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Are Health Expenditure and GDP Cointegrated: A Panel Analysis

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Abstract: This paper presents and analyzes long run relation between per capita health expenditure (PHE) and per capita gross domestic product (PGDP) over the period from 1970-2007 for a sample of 18 OECD countries using recent developed panel co-integration techniques. Firstly we test whether health expenditure and GDP series are stationary by using first generation, second generation test and panel unit root test based on structural break (PANKPSS) advanced by Carrion-I Silvestre et al.(2005) as a final point. After investigated to presence of long-run relation between health expenditure and GDP, finally we examine whether health care expenditures are a luxury good.

Key words: health care expenditures; cross-section dependency; panel co-integration
JEL Codes: C23, H51, H41, I18

1. Introduction

For policymakers, it is important to know the long run relationship between gross domestic product and health expenditures. Because, knowing this relationship enables them to make judgment on how much aggregate health expenditures will change in the future, based on a forecast of the trend in national income. Thus, we examine the long run relation among per capita gross domestic product (PGDP), per capita health expenditures (PHE) in 18 OECD countries during the 1970-2007 periods, using the recent panel co-integration techniques. Also we examine income elasticity for health expenditures in 18 OECD countries selected (Australia, Austria, Belgium, Canada, Denmark, Finland, Germany, Iceland, Ireland, Japan, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States, Portugal, Spain).

After the publication of the papers in Kleiman (1974) and Newhouse (1977), the examination of the determinants of health expenditures have begun debates based on whether health expenditures are a luxury good (Carrion-i Silvestre, 2005). Most cross-country studies find per capita income to be the most important determinant of per capita health expenditure. Thus we use data set of per capita health expenditures and per capita GDP. The coefficient estimate of per capita income is equal to or greater than one, leading to the conclusion that PHE is a luxury rather than a necessity. Otherwise, it is equal to be less than unity, or closer to being a necessity rather than a luxury.

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Gerdtham et al.(1992) estimate the impact of per capita income on per capita health expenditure by using data from 10 OECD countries for 1974, 1980, 1987. The results of this study indicate to health expenditures are a necessity good rather than luxury good. That is an income elasticity is exceeding one. Blomqvist and Carter (1997) present an income elasticity, which doesn't seem significantly different from one. But it is important to control whether health care expenditures and GDP are stationary. If they are not stationary, statistical evidence based on OLS regressions turns out to be spurious. In this case, estimated coefficients would be biased and inconsistent. For example, Hansen and King (1996) and Blomqvist and Carter (1997) were not able to find cointegration between health care expenditures and GDP except for a few countries. Most research suggests that both PHE and PGDP are non-stationary. Recently, researchers have begun to favor panel based unit root tests due to the increase in power of test. This increase in power stems from greater degrees of freedom and inclusion of heterogeneous cross-country information.

Mc Coskey and Selden (1998) used the panel unit root test of Im et al.(2003) as a first generation test and find that both PHE and PGDP are stationary. Gerdtham and Löthgren (2000) find that PHE and PGDP are non-stationary when they do inclusion of a time trend to Mc Coskey and Selden's study. They also presented evidence in favour of co-integration. Okunade and Karakus (2001) found income elasticity larger than unit. Sen(2005)'s research suggests a range of 0.21 and 0.51, implying health care is necessity.

Jewell et al. (2003) used a panel LM unit root test that allows for the possibility of structural breaks in order to determine stationarity of PHE and PGDP. Their results approve that PHE and PGDP are stationary around one or two breaks.

Carrion-i Silvestre (2005) applied the stationarity test of Carrion-i Silvestre et al. for 20 OECD countries during 1960-1997 and used the database that has been used in the paper is the one in Gerdtham and Lothgren (2000) and Jewell et al. (2003) and has shown that the panel data sets of PHE and GDP are stationary around a broken trend that exhibits multiple structural breaks.

The paper is organized as follows: Section 2 describes panel unit root, stationarity and cointegration tests used in this paper. Section 3 presents and discusses the findings of this study and last section concludes this study.

2. Model and data

The model is following as:

$$PHE_{it} = \beta_0 + \beta_1 PGDP_{it} + u_{it} \tag{1}$$

The dependent variable is real per capita health care expenditure (P*HE*) in each of the countries. Prior works also established the meaningful determinant to include: real per capita gross domestic product (P*GDP*). So we used PGDP as the independent variable. The a priori expectation from received theory is:

$$\partial PHE / \partial PGDP > 0 .$$

The database is used 1970-2007 periods for a sample of 18 OECD countries (Some countries were excluded for lack of data). Health expenditure data were obtained from OECD 2009 health database, real per capita GDP data were obtained from Penn World Table 4.3. All the model variables are in logs for regression analysis.

The panel unit root test based on structural break (PANKPSS) advanced by Carrion-i Silvestre et al.(2005) as well as first generation panel unit root tests, second generation test were employed. After investigated to presence of long-run relation between health expenditure and PGDP, finally we examine whether health care expenditures are a luxury good using OLS estimation technique.

Econometric estimation and hypotheses testing are done by using the Gauss 6.0 and E-views 6 programmes.

