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Ekaterini Panopoulou, Theologos Pantelidis

► **To cite this version:**

Ekaterini Panopoulou, Theologos Pantelidis. Convergence in Per Capita Health Expenditures and Health Outcomes in the OECD Countries. Applied Economics, 2011, pp.1. 10.1080/00036846.2011.583222 . hal-00712384

HAL Id: hal-00712384

<https://hal.science/hal-00712384>

Submitted on 27 Jun 2012

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Journal:	<i>Applied Economics</i>
Manuscript ID:	APE-2009-0571.R1
Journal Selection:	Applied Economics
Date Submitted by the Author:	11-Oct-2010
Complete List of Authors:	Panopoulou, Ekaterini; University of Piraeus, Department of Statistics and Insurance Science Pantelidis, Theologos; University of Crete, Department of Economics
JEL Code:	C23 - Models with Panel Data < C2 - Econometric Methods: Single Equation Models < C - Mathematical and Quantitative Methods, I10 - General < I1 - Health < I - Health, Education, and Welfare
Keywords:	Convergence clubs, health expenditure, health determinants, health outcomes, OECD countries

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For Peer Review

Convergence in Per Capita Health Expenditures and Health Outcomes in the OECD Countries

Ekaterini Panopoulou*

Department of Statistics and Insurance Science, University of Piraeus.

Theologos Pantelidis†

Department of Economics, University of Crete

Abstract

Our analysis of 19 OECD countries over the period 1972-2006 provides evidence of convergence in per capita health care expenditures for 17 countries, while the US and (to a lesser degree) Norway follow a different path. A simple decomposition of per capita health expenditures reveals that the divergence of the US comes from the divergence of the 'ratio of health care expenditures to GDP' component, while Norway's divergence is mainly caused by the 'labour productivity' component. Interestingly, our results suggest that convergence in per capita health expenditures among the 17 OECD countries does not lead to convergence in health outcomes. Finally, we extend our analysis to examine convergence in various determinants of health expenditures.

JEL Classification: C23; I10.

Keywords: Convergence clubs; health expenditure; health determinants; health outcomes; OECD countries.

Running Title: Convergence in per capita Health Expenditures and Health Outcomes

*Ekaterini Panopoulou, Department of Statistics and Insurance Science, University of Piraeus, 80 Karaoli & Dimitriou Str., 18534, Piraeus, Greece. E-mail: apano@unipi.gr. Tel: 0030 210 4142728. Fax: 0030 210 4142340.

† *Correspondence to:* Theologos Pantelidis, Department of Economics, University of Crete, Panepistimioupoli Gallou, 74100 Rethymno, Greece. E-mail: pantelidis@econ.soc.uoc.gr. Tel: 0030 2831077410. Fax: 0030 2831077404.

1 Introduction

Health care expenditure has been rising rapidly in the developed countries in the recent years. This rise constitutes a major concern for health policy makers. In this respect, research has focused on the determinants of health care expenditure with income growth being the undebatable determinant (see, inter alia, Hitiris and Posnett, 1992; Hansen and King, 1996; Di Matteo and Di Matteo, 1998; Karatzas, 2000; Herwartz and Theilen, 2003; Wang, 2009a; Cantarero and Lago-Penas, 2010). The long run elasticity of health expenditure on growth and the question of whether health is a luxury good has attracted attention by another line of the literature that focuses on the integration and cointegration properties of the variables of interest (see, inter alia, Hansen and King, 1996; Hitiris, 1997; McCoskey and Selden, 1998; Gerdtham and Lothgren, 2000; MacDonald and Hopkins, 2002; Jewell *et al.*, 2003; Clemente *et al.*, 2004; Ang, 2010).

