade, Mustafa, and Okeke 2004). Conversely, Pedro P. Barros (1998) finds no significant results between institutional factors and health expenditure. Institutional factors are sometimes proxied by the share of public financing in health care (Van Elk, Mot, and Franses 2009). This variable, jointly with the extent to which health care expenditure is privately financed, has been considered in estimations of health care expenditures (Jesús Clemente, Carmen Marcuello, and Antonio Montañés 2008). The extent to which health care expenditure is financed by the government leads political factors to play an important role in explaining health care expenditures (Nicole Attia and Valérie Bérenger 2007, 2009; Niklas Potrafke 2010; Josifidis et al. 2011). Leu (1986), Culyer (1988), and Theo Hitiris and John Posnett (1992) claim that it has a positive effect on health care spending, while Okunade, Mustafa, and Okeke (2004), and Moscone and Tosetti (2010) find a negative effect on health expenditure.

Private health care financing has been analysed through health insurance variables. Cameron et al. (1988) found a strong and positive impact of different health insurance coverage on the demand for health services. Many forms of private expenditure on longevity are determined positively and negatively by public expenditure decisions (Scherer and Devaux 2010), and as a consequence, it is necessary to analyse private and public components of expenditure separately. A special form of health expenditures is pharmaceutical expenditures, which have been identified as an important determinant of health care outcomes (Pierre-Yves Crémieux et al. 2005a, b; Emmaneul G. Guindon and Paul Contoyannis 2008).

From microeconomic theory, the relative price of health has been identified as another driver of health care expenditure. According to William J. Baumol (1967), the health sector has lower productivity than other sectors, which keeps relative prices of health higher. Jochen Hartwig (2008), Marc Pomp and Sunčica Vujić (2008),

and Van Elk, Mot, and Franses (2009) report a positive effect for the so-called Baumol effect, i.e. an increase in price decreases volume and increases in real health care expenditure in the long run. However, Gerdtham et al. (1992) find a not significant effect for the relative price of health.

Reactions to external events as well as spatial spillovers are expected to induce a structure of correlation in health expenditure data. When data contain cross-section dependence, conventional estimators such as ordinary least squares (OLS) are inefficient and the estimated standard errors are biased (Donald W. K. Andrews 2005). Jewell et al. (2003) introduce time-specific effects in the econometric specification to control for contemporaneous correlation. Nevertheless, the inclusion of time-specific effects implies that the common shocks have identical influences on each unit, an assumption that might be quite restrictive in empirical analysis. Other studies build the empirical distribution of unit root test statistics by bootstrap techniques (Freeman 2003; Carrion-i-Silvestre 2005). However, the bootstrap procedure is subject to size distortions in finite samples, especially in cases where N is small relative to T, as in the study of health expenditure in the OECD countries (Gangadharrao S. Maddala and Shaowen Wu 1999; Vanessa L. Smith et al. 2007). Few works on health expenditure explicitly account for cross-section dependence when studying its long-run economic relationships (Baltagi and Moscone 2010; Moscone and Tosetti 2010).

In this paper we consider that health expenditures *per capita* are explained by different sources of health expenditure funding: public, private and expenditures on medicines, income *per capita*, and the dependency rates of the population and technological progress. We also consider the effects of shocks that may hit health spending, such as advances in medical care technology, policy shifts, new diseases, and shifts in preferences and expectations of users of health services. With this intent we follow closely Mohammad H. Pesaran (2004, 2006), including a factor structure in the econometric specification. The factor structure can capture any contemporaneous correlation that arises from the common response of countries to such unanticipated events. Recent literature has recognized that cross section dependence is an important characteristic of health data, and has tried to incorporate it (Freeman 2003; Jewell et al. 2003; Carrion-i-Silvestre 2005; Baltagi and Moscone 2010; Moscone and Tosetti 2010). According to Moscone and Tosetti (2010) when the existence of global and local forms of cross-section dependence in health spending and income is not taken into account in the study of health expenditure, it is likely to provide policy makers with misleading results.