3. Some econometric testing and results

3.1 Analysis of stationary and unit root

This paper is utilized from Im, Pesaran and Shin (2003)(hereafter IPS)'s test, Fisher-type test proposed first by Maddala and Wu (1999) (hereafter MW) then developed Choi (2001), Levin, Lin and Chu(2002) (hereafter LLC), Hadri's (2000) test as first generation tests, cross-sectionally augmented dickey fuller test (hereafter CADF) as second generation test and Carrion-i Silvestre et al.(2005) test (PANKPSS) measuring presence of structural break.

Firstly we analyze first generation test, then second generation test. A first generation of models has analyzed the properties of panel-based unit root tests under the assumption that the data is independent and identically distributed (i.i.d) across individuals.

In general, this type of panel unit root tests is based on the following regression:

$$\Delta Y_{i,t} = \beta_i Y_{i,t-1} + Z_{i,t}\gamma + u_{i,t} \tag{2}$$

where i = 1, 2, … ,N is individual, for each individual t=1, 2, …,T time series observations are available, $Z_{i,t}$ is deterministic component and $u_{i,t}$ is error term. The null hypothesis of this type is ρ_i=0 for $\forall_i$.

The first of first generation panel unit root tests is LLC that allow for heterogeneity of individual deterministic effects and heterogeneous serial correlation structure of the error terms assuming homogeneous first order autoregressive parameters. They assume that both N and T tend to infinity but T increase at a faster rate, so N/T$\rightarrow$0. They assume that each individual time series contains a unit root against the alternative hypothesis that each time series stationary. Thus, referring to the model (2), LLC assume homogeneous autoregressive coefficients between individual, i.e., $\beta_i = \beta$ for all i, and test the null hypothesis $H_o : \beta_i = \beta = 0$ against the alternative $H_A : \beta_i = \beta \prec 0$ for all i. The structure of the LLC analysis may be specified as follows:

$$\Delta Y_{i,t} = \alpha_i + \beta_i Y_{i,t-1} + \delta_i \tau + \sum_{j=1}^{p_i} \phi_{ij} \Delta Y_{i,t-j} + u_{it} \tag{3}$$

i = 1, … , N, t= 1,…,T where τ is trend, α_i is individual effects, u_{it} is assumed to be independently distributed across individuals. LLC estimate to this regression using pooled OLS. In this regression deterministic components are an important source of heterogeneity since the coefficient of the lagged dependent variable is restricted to be homogeneous across all members in the panel (Barbieri, 2006). Other test, Im, Pesaran and Shin (2003) test allows for residual serial correlation and heterogeneity of the dynamics and error variances across units. Hypothesis of IPS may be specified as follows:

$$H_o : \beta_i = \beta = 0$$
$$H_A : \beta_i \prec 0 \quad \text{for all i}$$

The alternative hypothesis allows that for some (but not all) of individuals series to have unit roots. IPS compute separate unit root tests for the N cross-section units. IPS define their t-bar statistics as a simple average of the individual ADF statistics, t_i, for the null as: $\bar{t} = \sum_{i=1}^{N} t_i / N$

It is assumed that t_i are i.i.d and have finite mean and variance and E(t_i), Var(t_i) is computed using Monte-Carlo simulation technique. Other test Maddala and Wu (1999) consider deficiency of both the LLC and IPS frameworks and offer an alternative testing strategy (Barbieri, 2006). MW is based on a combination of the p-values of the test statistics for a unit root in each cross-sectional unit.

Hadri (2000) test permits an easy formulation for a residual based LM test of stationary. Hadri adopts the following components representation:

$$Y_{it} = Z'_{it}\gamma + r_{it} + \varepsilon_{it}$$

where Z_{it} is deterministic component, r_{it} is a random walk:

$$r_{it} = r_{i,t-1} + u_{it}$$

where $u_{it} \sim iid(0,\sigma_u^2)$ and $\varepsilon_{i,t}$ is stationary process. Hypothesis of Hadri's test is different from other first generation tests. The null of hypothesis of trend stationary corresponds to the hypothesis that the random walk equals zero. Further, this test allows the disturbance terms to be heteroscedastic across i.

It has to be controlled whether there is dependency across cross-section in regression. Thus, we test Breusch and Pagan's (1980) cross-section LM testing. Since number of cross-section observation is smaller number of time series observation in our model, it is take into accounted CDLM1 test of Pesaran (2004). CDLM1 test statistic is following as:

$$\text{CDLM1} = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2 \sim \chi^2_{N(N-1)/2}$$

where $\hat{\rho}_{ij}$ is correlation of coefficient across residuals obtained from each regression estimated by OLS estimator. One of second generation tests is Cross-Sectionally Augmented Dickey Fuller (thereafter CADF) testing. Pesaran (2003) presents a new procedure for testing unit root in dynamic panels subject to possibly cross sectionally dependent in addition to serially correlated errors. Pesaran (2003) proposes a test based on standard unit root statistics in a CADF regression. CADF process can be reduced with estimated to this equation:

$$\Delta Y_{it} = \alpha_i + \beta_i Y_{i,t} - 1 + \sum_{j=1}^{p_i}\delta_{ij}\Delta Y_{i,t-j} + d_i\tau + c_i\overline{Y}_{t-1} + \sum_{j=0}^{p_i}\varphi_{ij}\Delta\overline{Y}_{i,t-j} + \varepsilon_{it} \tag{4}$$