Despite its potential importance and usefulness, the analysis of cross-country disparities in this context has not received much attention as very few studies focus on the issue of health care convergence for a set of countries. Hitiris (1997) examines whether health expenditures converge for a group of European Community countries and finds no evidence of convergence. He argues that economic convergence of the EU members will eventually lead to convergence of health expenditure. In a more recent study, Hitiris and Nixon (2001) find that EU economic integration leads to income convergence and to convergence in various sectors and the health sector in particular. However, the authors conclude that there is no clear evidence in favour of the existence of a single health function for all the EU member states. Such a case can become even more complex if the analysis is extended to cover the OECD countries. Employing an empirical growth theoretical framework in order to examine the determinants of growth of per capita health expenditures for 24 OECD countries, Barros (1998) finds that the higher the health care expenditures per capita are, the lower the growth rate is. The author suggests that this is an indication of convergence of health care expenditures. The rapid growth in US health care expenditure and the 'catch-up' hypothesis in the

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OECD countries is the focus of Narayan's (2007) study. Specifically the author examines whether per capita health expenditures of Canada, Japan, Spain, Switzerland and the UK converge to the US per capita health expenditures and finds strong evidence in favour of convergence.¹

Taking a different route, Alcande-Unzu *et al.* (2009) address the issue of cross country disparities in health care expenditure by employing a factor decomposition model. The authors extend the decomposition of Cheng and Li (2006) to include per capita health care expenditure and show that it can be expressed as the product of the ratio of health care expenditures to GDP, labour productivity, employment rate, activity rate and the ratio of working age population to total population. Their findings suggest that the main determinants of cross-country dispersion in per capita health care expenditure are the ratio of health care expenditures to GDP and labour productivity.

This factor decomposition is the starting point of our analysis. Specifically, the first objective of our analysis is to examine convergence in per capita health expenditures for a group of 19 OECD countries over the period 1972-2006 and use the aforementioned decomposition to identify the reasons for the observed divergent behaviour of some countries. It is obvious that the examination of the economic characteristics that lead to health expenditure convergence/divergence is critical for policymakers since the majority of the OECD countries face budget deficits. Health care spending has put a pressure on public budgets during the past two decades. Moreover, evidence on convergence would point to increased expenditure on health and thus increased deficits, unless some other sectors, such as education and other public services have to be sacrificed. This can potentially be a contentious issue in some countries. Our results suggest convergence in per capita health expenditures among 17 OECD countries, while Norway and especially the US follow a different path with substantially higher per capita health expenditures. It turns out that the divergence of the US comes from

¹Wang (2009b) also focuses on the degree of convergence of US health care expenditures and its major components using state level data. His findings point to moderate convergence in total health care costs accompanied by divergence in the components.

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4 the divergence in the ‘ratio of health care expenditures to GDP’ component, while
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6 Norway’s divergence is mainly caused by the ‘labour productivity’ component.
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8 We also move one step forward and investigate whether convergence in per capita
9 health expenditures implies convergence in health outcomes as well. Interestingly, our
10 results show that convergence in per capita health expenditures does not, in general,
11 lead to convergence in health outcomes. Finally, we extend our analysis to provide some
12 insights into the cross-country disparities in major determinants of health expenditures.
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18 We should note that our analysis is based on a new methodology introduced by
19 Phillips and Sul (2007a, PS henceforth). This methodology has two important ad-
20 vantages compared to alternative approaches available in the literature. First, it is
21 based on a nonlinear time-varying factor model that incorporates the possibility of
22 transitional heterogeneity or even transitional divergence. Moreover, the methodology
23 is robust to the stationarity properties of the series under scrutiny. Second, and more
24 importantly, this methodology provides a simple empirical algorithm that can be used
25 to identify groups of countries that converge to different equilibria when the full panel
26 of the countries under scrutiny diverge. Moreover the algorithm also detects individual
27 countries that diverge from the panel. This enables us to identify the reasons for the
28 divergent behaviour of some countries.
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38 The rest of the paper is organised as follows. Section 2 describes the methodology
39 we use to examine health convergence among the OECD countries. Sections 3-5 report
40 our empirical findings and Section 6 concludes the paper.
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45 **2 Econometric Methodology**

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49 In this section, we outline the econometric methodology we employ to examine the
50 existence of convergence in per capita health care expenditure, health outcomes and
51 various determinants of health expenditures. The methodology was introduced by PS
52 in order to test for conditional sigma convergence in a panel of countries. We also
53 briefly discuss the clustering algorithm, put forward by PS and employed in Phillips
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and Sul (2007b, 2009), which allows us to classify countries into convergence subgroups in cases where the full panel diverges.