2. Model Specification and Time Series Analysis

The empirical model that motivates our research of the determinants of health expenditures is the following linear heterogeneous panel framework:

$$H_{it} = \beta_i' X_{it} + u_{it} \tag{1}$$

where $\begin{cases} i = 1, 2, \ldots, 30 \text{ denotes countries;} \\ t = 1, \ldots, 20 \text{ denotes periods (years).} \end{cases}$

In Equation (1), H_{it}, real *per capita* health care expenditure in the ith country at time t, health care expenditure is estimated against the way it is financed, i.e. by government (H^{PU}), privately (H^{PR}), and expenditures in medications (H^{PH}). These expenditures were computed over total health care expenditure. The set of regressors also includes income *per capita* (Y), and the dependency rates for old (DR^{65}) and young (DR^{15}) age structure. We also study the relationship between technological progress and health care expenditure using infant mortality (IM) as a proxy for changes in medical care technology. All variables are expressed in natural logarithms and description of all data and data sources is provided in Appendix.

The three-way error component term of Equation (1) is given by:

$$u_{it} = \lambda_t + \eta_i + \gamma_i' C_t + \varepsilon_{it} \tag{2}$$

where λ_t accounts for time-specific effects and η_i accounts for unobservable country-specific effects. The term ε_{it} is the random disturbance in the regression, varying across time and country cells. We may also have a third error component, C_t, that accounts for unobserved common effects. From Equation (2), correlation arises because the responses to common external forces or perturbations are similar, though not identical, across countries. Notice that common factors induce a correlation between pairs of statistical units that does not depend on how close they are in the geographical space. In Model (1), we allow X_{it} to be correlated with the unobserved effects, C_t. Therefore, common factors can impact health expenditure not only directly via the factor structure (2), but also indirectly by affecting the regressors. We estimate the parameters β_i in Model (1) applying the Common Correlated Effects (CCE) method developed by Pesaran (2006):

$$H_{it} = \lambda_t + \eta_i + \beta_i' X_{it} + \pi_i' \overline{\omega}_t + v_{it} \tag{3}$$

where $\overline{\omega}_t = (\overline{H}_t, \overline{X}_t')$, with $\overline{H}_t$ being the cross section average of the dependent variable and $\overline{X}_t'$ the cross section average of the regressors. Here, heterogeneity is captured by the individual specific fixed effects, η_i, the time dummies, λ_t, and the loadings, π_i. In our analysis we will compute the CCE-Pesaran Pooled Estimator (CCE-PPE) for the average of the coefficients (Pesaran 2006). Performing Monte Carlo experiments, Pesaran and Tosetti (2009) showed that this estimator has good small sample properties when the errors follow either a pure factor structure, a pure spatial process, or a linear combination of them.

2.1 Time Series Properties of the Data

We use annual data on 30 OECD countries from 1990 to 2009 gathered from the OECD Health Dataset. To measure health expenditures *per capita* and income *per capita*, we used *per capita* total health care expenditure and *per capita* income estimated in GDP purchasing power parity, and expressed in US Dollars. We used the

population aged over 65 years old and under 15 years old to proxy the dependency rates of the population. Infant mortality rate is used to measure technological progress. The different sources of health expenditure funding: public, private, and expenditures on medication are computed as government expenditure over total health care expenditure; out of pocket expenditure on health over total health care expenditure; and expenses on medication over total health care expenditure, respectively.

Since the appropriateness of the cointegration analysis depends on all series being integrated of order one, the time series properties of the data must be ascertained before any estimation is carried out. There are several statistics that may be used to test for a unit root in panel data, but since our panel data set is not too long, we use the Kyung So Im, Pesaran, and Yongcheol Shin (2003) test (IPS). In contrast to the Andrew Levin, Chien-Fu Lin, and Chia-Shang J. Chu (2002) test, the IPS's *t*-bar statistic is based on the mean Augmented Dickey-Fuller (ADF) test statistics and is calculated independently for each cross section of the panel. Based on Monte Carlo experiment results, IPS demonstrate that their test has more favorable finite sample properties than the LL test.