where $\overline{Y}_t = N^{-1}\sum_{j=1}^{N}Y_{jt}$, $\Delta\overline{Y}_{i,t} = N^{-1}\sum_{j=1}^{N}\Delta Y_{jt}$ and ε_{it} is regression errors. Let $CADF_i$ be the ADF statistics for the i-th cross-sectional unit given by the t-ratio of the OLS estimate $\hat{\beta}_i$ of β_i in the CADF regression(4). Individual CADF statistics are used to develop a modified version of IPS t-bar test (denoted CIPS for Cross-sectionally Augmented IPS) that simultaneously take account of cross-section dependence and residual serial correlation:

$$CIPS = N^{-1}\sum_{i=1}^{n}CADF_i$$

Hypothesizes of both CADF and CIPS is same. The null hypothesis is formulated as:

$H_o : \beta_i = 0$ This hypothesis implies that all the time series are nonstationary

$H_A : \beta_i \prec 0$ This hypothesis implies that all the time series are stationary process.

So far, unit root tests analyzed have assumed that data is produced by a linear process and a structural break occurs in data generating process. But when we ignore to presence of break, we can obtain biased results. Im and Lee (2001) and Carrion-i Silvestre et al. (2001, 2002) are pioneer to this application. Im and Lee (2001) analyzed the case of structural break that changes mean of series in individual effects and model which has trending regressor. Carrion-i Silvestre et al.'s (2005) panel stationary test allows for multiple structural breaks through the incorporation of dummy variables in the deterministic model. Carrion-i Silvestre et al. (2005) allow for structural changes to shift the mean and trend of individual time series. Further, they allow that each individual in the panel can have different number of breaks located at different dates. In this case, under the null hypothesis the data generating process for the variable is assumed to be:

$$Y_{i,t} = \alpha_{i,t} + \delta_{i,t} + u_{i,t} \tag{5}$$

$$\alpha_{i,t} = \sum_{k=1}^{m_i} \varphi_{i,k} D(T^i_{b,k})_t \ + \sum_{k=1}^{m} \phi_{i,k} DU_{i,k,t} + \alpha_{i,t-1} + \varepsilon_{i,t} \tag{6}$$

$$\alpha_{i,0} = \alpha_i \tag{7}$$

where $\varepsilon_{i,t}$ ~ i.i.d$(0, \sigma^2_{\varepsilon_i})$ and $\alpha_{i,0} = \alpha_i$ a constant, with i= (1,…, N) individuals and t=(1,…,T) time periods. The dummy variables $D(T^i_{b,k})_t$ and $DU_{i,k,t}$ are defined as:

$$D(T^i_{b,k})_t = \begin{cases} 1 & t = T^i_{b,k} + 1 \\ 0 & \text{elsewhere} \end{cases}$$

$$DU_{i,k,t} = \begin{cases} 1 & t > T^i_{b,k} \\ 0 & \text{elsewhere} \end{cases}$$

where $T^i_{b,k}$ is date of the break for i-th individual.

m is allowed to be max number of breaks since k=1,…, m. It is assumed that $u_{i,t}$ and $\varepsilon_{i,t}$ are independent as in Hadri's test. But their null of hypothesis different from panel data test of Hadri (2000), $H_o : \sigma^2_{\varepsilon,i} = 0$ under null of hypothesis, which the model given by (5) and (6) becomes:

$$Y_{i,t} = \alpha_i + \sum_{k=1}^{m_i} \varphi_{i,k} DU_{i,k,t} + \sum_{k=1}^{m_i} \Theta_{i,k} DT^*_{i,k,t} + \delta_{i,t} + u_{i,t} \tag{8}$$

where $DT^*_{i,k,t}$ = t- $T^i_{b,k}$, t> $T^i_{b,k}$, $DT^*_{i,k,t}$ = 0 elsewhere.

This model (8) includes individual structural break effect (shifts in the mean caused by structural breaks), temporal effects (for $\delta_i \neq 0$), temporary structural break effect (for $\Theta_{i,k} \neq 0$ that is only there are changes in individual time trends).

The specification given by (8) is general enough to allow three characteristics (Carrion-I Silvestre et al. (2005):

(1) The structural breaks have different effects on each individual time series. This effects are measured by $\Theta_{i,k}$ and $\varphi_{i,k}$.

(2) Structural breaks may occur in different dates for each individual time series.

(3) The number of structural break may change from individual to individual.