2.1 The log t Test

Suppose that we have panel data for a variable X_{it} , $i = 1, \dots, N$ and $t = 1, \dots, T$ where N and T are the number of countries and the sample size respectively.

PS decompose X_{it} into the systematic, g_{it} , and the transitory, a_{it} , components. In other words,

$$X_{it} = g_{it} + a_{it} \quad (1)$$

We can discriminate between the common and idiosyncratic components of the panel by using the following transformation of (1):

$$X_{it} = \left(\frac{g_{it} + a_{it}}{\mu_t} \right) \mu_t = \delta_{it} \mu_t, \text{ for all } i, t \quad (2)$$

In this way, the variable of interest, X_{it} , is decomposed in two components, one common, μ_t , and one idiosyncratic, δ_{it} , both of which are time-varying. The idiosyncratic component, δ_{it} , is a measure of the distance between X_{it} and the common component, μ_t . This formulation allows us to test for convergence by testing whether the factor loadings δ_{it} converge to a constant, δ , by taking ratios instead of differences and thus eliminating the common component. To do so, PS define the relative transition parameter, h_{it} , as

$$h_{it} = \frac{X_{it}}{\frac{1}{N} \sum_{i=1}^N X_{it}} = \frac{\delta_{it}}{\frac{1}{N} \sum_{i=1}^N \delta_{it}} \quad (3)$$

which measures the loading coefficient δ_{it} in relation to the panel average and as such the transition path for the variable of interest of country i relative to the panel average. Whenever the factor loadings δ_{it} converge to a constant, δ , h_{it} converges to unity and the cross-sectional variation (H_t) of the relative transition path converges to zero as

$t \rightarrow \infty$, i.e.

$$H_t = \frac{1}{N} \sum_{i=1}^N (h_{it} - 1)^2 \rightarrow 0, \text{ as } t \rightarrow \infty$$

Note that the cross-sectional mean of the relative transition paths, h_{it} , is unity by construction. PS implement the following semiparametric model for δ_{it} :

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^\alpha}$$

where $\xi_{it} \sim iid(0, 1)$ across i , σ_i are idiosyncratic scale parameters, $L(t)$ is a slowly varying function, such as $\log(t)$ for which $L(t) \rightarrow \infty$ as $t \rightarrow \infty$, and α denotes the speed of convergence, i.e. the rate at which this cross-sectional variation decays to zero. This representation ensures that δ_{it} converges to δ_i whenever $\alpha \succeq 0$. The null hypothesis of convergence is as follows:

$$\mathcal{H}_0 : \delta_i = \delta \text{ and } \alpha \succeq 0$$

while the alternative is

$$\mathcal{H}_A : \delta_i \neq \delta \text{ for all } i \text{ or } \alpha \prec 0$$

The null hypothesis implies convergence for all countries, while the alternative hypothesis implies no convergence for some countries. The alternative hypothesis can accommodate both overall divergence and club convergence, i.e. the possibility that some of the countries under scrutiny form convergent groups at different factor loadings, say δ_1 and δ_2 . The following subsection describes an empirical algorithm that can be implemented to identify such convergent subgroups. PS show that under convergence, H_t has the following limiting form

$$H_t \sim \frac{A}{L(t)^2 t^{2\alpha}}, \text{ as } t \rightarrow \infty \quad (4)$$

where A is a strictly positive constant.