Table 1 reports the test results based on the inclusion of an intercept and trend. In every case the null that every variable contains a unit root for the series in logs is not rejected. Although not shown here, unit root tests on the first differences suggest that all variables are stationary in first differences.

Table 1 Panel Unit Root Tests

Series in log-levels	H	Y	DR^{65}	DR^{15}	IM	H^{PH}	H^{PR}	H^{PU}
IPS test	-2.22	-2.30	-1.06	-1.70	-1.96	-1.78	-2.27	-1.83

Notes: The null hypothesis is that the series is a unit root process. An intercept and trend are included in the test equation. The lag length was selected by using the Akaike Information Criteria. The critical values are taken from Im, Pesaran, and Shin (2003). * Rejects the null at the 10% level (CV≈−2:39); ** rejects the null at the 5% level (CV≈−2:46); *** rejects the null at the 1% level (CV≈−2:58).

Source: Authors.

The panel unit root tests applied previously do not account for cross-sectional dependence of the contemporaneous error terms. It has been shown in the literature that failing to consider cross-sectional dependence may cause substantial size distortions (see, for example, Anindya Banerjee 1999; Pesaran 2007). To avoid this mis-performance of the unit root tests we proceed with our panel unit root analysis relaxing the assumption of cross-sectional independence, the test proposed by Pesaran (2007). The Cross-Sectional Augmented IPS Panel Unit Root Test (CIPS) proposed by Pesaran (2007) is a panel fixed effects test allowing for parameter heterogeneity and serial correlation between the cross sections, correcting their dependency.

The CIPS test has been designed for testing the unit root hypothesis when the variable under study has a factor structure. The critical values for the CIPS tests are given in Tables 2 in Pesaran (2007).

Table 2   Pesaran (2007), Cross-Sectional Augmented IPS (CIPS) Test

Series in log-levels lag	p=0	p=1	p=2	p=3
H	-2.237	-2.499	-2.468	-2.183
Y	-1.929	-2.197	-1.701	-1.920
DR^{65}	-1.678	-1.721	-1.501	-1.424
DR^{15}	-1.349	-1.260	-1.319	-1.314
IM	-2.722	-1.905	-1.761	-1.578
H^{PH}	-2.258	-2.588	-2.130	-1.677
H^{PR}	-2.163	-2.127	-2.003	-2.010
H^{PU}	-2.155	-2.331	-1.962	-2.009

Notes: The null hypothesis is that the series is a unit root process. Critical values for the CIPS test with an intercept and trend are: CV$\approx$–2:89 (10%), CV$\approx$–2:68 (5%), and CV$\approx$–2:84 (1%) (see Pesaran 2007). * Rejects the null at the 10% level; ** rejects the null at the 5% level; *** rejects the null at the 1% level.

Source: Authors.

In Table 2 we report the results for the Pesaran Cross-Sectional Augmented IPS test. The model used to test the unit root hypothesis is the one with intercept and trend. Because our data are annual we test until three lag lengths. The unit root test hypothesis is not rejected at the conventional level of significance for the three variables considering a lag length of 2 or 3. These results indicate that variables under analysis are integrated of order 1.

3. Cointegration Analysis

In this section we report our cointegration analysis results based on the Peter Pedroni (1999, 2001, 2004) cointegration test. Two classes of statistics are considered in the context of the Pedroni test. The first type is based on pooling the residuals of the regression along the within-dimension of the panel, whereas the second type is based on pooling the residuals of the regression along the between-dimension of the panel. For the first type, the test statistics are the panel v-statistic, the panel ρ-statistic, the panel PP-statistic, and the panel ADF-statistic. These statistics are constructed by taking the ratio of the sum of the numerators and the sum of the denominators of the analogous conventional time-series statistics across the individual members of the panel. The tests for the second type include the group ρ-statistic, the group PP-statistic, and the group ADF-statistic. They are simply the group mean statistics of the conventional individual time-series statistics. All statistics have been standardized by the means and variances so that they are asymptotically distributed N(0,1) under the null hypothesis of no cointegration. As one-sided tests, large positive values of the panel v-statistic reject the null hypothesis of no cointegration. For the remaining statistics (the panel ρ, the panel PP, the panel ADF, the group ρ, the group PP, and the group ADF tests), large negative values reject this null hypothesis. See Pedroni (2004) for a detailed discussion.