The test null of hypothesis of a stationary panel ($\sigma^2_{\varepsilon,i} = 0$) that proposed by Hadri (2000) and advanced Carrion-i Silvestre et al. (2005) with representation given by:

$$LM_{\text{hom}(\lambda)} = N^{-1} \sum_{i=1}^{N} (\hat{\omega}^{-2} T^{-2} \sum_{t=1}^{T} S^2_{i,t}) \tag{9}$$

where $S_{i,t} = \sum_{j=1}^{t} \hat{u}_{i,j}$ and $S_{i,t}$ denotes the partial sum process that obtained when it is used the estimated OLS residuals of (8) and where $\hat{\omega}^2_i$ is a consistent estimate of the long-run variance $\varepsilon_{i,t}$. λ in (9) denotes the dependence of LM statistic on the dates of break. For each individual i, it is defined as the vector $\lambda_i = (\lambda_{i,1}, ..., \lambda_{i,m_i})' = (T^i_{b,1}/T, ..., T^i_{b,m_i}/T)'$ which indicates the relative positions of the dates of the breaks on the entire the period, T. If variance is allowed to change across cross-section individual, then LM test statistic is can be expressed as:

$$\text{LM}_{\text{het}(\lambda)} = N^{-1} \sum_{i=1}^{N} (\hat{\omega}_i^{-2} T^{-2} \sum_{t=1}^{T} S^2_{i,t}) \tag{10}$$

LM statistics is standardized as:

$$Z(\lambda) = \frac{\sqrt{N}(LM(\lambda) - \bar{\xi})}{\bar{\varsigma}} \sim N(0,1)$$

They showed that $Z(\lambda)$ statistic normally distributed as firstly $T \to \infty$ followed by $N \to \infty$. For variable $Z(\lambda)$, the expectation (ξ_i) and variance (ς_i^2) are given by:

$$\xi_i = A\sum_{k=1}^{m_i+1}(\lambda_{i,k} - \lambda_{i,k-1})^2$$

$$\varsigma^2{}_i = B\sum_{k=1}^{m_i+1}(\lambda_{i,k} - \lambda_{i,k-1})^4$$

Carrion-i Silvestre et al. (2005) accept to being $\lambda_{i,0} = 0$, $\lambda_{i,m+1} = 1$, A=1/6, B=1/45 under restriction to $\alpha_i = \Theta_{i,k} = 0$ while they accept to being A=1/15, B=11/6300 under hypothesis of $\alpha_i \neq \Theta_{i,k} \neq 0$.

Since computed to $Z(\lambda)$ statistics, it must be detected the breaks in each one of the individual time series. Carrion-i Silvestre et al.(2005) determine endogenously structural break. Thus they follow Bai and Perron (1998)'s the global minimization of sum of squared residuals process (SSR). They choose as the estimate of the dates of the breaks the argument that minimizes the sequence of individual SSR $(\hat{T}^i_{b,1}, ..., \hat{T}^i_{b,m_i})$ computed from (8).

$$(\hat{T}^i_{b,1}, \ldots, \hat{T}^i_{b,mi}) = \arg\min_{T^i_{b,1},\ldots,T^i_{b,mi}} SSR(\, T^i_{b,1}, \ldots, T^i_{b,mi}\,)$$

After the dates for all possible $m_i \leq m^{\max}, i = (1,...,N)$ have been estimated, the point is to select the suitable number of structural breaks and determine optimal value for m_i. Bai and Perron (1998) propose this concern using two different procedures. The first procedure makes use of information criteria or more specifically the Bayesian Information criterion (BIC) and the modified Schwarz Information criterion (LWZ) of Liu et al. (1997). The second procedure is based on sequential computation of structural breaks with the application of *pseudo* F-type test statistics. Bai and Perron (2001) compare the procedures and conclude that second one outperforms the first one. Thus, if there are trending regressors, then the number of structural breaks should be estimated using BIC and LWZ Information criteria. On the other hand when the model doesn't include trending regressors, the number of structural breaks should be estimated using sequential procedure (Carrion-i Silvestre et al.,2005).

3.2 Analysis of cointegration

If the presence of a unit root is detected in the variables, then it is necessary to check for the presence of a cointegrating relationship among the variables. There are two types of panel cointegration tests in the literature. The first is similar to the Engle and Granger (1987) framework which includes testing the stationarity of the residuals from a levels regression. The second panel cointegration test is based on multivariate cointegration technique proposed by Johansen (1988).

Pedroni (1999, 2004) and Kao (1999) extend the Engle-Granger (1987) cointegration test. Kao(1999) presents DF and ADF type tests fort he null hypothesis of no cointegration in panel data. Kao considers the special case where cointegration vectors are homogeneous between individuals. Thus the test don't allow for heterogeneity under alternative hypothesis. The DF type test from Kao follows the following model:

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{i,t} \tag{11}$$

where i=1, … , N and t=1,…T.

Both Y_{it} and X_{it} are random walks. It follows that under the null hypothesis of no cointegration, the residual series, $\varepsilon_{i,t}$, should be nonstationary. The ADF type test from Kao is based on the estimated residuals of the following equation: $\hat{\varepsilon}_{i,t} = \rho\hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{p}\varphi_j\Delta\hat{\varepsilon}_{i,t-j} + v_{itp}$ where $\hat{\varepsilon}_{i,t}$,is the estimated residual of equation (11) and p denotes number of the lags in ADF specification. To test whether Y_{it} and X_{it} are cointegrated based on DF or ADF test statistics, the null and the alternative hypotheses can be written as $H_o : \rho = 1$, $H_A : \rho < 1$ respectively.

Pedroni (1999, 2004) proposes a residual-based test for he null of cointegration for dynamic panels with multiple regressors in which the short run dynamics and the long run slope coefficients are permitted to be heterogeneous across individuals. The test allows for individual heterogeneous fixed effects and trend terms. Pedroni considers the use of seven residual-based panel cointegration statistics, four based on pooling the data along the within-dimension and three based on pooling along the between-dimension.