Now, consider the ratio H_1/H_t that measures the distance of the panel from the

common limit. We can easily test \mathcal{H}_0 based on the following $\log t$ regression

$$\log(H_1/H_t) - 2\log L(t) = \hat{c} + \hat{b}\log t + u_t, t = [rT], \dots, T$$

where $L(t) = \log(t)$ and $r > 0$. Specifically, the regression is run after a fraction (r) of the sample is removed. PS recommend setting r equal to 0.3, since extensive Monte Carlo simulations show that this choice of r is satisfactory in terms of both size and power properties of the test.

The fitted coefficient \hat{b} of $\log t$ converges to the speed of convergence parameter 2α under the null hypothesis of convergence where $\hat{\alpha}$ is the estimate of α in \mathcal{H}_0 (see also equation (4)). We focus on the sign of the estimated coefficient, \hat{b} , since convergence of the full panel requires that b is either positive or equal to zero. This is tested by means of the conventional t-statistic, t_b , that is, convergence is supported if $t_b \succ -1.65$. The standard error of our estimates is calculated using a HAC estimator for the long-run variance of the residuals. In this study, we employ the Quadratic spectral kernel and determine the bandwidth by means of the Andrews (1991) data-dependent procedure. Finally, we should note that the size of b indicates the speed of convergence (for positive values). That is, high values of b suggest a fast rate of convergence.

The aforementioned convergence test has numerous advantages over existing ones. First, the methodology does not rely on any particular assumption concerning trend stationarity or stochastic nonstationarity. Second, it is based on a model that incorporates the possibility of transitional heterogeneity or even transitional divergence. This is crucial since it is not proper to test for convergence by means of standard unit root and cointegration tests in the presence of heterogeneity. For example, PS show that two series can converge even if they are not cointegrated (this is the case of asymptotic cointegration). Thus, the methodology of PS can be considered as an asymptotic cointegration test that does not suffer from the small sample problems of standard unit root and cointegration tests. Third, when the full panel of the countries under scrutiny diverges, the methodology provides a simple empirical algorithm (described in

the following section) that can be used to identify groups of countries that converge to different equilibria and at the same time allow individual countries to diverge.

2.2 Club Convergence Algorithm

Whenever a researcher examines convergence within a panel of countries, it is often the case that the full panel diverges. In such cases, PS propose an empirical algorithm that can be used to determine subgroups of countries that converge to different steady states. We now briefly describe the four steps of this empirical algorithm.

- Step 1 (Ordering): We order the members of the panel according to the last observation, since evidence of convergence will, in general, be most apparent in the recent years. Alternatively, the ordering of the series can be done based on a time series average of the final observations.
- Step 2 (Core Group Formation): We try to identify a core group of countries that provide strong evidence of convergence. Specifically, we estimate a sequence of *logt* regressions using the k highest members (Step 1) for all different values of k (i.e. $2 \leq k < N$). We choose the regression that generates the maximum convergence t-statistic $t_{b,k}$ (where $t_{b,k} > -1.65$ so that convergence is ensured for the corresponding group). The corresponding group forms the core convergence group.
- Step 3 (Club Membership): We now evaluate each individual country not included in the core convergence group (Step 2) for membership in this group. More in detail, we add one country at a time and calculate the convergence t-statistic from the *logt* regression. The new country (member) satisfies the membership condition if the associated t-statistic is greater than a chosen critical value c^* (i.e. $t_b > c^*$). All countries that satisfy the membership condition are added to the core convergence group. Finally, we check whether the whole group (i.e. the members of the initial core group and the additional selected members) satisfies

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5 the criterion for convergence.

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7 • Step 4 (Recursion and Stopping): We run the *logt* regression for all the countries
8 not included in the club formed in the previous step. If the corresponding *t*-
9 statistic indicates convergence, these countries form a second convergence club.
10 Otherwise, Steps 1 to 3 are repeated in order to reveal additional subconvergence
11 clusters. If no core group can be found (Step 2), then these countries display a
12 divergent behaviour.
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18 19 20 **3 Factor decomposition of per capita health care expen-** 21 **diture** 22 23 24 25