The panel cointegration test proposed by Pedroni (2004) is reported in Table 3. Pedroni (1999) showed that the panel-ADF and group-ADF statistics have better small sample properties than the other statistics, and are more reliable as a result. Table 3 shows that the panel-ADF and group-ADF statistics significantly reject the null hypothesis of no cointegration as given by Equation (1).

Table 3   Pedroni (2004), Panel Cointegration Tests

Test the following relation: $H_{it} = \alpha_i + \beta_i' X_{it} + u_{it}$[a]

Test statistics[b]

Panel ν-stat	1.127
Panel ρ-stat	4.299
Panel PP-stat	-7.539***
Panel ADF-stat	-7.678***
Group ρ-stat	5.469
Group PP-stat	-11.265***
Group ADF-stat	-11.603***

Notes: [a] Where, X_{it} contains Y_{it}, DR_{it}^{65}, DR_{it}^{15}, IM_{it}, H_{it}^{PH}, H_{it}^{PR}, and H_{it}^{PU}. We report only the intercept and the trend case. [b] The tests statistics are distributed as (0,1) under the null of no cointegration. The statistics are constructed using small sample adjustment factors from Pedroni (1999, 2004). * Rejects the null at the 10% level; ** rejects the null at the 5% level; *** rejects the null at the 1% level.

Source: Authors.

The cointegration test applied previously does not account for cross sectional dependence of the contemporaneous error terms. Now, the cross section augmented regression is given by Equation (3) and to estimate parameters Sean Holly, Pesaran, and Takashi Yamagata (2010) use the pooled CCE estimator in Pesaran (2006).

We have computed the CCE test statistics proposed by Banerjee and Carrion-i-Silvestre (2011) using up to three lags for the autoregressive correction in (13). The computation of the cross section augmented ADF cointegration (CADFC) statistic gives $CADFC = -2{:}56$ when $p = 0$, $CADFC = -2{:}98$ when $p = 1$, $CADFC = -2{:}93$ when $p = 2$ and $CADFC = -3{:}29$ when $p = 3$, p being the order of the autoregressive correction that is used. When we compare the values of the CADFC statistic with the critical values given in Table 4 of Banerjee and Carrion-i-Silvestre (2011) for $N = 30$ and $T = 20$, we conclude that except for $p = 0$ and $p = 2$, the null hypothesis of no cointegration is rejected at the 5% level of significance. We also conclude that except for $p = 0$ the null hypothesis is rejected at the 10% level of significance.

4. Estimation of the Long-Run Equilibrium

Our final step is the estimation of the long-run relationships between real *per capita* health expenditure and health expenses financed by government, privately, and spent on medications, income, age structure of the population, and technology. Conversely, the error correction model (ECM) is suited to estimate the speed at which the dependent variable returns to equilibrium after a change in one of the regressors and it too is used to determine bidirectional causality between the variables in the model, and we believe that this causality has been well determined in earlier literature that has been investigating health-income elasticity (Nancy J. Devlin and Paul Hansen 2001; Paul Frijters, John P. Haisken-DeNew, and Michael A. Shields 2005; Erkan Erdil and Ibrahim Hakan Yetkiner 2009). Thus, in order to estimate the long-run relationship, we had to choose the econometric technique best suited to our panel data characteristics. We begin performing the general diagnostic tests for cross section dependence in panels suggested by Pesaran (2004). The hypothesis that there is no cross sectional

dependence is rejected. Therefore, we proceed to estimate our panel data model subject to cross section dependence, as suggested by Pesaran (2006).