Maddala and Wu (1999) use Fisher-type test to propose an alternative approach to testing for cointegration in panel data by combining tests from individual cross-sections to obtain at test statistic for the full panel. Johansen Fisher panel cointegration test combines individual Johansen's cointegration trace tests and maximum eigen value tests. In Johansen's multivariate cointegration technique, trace statistic tests for at most r cointegrating vectors among a system of N>r time series, and the maximal eigen value statistic tests for exactly r cointegrating vectors against the alternative hypothesis of r+1 cointegrating vectors.

4. Empirical results

4.1 Results of unit root and stationarity tests

Table 1 presents the panel data test statistics of PGDP, for the unit root and stationary tests that do not allow for the presence of cross-section dependency (denoted first generation panel unit root tests). The results shown in Table 1 indicate that the LLC, IPS tests except for ADF and PP tests fail to reject the null of non-stationary GDP for all 18 countries the model with constant. But Hadri (2000) test supports results of ADF and PP tests. That is, according to Hadri's test, we accept to presence of non-stationary in PGDP. If we take into account the model with trend, we obtain that unit root in PGDP is rejected for 18 countries by means of all tests except for Hadri test.

Table 1 Result of first generation unit root tests for PGDP in level

First generation tests	Without trend		With trend	
	Test stat.	Prob.	Test stat.	Prob.
Levin, Lin & Chu t stat.	-15.529	0.000	-264.289	0.000
Im, Pesaran and Shin W stat.	-25.761	0.000	-129.097	0.000
ADF–Fisher Chi-square stat.	19.232	0.990	288.620	0.000
PP–Fisher Chi-square stat.	19.262	0.980	267.778	0.000
Hadri Z-stat.	7.841	0.000	6.987	0.000
Hadri Het. Cons Z stat.	15.303	0.000	5.106	0.000

Note: Number of lag for LLC, IPS, ADF-Fisher and PP-Fisher test statistics was selected by Schwarz criterion and for Hadri test was selected by Newey and West (1994) criterion.

Table 2 Result of first generation unit root tests for PHE in level

First Generation Tests	Without trend		With trend	
	Test stat.	Prob.	Test stat.	Prob.
Levin, Lin & Chu t stat.	24.319	1.000	7.794	1.000
Im, Pesaran and Shin W stat.	27.044	1.000	11.937	1.000
ADF–Fisher Chi-square stat.	0.116	1.000	15.319	0.990
PP–Fisher Chi-square stat.	0.096	1.000	5.946	1.000
Hadri Z-stat.	15.822	0.000	12.399	0.000
Hadri Het. Cons Z stat.	15.879	0.000	12.244	0.000

Note: Number of lag for LLC, IPS, ADF-Fisher and PP-Fisher test statistics was selected by Schwarz criterion and for Hadri test was selected by Newey and West (1994) criterion.

Table 2 presents the panel data test statistics of PHE, for the unit root and stationary tests that do not allow for the presence of cross-section dependency (denoted first generation panel unit root tests). The results shown in Table 2 clearly indicate that all tests fail to reject the null of non-stationary PHE for all 18 countries the model with constant and with trend. Hadri (2000) test also supports ths result.

After obtained these results, it has to be investigated whether PGDP and PHE have cross-section dependency. Thus, we test Breusch and Pagan's (1980) cross-section LM testing. Since number of cross-section observation is smaller than number of time series observation in our model, it is taken into account CDLM1 test of Pesaran (2004). According to Table 3 and Table 4, probability value of CDLM1 test of both PGDP and PHE converges to zero. Since probability value is smaller than significance level (0.05), we reject to presence of cross-sectional independence. Thus, we must rely on second generation unit root tests instead of first generation unit root tests. First generation tests depend crucially upon the independence assumption across individuals, and hence not applicable since cross sectional correlation is present. So, we must consider results of Table 5.

Table 3 Results of cross-section dependence tests in panel for PGDP

	Without trend		With trend	
	T stat.	Prob.	T stat.	Prob.
CDLM1	625.95	0.00	620.88	0.00
CDLM2	27.03	0.00	26.74	0.00
CDLM	-2.50	0.00	-2.43	0.00

Table 4 Results of cross-section dependence tests in panel for PHE

	Without trend		With trend	
	T stat.	Prob.	T stat.	Prob.
CDLM1	299.12	0.00	313.28	0.00
CDLM2	8.35	0.00	9.16	0.00
CDLM	-3.08	0.00	-2.74	0.00

Table 5 CIPS statistics of PGDP and PHE for all countries

	Without trend		With trend	
Variables	CIPS stat.	CV(%5)	CIPS stat.	CV(%5)
GDP	-0.8664	-3.34	-1.0508	-3.87
HE	-1.5156	-3.34	-2.4435	-3.87

Table 5 presents panel data test statistics, for the unit root and stationary tests that do allow for the presence of dependency across panel members. As is seen from Table 5, results mean value of CADF(CIPS stat.) show that null of a unit root in each country's both PGDP and PHE series can be rejected at the 5% level in the model with trend and constant in all countries.