When the cointegration relationship does not account for cross sectional dependence of the contemporaneous error terms, it has been shown in the literature that failing to consider cross sectional dependence may cause substantial size distortions (see, for example, O'Connell 1998; Pesaran 2007). We performed the general diagnostic tests for cross section dependence in panels suggested by Pesaran (2004) as shown in Table 4. The hypothesis that there is no cross sectional dependence is rejected. Therefore, we proceed to estimate our panel data model subject to error cross section dependence, as suggested by Pesaran (2006). The Pesaran's (2006) Monte Carlo simulations show that common correlated effects - Pesaran (2006) pooled estimator (CCE-PPE) has satisfactory small sample properties. Pesaran's (2006) Monte Carlo simulations also showed that the mean group estimators (CCE-PMG) have satisfactory properties when N and T are relatively large.

Table 4 shows that when removing the cross dependency, real *per capita* health care expenditure clearly increases with health care expenditure financed by government. Health care expenditure also increases with income *per capita*, with the elderly and young dependents on the society, with the advances in technology, and with health care expenditure financed privately and with medication expenses. Culyer (1988) suggests that the luxury good view of health care may be based on a misspecification of the determinants of health, with the possibility of omitted variables as a cause of the misspecification. Our pooled results show that when government expenditure on health, the age structure of the population, and technological progress have been included in the estimation, the ability to pay becomes a less important determinant of health expenditure.

Table 4 CCE-PPE Panel Estimates of the Cointegration Relationship: $H_{it} = \beta_i' X_{it} + u_{it}$

	Y_{it}	DR_{it}^{15}	DR_{it}^{65}	IM_{it}	H_{it}^{PH}	H_{it}^{PR}	H_{it}^{PU}
Fixed effects estimates	0.057	0.174	0.082	0.005	0.044*	0.095***	0.668***
t-stat in brackets	(0.963)	(1.488)	(0.586)	(0.219)	(1.746)	(4.506)	(13.604)
CD test statistic[a]	5.408						
Pesaran's (2006) CCE pooled estimates[b]	0.066	0.284**	0.227*	0.029	0.056**	0.090***	0.651***
t-stat in brackets	(1.148)	(2.426)	(1.596)	(1.003)	(2.532)	(3.948)	(12.833)

Notes: [a] Pesaran's (2004) General Diagnostic Tests for Cross Section Dependence (residuals). [b] CCE Pooled Estimator is defined by Equation (65) and t-stat is the associated t-ratio of the standard error based on Newey-West type variance estimator of Equation (74) in Pesaran (2006). * Rejects the null at the 10% level; ** rejects the null at the 5% level; *** rejects the null at the 1% level.

Source: Authors.

Health care expenditure financed by government explains around 65% of the increase in health expenses, the out of pocket health care expenses explain 9%, and the expenses on pharmaceutical goods explains 5.6% of the variations in the real *per capita* health care expenditure. Similar to Leu (1986), Culyer (1988), and Hitiris and Posnett (1992), we claim that the extent to which health care expenditure is financed by the government has a positive effect on health care spending. We also claim that the importance of the income variable fades away at the expense of the health care

expenditure financed by the government, privately, and expenditures on medications. In a comparable study developed for the United States, Moscone and Tosetti (2010) achieved a similar result when controlling for other non-income determinants of health expenditure. They concluded that while the ability to pay is a determinant of health care spending, the existence of publicly financed programs weakens the link between income and the standard of care. Our results corroborate this argument, as the estimated coefficient of the income variable is not statistically significant. Thus, public intervention, public funding, and health insurance make the demand for health care independent of an individual's income. Technology progress is found to be not statistically significant in explaining health expenses. As did Gerdtham et al. (1998), we found a positive effect of youth dependency rate on health care expenditures. In our sample youth dependency rate explains around 28%, while the old-dependency explains around 23% of the increase in health expenses. This result supports the argument of the tendency for health expenditures *per capita* to increase with age (Oliveira Martins and De la Maisonneuve 2006; Josifidis et al. 2011).

Table 5 has the estimation results for each individual country. Regarding individual country estimators, we find that the estimation results for the determinants of health expenditure in the OECD vary considerably across countries, which validates the microeconometric methodology followed in this article. By including a factor structure in the econometric specification to consider advances in medical care technology, policy shifts, new diseases, and shifts in preferences and expectations by users of health services, it allows for these external effects to have different influences on each country. Similar to the pooled estimate, health care expenditure financed by government explains around 65% of the variations in the real *per capita* health care expenditure in Austria, Greece and New Zealand. With respect to private health care expenses, we have Australia, Austria, Czech Republic, Netherlands, New Zealand, and United Kingdom with an estimated coefficient around 9% similar to the pooled estimate. As with the pooled estimates, expenses on pharmaceutical goods explain around 6% of the variations in the real *per capita* health care expenditure in Australia, France, Hungary, Iceland, Slovak Republic, Spain, Switzerland, and United States. Conversely to the pooled estimates, we have significant and positive estimators for technology progress in Austria, Czech Republic, France, Iceland, Mexico, and Poland. The elderly dependency rate is both positive and significant in Belgium, Hungary, Mexico, Poland and Slovak Republic. In our sample, youth dependency rate is positive and significant in European countries: Austria, Finland, Hungary, Luxembourg, Slovak Republic, Switzerland, Turkey, and United Kingdom.

Table 5   CCE-PPE Individual Estimates of the Cointegration Relationship: $H_{it} = \beta_i' X_{it} + u_{it}$
CCE Estimator for each Country[a]

	Y_{it}	Dr_{it}^{15}	DR_{it}^{65}	IM_{it}	H_{it}^{PH}	H_{it}^{PR}	H_{it}^{PU}
Australia	0.29***	0.136	-0.008	0.019	0.109***	0.079***	0.189***
	(2.64)	(0.54)	(-0.07)	(1.06)	(4.54)	(2.93)	(2.91)
Austria	0.103	0.687***	0.114	0.047***	-0.006	0.098**	0.676***
	(1.07)	(5.59)	(0.86)	(3.92)	(-0.19)	(2.18)	(10.73)
Belgium	0.154	-1.755**	2.634***	0.081	-0.111	0.435***	-0.100
	(0.41)	(-2.19)	(3.81)	(1.25)	(-0.75)	(3.57)	(-1.30)
Canada	-0.125***	-0.007	-0.426***	-0.062***	-0.015	0.19***	0.806***
	(-3.68)	(-0.06)	(-2.58)	(-3.10)	(-0.23)	(7.31)	(20.15)