Carrion-i-Silvestre et al. (2005) and Carrion-i-Silvestre (2005), all of whom conclude that the unit root hypothesis can be strongly rejected once the level and/or slope shifts are taken into account. In this paper, we apply the test of Carrion-i-Silvestre et al. (2005). The empirical analysis first specifies a maximum of m max = 5 structural breaks, which appears to be reasonable given the number of time observations (T = 38) in our study. Table 6 and Table 7 show our results. Table 6 Panel A presents results of panel unit root test based on structural break for PGDP. The null of stationary for PGDP series can not be rejected by either the homogeneous or the heterogeneous long-run version of test in the model with constant and trend if we use the bootstrap critical values, as shown in Panel B. Thus, Carrion-i Silvestre et al.(2005) test (i.e., PANKPSS) also support results of CIPS stat for PGDP series. In Table 7, Panel A presents results of PANKPSS for PHE series. In contrary to results of PGDP, the null of stationary for PHE series can be rejected by either the homogeneous or heterogeneous long-run version of test in the model with trend if we use the bootstrap critical value, as shown in Panel B. On the other hand, if it is taken account of the model with only constant, then the null of stationary for PHE series can not be rejected by either two long-run version.

Table 6 Panel stationary test with structural breaks for PGDP

Panel A: Panel stationary test based on structural break (The test of carrion-i silvestre et al., 2005)					
		Constant		Time trend	
		Test stat.	P Val.	Test stat.	P Val.
LM (λ)	Hom.	1813.29	0.000	907.565	0.000
LM (λ)	Het.	1258.95	0.000	465.617	0.000

Panel B: Bootstrap distribution (%)				
	Boots CV. (Constant)		Boots CV. (Time Trend)	
	Hom	Het	Hom	Het
0.01	-1.429	3.73	-0.107	15.481
0.025	-1.14	4.26	0.194	18.606
0.05	-0.88	4.81	0.506	21.542
0.10	-0.50	5.50	1.084	24.792
0.90	20.02	17.88	102.865	62.163
0.95	179.17	101.78	167.551	71.069
0.975	321.04	190.22	253.474	83.015
0.99	425.35	269.38	555.598	146.865

Note: The finite sample critical values are computed by means of Monte Carlo simulations using 10,000 replications. LM (λ) (hom) and LM(λ) (het) denote the Carrion-i-Silvestre et al. (2005) KPSS test assuming homogeneity and heterogeneity, respectively, in the estimation of the long-run variance.

Table 7 Panel stationary test with structural breaks for PHE

Panel A: Panel stationary test based on structural break (The test of Carrion-i-Silvestre et al., 2005)					
		Constant		Time trend	
		Test stat.	P Val.	Test stat.	P Val.
LM (λ)	Hom.	30.234	0.00	13.517	0.00
LM (λ)	Het.	129.39	0.00	30.342	0.00

Panel B: Bootstrap distribution (%)				
	Boots CV. (Constant)		Boots CV. (Time trend)	
	Hom	Het	Hom	Het
0.01	7.46	7.99	6.07	11.96
0.025	8.41	9.42	6.75	13.92
0.05	9.45	10.88	7.44	15.89
0.10	10.40	13.51	8.15	18.88
0.90	25.80	45.44	17.95	46.89
0.95	29.83	53.34	20.12	51.35
0.975	34.89	61.98	22.08	55.56
0.99	41.49	72.71	23.73	62.85

Note: The finite sample critical values are computed by means of Monte Carlo simulations using 10,000 replications. LM (λ)(hom) and LM(λ) (het) denote the Carrion-i-Silvestre et al. (2005) KPSS test assuming homogeneity and heterogeneity, respectively, in the estimation of the long-run variance.

After determined presence of non-stationary for PGDP and PHE, we investigate to degree of stationary of this variables. Table 8 and Table 9 clearly indicate that both PGDP and PHE are I(1) variables.

Table 8 Result of first generation unit root tests for PGDP in first difference

First generation tests	Without trend		With trend	
	Test stat.	Prob.	Test stat.	Prob.
Levin, Lin & Chu t stat.	-1033.06	0.00	-1092.97	0.00
Im, Pesaran and Shin W stat.	-269.540	0.00	-298.546	0.00
ADF–Fisher Chi-square stat.	144.654	0.00	375.885	0.00
PP–Fisher Chi-square stat.	143.557	0.00	370.582	0.00
Hadri Z-stat.	4.710	0.00	6.553	0.00
Hadri Het. Cons Z stat.	4.116	0.00	4.386	0.00

Table 9 Result of first generation unit root tests for PHE in first difference

First generation tests	Without trend		With trend	
	Test stat.	Prob.	Test stat.	Prob.
Levin, Lin & Chu t stat.	-4.301	0.00	-7.910	0.00
Im, Pesaran and Shin W stat.	-4.939	0.00	-9.180	0.00
ADF–Fisher Chi-square stat.	116.763	0.00	203.630	0.00
PP–Fisher Chi-square stat.	131.309	0.00	260.336	0.00
Hadri Z-stat.	12.097	0.00	6.001	0.00
Hadri Het. Cons Z stat.	11.365	0.00	8.281	0.00

4.2 Results of cointegration tests

The panel cointegration tests point to the existence of a long run relationship between health expenditures and GDP per capita, see Tables 10, 11, 12. For example, the null of no cointegration is rejected by most of the Pedroni (1999) tests at the 5 percent level. Similarly Kao residual cointegration test shows that existence of cointegration among variables. As seen from results of Table 12, for the panel rank test the hypothesis that the largest rank in the panel is r =0 is rejected, but the hypothesis of a largest rank of r =1 can not be rejected. Based on this result, it is concluded that PHE and PGDP are cointegrated around linear trends for the sample of OECD countries.