Czech Republic	0.27***	-1.342***	-0.69*	0.091***	-0.094*	0.076***	0.941***
	(4.36)	(-3.48)	(-1.73)	(2.76)	(-1.65)	(3.62)	(22.95)
Denmark	0.061	-0.397**	-0.81***	-0.01	-0.093***	0.231***	1.052***
	(0.60)	(-2.32)	(-3.05)	(-0.44)	(-3.72)	(6.24)	(5.13)
Finland	0.033	0.607*	-0.332*	-0.025	-0.048	0.198***	0.819***
	(1.22)	(1.75)	(-1.71)	(-1.32)	(-0.65)	(2.79)	(16.71)
France	0.000	0.412***	-0.08	0.026**	0.04*	0.047***	0.811***
	(0.00)	(4.63)	(-1.04)	(2.00)	(1.82)	(3.62)	(45.06)
Germany	0.115	-0.969	-0.556	0.021	-0.092	-0.072	0.385**
	(0.73)	(-1.25)	(-0.69)	(0.15)	(-1.17)	(-0.73)	(2.29)
Greece	0.046	0.151	-1.584***	-0.009	0.14***	0.26***	0.603***
	(0.56)	(1.58)	(-6.47)	(-0.69)	(6.67)	(23.64)	(15.87)
Hungary	-0.105	5.103***	5.094***	-0.18***	0.118***	0.368***	1.029***
	(-0.81)	(7.48)	(3.70)	(-3.67)	(4.72)	(10.51)	(14.49)
Iceland	0.043	-0.015	0.061	0.015***	0.041***	0.157***	0.777***
	(1.54)	(-0.13)	(0.73)	(2.50)	(4.10)	(39.25)	(40.89)
Ireland	-0.36***	-0.466*	0.063	-0.042	0.143**	-0.046	0.866***
	(-3.50)	(-1.69)	(0.24)	(-1.27)	(2.01)	(-1.15)	(7.53)
Italy	0.106	0.129	-0.099	-0.013	0.009	0.208***	0.732***
	(1.26)	(0.92)	(-0.51)	(-0.43)	(0.22)	(3.92)	(13.56)
Japan	0.397***	-0.848*	0.603	-0.146**	-0.006	-0.033	0.295***
	(3.48)	(-1.70)	(1.21)	(-2.09)	(-0.13)	(-0.61)	(2.73)
Korea	0.071	-0.065	-0.143	-0.137*	-0.174	0.747***	0.463***
	(1.01)	(-0.18)	(-0.42)	(-1.85)	(-1.18)	(5.49)	(8.74)
Luxembourg	-1.321**	4.313***	2.993	-0.076	-0.194	-0.108	1.103***
	(-2.15)	(2.92)	(0.80)	(-0.62)	(-0.63)	(-1.05)	(3.09)
Mexico	0.028***	0.027	0.054**	0.023***	-0.007***	0.547***	0.435***
	(3.50)	(0.63)	(2.57)	(3.83)	(-3.50)	(54.70)	(87.00)
Netherlands	-0.561**	-2.181***	-0.785	-0.079	0.053	0.097***	0.145
	(-2.41)	(-2.96)	(-0.87)	(-0.75)	(0.22)	(3.35)	(0.87)
New Zealand	-0.022	0.066	-0.073	-0.039*	0.173***	0.09**	0.669***
	(-0.39)	(0.61)	(-0.66)	(-1.86)	(5.41)	(1.96)	(13.12)
Norway	-0.055***	-0.866***	-1.281***	0.04*	0.01	0.165***	0.892***
	(-5.00)	(-4.35)	(-5.14)	(1.91)	(0.53)	(5.89)	(15.93)
Poland	0.608***	-2.426***	1.316**	-0.093	0.178	0.213***	0.93***
	(4.90)	(-3.33)	(2.31)	(-1.12)	(0.98)	(11.21)	(5.78)
Portugal	-0.004	0.531	0.593	-0.066	0.621***	0.002	0.357***
	(-0.02)	(1.12)	(0.98)	(-0.47)	(5.05)	(0.14)	(3.16)
Slovak Republic	0.238***	1.722***	0.716***	-0.079**	0.058***	0.215***	0.814***
	(2.74)	(2.90)	(4.12)	(-2.08)	(6.45)	(13.44)	(14.03)
Spain	-0.166**	-0.452***	-0.325**	0.122	0.102*	-0.002	0.732***
	(-2.34)	(-6.46)	(-2.52)	(1.42)	(1.89)	(-0.50)	(8.61)
Sweden	0.007	1.677***	0.045	-0.003	-0.034	-0.558*	0.941***
	(0.06)	(2.34)	(0.12)	(-0.12)	(-0.35)	(-1.83)	(6.23)
Switzerland	0.153***	-0.452**	-1.349***	-0.003	0.118*	0.24***	0.713***
	(3.12)	(-1.97)	(-2.47)	(-0.16)	(1.67)	(3.75)	(19.81)
Turkey	-0.267	5.698***	-0.061	-0.206***	0.29***	0.364***	1.182***
	(-1.32)	(2.80)	(-0.11)	(-3.49)	(5.58)	(4.18)	(18.76)
United Kingdom	0.358***	0.401***	0.272	0.01	-0.11***	0.106***	0.922***
	(3.85)	(2.57)	(1.28)	(0.25)	(-3.44)	(2.65)	(12.46)
United States	0.096***	-0.091	0.093	-0.074	0.134***	0.408***	0.764***
	(3.84)	(-0.25)	(0.35)	(-0.90)	(3.35)	(8.00)	(12.32)