Table 10 Pedroni panel cointegration test

Alternative hypothesis: Common AR coefficient(within-dimension)				
	Statistic	Probability value	Weighted statistic	Probability value
Panel v-stat	17.88	0.00	5.48	0.00
Panel-rho stat	-28.12	0.00	-2.89	0.00
Panel-PP stat	-44.71	0.00	-2.12	0.01
Panel ADF-stat	3.21	0.99	-4.85	0.00
Alternative hypothesis: Individual AR coefficient (between-dimension)				
	Stat.	Probability value		
Group-rho stat	-1.61	0.0528		
Group-PP stat	-2.93	0.0001		
Group ADF-stat	-4.35	0.0000		

Note: Trend assumption: no deterministic trend, lag selection: automatic SIC with a max lag of 6 and Newey-West bandwith selection with Barlett kernel.

We follow equation (1). In equation (1), $PHE_{i,t}$ is real per capita health expenditure, $PGDP_{i,t}$ is real per capita gross domestic product and $u_{i,t}$ is error term. Table 13 contains OLS estimates the equation (1) from

OECD data, using the natural logarithm of real per capita health expenditure ($PHE_{i,t}$) as the dependent variable. All variable considered are I(0). The null hypothesis of no first or second order autocorrelation could not be rejected in regression. According to the OLS estimates, coefficient estimated of income elasticity for PHE is statistically (1%) is different from one and below unity, implying health care expenditure is a necessity good. Further, per capita GDP ($PGDP_{i,t}$) explains about 77% (adjusted R-square) of the variation in per capita health expenditures ($PHE_{i,t}$). This result is consistent with some previous studies.

Table 11 Kao residual cointegration test

	T stat	Prob val.
ADF	2.87	0.002
Residual variance	1199	-
HAC variance	1201	-

Note: Trend assumption: no deterministic trend, lag selection: automatic AIC with a max lag of 6 and Newey-West bandwith selection with Barlett kernel.

Table 12 Johansen-fisher panel cointegration results

Number of cointegrating vectors	Fisher stat. from trace stat.	Prob.	Fisher stat. from max. eigen test	Prob.
$r \leq 0$	100.1	0.000	92.22	0.000
$r \leq 1$	39.44	0.318	39.44	0.318

Note: Trend assumption: Linear deterministic trend (restricted). EViews6 computes probabilities using asymptotic Chi-square distribution. Lag length is equal to 1.

Table 13 Results of OLS estimation technique

Variable	Coefficient	Std. error	t-stat	Prob.
C	4.66	0.049	93.86	0.00
Log (PGDP)	0.87	0.017	48.37	0.00

5. Conclusion

In this study, we examined the long-run relationship between per capita health care expenditures and per capita GDP in a sample of OECD countries. We applied the Johansen multivariate cointegration technique to investigate the cointegrating relationship between per capita health expenditures and per capita GDP in OECD countries selected during the 1970-2007 period. Firstly, we applied the first generation panel unit root tests, second generation panel unit root test and Carrion-i Silvestre et al.'s (2005) panel stationary test with structural breaks (PANKPSS). We find that all of the series are found as integrated of order one I (1).

Then, we performed the cointegration analyses. As a result, we find evidence for one cointegrating relationship between the health care expenditures and PGDP. That is, there is a long-run relationship among the considered series. As can be seen from obtained empirical results, governments must be focused on their health care system and must research in direction of making more efficiency their health care system.

After obtained all these finding, we investigate whether health care expenditure is luxury good. As a result, we find that health care expenditure is a necessity good for 18 OECD countries selected.

References:

Bai, J. and Perron, P. (1998), "Estimating and testing linear models with multiple structural changes", *Econometrica,* Vol. 66, No. 1, pp. 47-78.

Bai, J. and Perron, P. (2001), "Computation and analysis of multiple structural change models", *Journal of Applied Econometrics,* Vol. 18, No. 1, pp. 1-22.