Notes: A CCE Estimator for a Country is defined by Equation (26) and the corresponding t-stat associated to the standard error based on Newey-West type variance estimator of Equation (50) in Pesaran (2006) (t-stat in brackets). * Rejects the null at the 10% level; ** rejects the null at the 5% level; *** rejects the null at the 1% level.

Source: Author.

The income elasticity is found to be significant and considerably smaller than the one in Australia, Czech Republic, Japan, Mexico, Slovak Republic, Switzerland, United Kingdom, and United States. Furthermore, in Canada, Ireland, Luxembourg, Netherlands, Norway, and Spain, health care appears as an inferior good, since the public funding as well as health insurance make demand for health care inversely related to an individual's income.

5. Conclusion

This paper analyzes the long-run economic relationship between health care expenditure and a set of determinants of health expenditure in the OECD countries. Using a panel of 30 OECD countries over the period from 1990 to 2009, we have studied the non-stationarity and cointegration properties of health care spending and its sources of funding, income, and non-income variables. Our analysis indicates that health care expenditure, the different sources of health expenditure funding computed over total health care expenditure: public, private, and expenditures on medicines, income *per capita*, the dependency rates of the population, and technological progress are non-stationary, and that they are linked in the long run. Our empirical study finds that to a large extent health care spending is independent of an individual's income. We also detect a significant cross-country dependence, which justifies the inclusion of factor structure that synthesizes the effects of shocks that may hit health spending, such as advances in medical care technology, policy shifts, new diseases, and shifts in preferences and expectations by users of health services.

Our results show that when health care expenditure is mainly financed by government it weakens the estimated coefficient for the income variable, controlling for dependency rates for old and young age structure and technological progress. The weight of the income therefore dilutes when controlling for the way health care expenses are financed, as well as other non-income determinants of health expenditure. As for non-income determinants, the percentage of young and elderly people reveals a significant and positive impact on health care expenditures. Health care spending increases with both youth and, the elderly. The policy implications of these results are of great importance since health care expenditures in industrial countries have been growing rapidly over the past years. This rapid growth jeopardizes the sustainability of public budgets and causes an increasing interest in the determinants of health care expenditures.

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Appendix

Data

Our empirical work uses annual data on 30 OECD countries from 1989 to 2009 ($T = 20$), gathered from the OECD Data Set. We collected information on *per capita* total health care expenditure and *per capita* income estimated in GDP purchasing power parity, and expressed in US dollars. We also gathered data for the following variables that have been identified by the literature as having a role in determining health care expenditure taken from OECD Health Database: the dependency rates for old and young people, defined as the population aged over 65 and under 15, respectively; the infant mortality rate; the public expenditure on health care computed as government expenditure over total health care expenditure; private expenditure computed as out of pocket expenditure on health over total health care expenditure; and the pharmaceutical expenditure computed as expenses on medicines over total health care expenditure.

Data Sources

From the OECD Database, it was obtained for the period 1990-2009:

H: Total health expenditure *per capita*, US dollars, purchasing power parity (PPP).

Y: GDP *per capita*, US dollars, current prices and purchasing power parity (PPP).

DR^{65}: Dependency rate as the ratio of population aged 65 and over as percentage of total population.

DR^{15}: Dependency rate as the ratio of population aged less than 15 as a percentage of total population.

IM: Infant mortality: deaths per 1000 live births.

H^{PH}: Pharmaceutical expenditure computed as expenditure on medicines over total health care expenditure.

H^{PR}: Private health expenditure computed as out of pocket expenditure over total health care expenditure.

H^{PU}: Public health expenditure computed as government expenditure over total health care expenditure.