Bai, J. and Ng S. (2004), "A panic attack on unit roots and cointegration", *Econometrica*, Vol. 72, No. 4, pp. 1127-1177.
Barbieri, L.(2006), "Panel unit root tests: A review", Quaderni del Dipartimento di Scienze Economiche e Sociali, Serie Rossa, n.43, Università Cattolica del Sacro Cuore, Piacenza.
Blomqvist, A. G. and Carter, R. A. (1997), "Is health care really a luxury?", *Journal of Health Economics,* Vol. 16, No. 2, pp. 207-229.
Breusch, T. S. and Pagan, A. R, (1980), "The lagrange multiplier test and its applications to model specification in econometrics", *Review of Economic Studies*, Blackwell Publishing, Vol. 47, No. 1, pp. 239-253.
Carrion-i-Silvestre, J. L.,del Barrio-Castro, T. and Lopez-Bazo, E. (2005), "Breaking the panels: An application to the GDP per capita", *Econometrics Journal,* Vol. 8, No. 2, pp. 159-175.
Carrion-i-Silvestre, J. L. (2005), "Health care expenditure and GDP: Are they broken stationary?", *Journal of Health Economics*, Vol. 24, No. 5, pp. 939-854.
Choi, I. (2001), "Unit roots tests for panel data", *Journal of International Money and Finance,* Vol. 20, No. 2, pp. 249-272.
Engle, R. F. and Granger, C. W. J. (1987), "Co-integration and error correction: Representation, estimation and testing", *Econometrica,* Vol. 55, No. 2, pp. 251-276.
Gerdtham, U. G.., Sogaard, J., Andersson, F. and Jonsson, B. (1992), "A pooled cross-section analysis of the health care expenditures of the OECD countries", in: Peter Zweifel and H. E. Freeh (Eds.), *Health Economics Worldwide*, Kluwer Academic Publishers.
Gerdtham, U. G.. and Lothgren, M. (2000), "On stationarity and cointegration of international health expenditure and GDP", *Journal of Health Economics,* Vol. 19, No. 4, pp. 461-475.
Hadri, K. (2000), "Testing for stationarity in heterogenous panels", *Econometrics Journal,* Vol. 3, No. 2, pp. 148-161.
Hansen, P. and King, A. (1996), "The determinants of health care expenditure: A cointegration approach", *Journal of Health Economics,* Vol. 15, No. 1, pp. 127-137.
Hansen, P. and King, A. (1998), "Heath care expenditure and GDP: panel data unit root test results comment", *Journal of Health Economics,* Vol. 17, No. 3, pp. 377-381.
Im, K. S., Pesaran, M. H. and Shin, Y. (2003), "Testing for unit roots in heterogeneous panels", *Journal of Econometrics*, Vol. 115, No. 1, pp. 53-74.
Jewell, T., Lee, J., Tieslau, M. and Strazicich, M. C. (2003), "Stationarity of heath expenditures and GDP: Evidence from panel unit root tests with heterogeneous structural breaks", *Journal of Health Economics,* Vol. 22, No. 2, pp. 313-323.
Johansen, S. (1988), "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control,* Vol. 12, No. 2-3, pp. 231-254.
Johansen, S. (1992), "Determination of cointegration rank in the presence of a linear trend", *Oxford Bulletin of Economics and Statistics,* Vol. 54, No.3, pp. 383-397.
Kleiman, E. (1974), "The determinants of national outlay on health", in: Perlman M. (ed.): *The Economics of Health and Medical Care*, Macmillan, London.
Kao, C. (1999), "Spurious regression and residual-based tests for cointegration in panel data", *Journal of Econometrics,* Vol. 90, No. 1, pp. 1-44.
Levin, A., C. F. Lin and C. S. Chu (2002), "Unit root in panel data: Asymptotic and finite-sample properties", *Journal of Econometrics,* Vol. 108, No. 1, pp. 1-24.
Levin, Andrew and Chien-Fu Lin (1992), *Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties*, mimeo, University of California, San Diego.
Maddala, G. S. and Wu, S. (1999), "A comparative study of unit root tests with panel data and a new simple test", *Oxford Bulletin of Economics and Statistics,* Vol. 61, special issue Nov., pp. 631-652.
McCoskey, S. and Selden, T. M. (1998), "Health care expenditures and GDP: Panel data unit root test results", *Journal of Health Economics,* Vol. 17, No. 3, pp. 377-381.
Newey, Whitney and Kenneth West (1987), "A simple, positive semi-definite, heteroskedasticity and auto correlation consistent covariance matrix", *Econometrica*, Vol. 55, No. 3, pp. 703-708.
Newey, W. K. and West, K. D. (1994), "Automatic lag selection in covariance matrix estimation", *Review of Economic Studies,* Vol. 61, No. 4, pp. 631-653.
Newhouse, J. P. (1977), "Medical care expenditures: A cross-national survey"; *Journal of Human Resources,* Vol. 12, No. 1, pp. 115-125.
Okunade, A., Karakus and M. C. (2001), "Unit root and cointegration tests: Time series versus panel estimates for international health expenditure models"; *Applied Economics,* Vol. 33, No. 9, pp. 1131-1137.
Organisation for Economic Co-operation and Development (2009), *OECD Health Data:2009*, OECD: Paris.
Pedroni, P. (1999), "Critical values for cointegration tests in heterogeneous panels with multiple regressors"; *Oxford Bulletin of Economics and Statistics,* Vol. 61, special issue, pp. 653-670.
Pesaran, H. M. (2003), "Estimation and inference in large heterogeneous panels with cross section dependence", Cambridge working papers in economics 0305, Faculty of Economics, University of Cambridge.
Pesaran, H. M. (2004), "General diagnostic tests for cross section dependence in panels," IZA discussion papers 1240, Institute for the Study of Labor (IZA).
Sen, A. (2005), "Is health care a luxury? New evidence from OECD data", *International Journal of Health Care Finance and Economics*, Vol. 5, No. 2, pp.147-164.