26 In this section we describe the methodology employed to decompose per capita health
27 care expenditures in factors and then apply the econometric methodology described in
28 the previous section to reveal cross-country disparities among the OECD countries.
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30 The decomposition methodology we employ comes from the literature of per capita
31 income convergence and was proposed by Cheng and Li (2006). The authors show that
32 per capita GDP can be decomposed into the product of labour productivity, employ-
33 ment rate, activity rate and the ratio of working age population to total population.
34 Alcalde-Unzu *et al.* (2009) extend this decomposition to include per capita health care
35 expenditure and show that it can be expressed as the product of the ratio of health
36 care expenditures to GDP, labour productivity, employment rate, activity rate and the
37 ratio of working age population to total population.
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46 More in detail, let x_{it} denote the per capita health care expenditure in country i
47 in period t . It can be calculated by dividing health care expenditure (H_{it}) and the
48 total population in country i (N_{it}). In the same manner, we let Y_{it} , E_{it} , A_{it} and W_{it}
49 be country's i GDP, total employment, active population and working-age population,
50 respectively. It is easy to see that per capita health care expenditure can be written
51 as the product of the following factors: the ratio of health care expenditures to GDP
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($s_{it} = H_{it}/Y_{it}$), labour productivity ($y_{it} = Y_{it}/E_{it}$), employment rate ($e_{it} = E_{it}/A_{it}$), activity rate ($a_{it} = A_{it}/W_{it}$) and the proportion of working age population in total population ($w_{it} = W_{it}/N_{it}$). As a result, the variable of interest, x_{it} , can be written as follows:

$$x_{it} \equiv s_{it} \cdot y_{it} \cdot e_{it} \cdot a_{it} \cdot w_{it} \quad (5)$$

We are interested in examining convergence in per capita health care expenditures. The data we employ are taken from the OECD Health Database (OECD, 2008). Since our methodology requires a balanced panel, we end up with 19 OECD countries examined over the period 1972-2006. The countries under scrutiny are listed in Table 1, Panel A. The same table (Panel B) contains a list of variables' definitions and conversions employed.²

We first employ the log t test for the panel of per capita health care expenditures, x_{it} , for the 19 countries under scrutiny. The point estimate of b , reported in Table 2, is statistically less than zero ($\hat{b} = -0.471$, $t_b = -5.024$) suggesting divergence of the 19 OECD countries. Afterwards, we implement the algorithm described in Section 2.2 to identify subgroups of countries that converge to different equilibria. Our results indicate that the countries under examination are divided into two convergence clubs. Specifically, the first convergence club contains Norway and the US with substantially higher per capita health expenditures compared to the remaining 17 countries that form the second club.

Figure 1 presents the relative transition paths, h_{it} , calculated based on equation (3) for Norway, the US and the remaining countries (calculated as the cross-country average of their relative transition paths). Each transition path shows the position of the country or club relative to the panel average. The 19-country average corresponds to the unity level. A transition path below unity indicates that the level of the country or club is below the panel average, while a transition path above unity indicates that

²Note that the period and countries under scrutiny are slightly different for some of the variables examined in the following sections. The relevant information is reported in Panel B of Table 1.

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the level of the country or club is above the panel average. It is clear that Norway and especially the US appear to be away and above the other countries, while their divergence from the panel increases over time. Interestingly, Norway's per capita health care expenditures are initially below the panel average with a constant increasing trend though. As a result, Norway is well above the average during the recent years.

It is now of great interest to identify the reasons of divergence for Norway and the US from the rest of OECD countries. We can investigate this issue based on the decomposition of per capita health expenditures given in equation (5). Specifically, we examine convergence among the 19 OECD countries included in our analysis for each one of the five factors reported in equation (5). The results are reported in Table 2 and can be summarised as follows.

1. There is full convergence among the 19 countries for three out of five factors, namely the employment rate (e_{it}), the activity rate (a_{it}) and the proportion of working age population in total population (w_{it}). Convergence is faster for e_{it} and w_{it} (the estimated values of b are statistically greater than zero) and slower for the activity rate (the estimated b is not statistically different from zero). As a conclusion, none of these three factors can account for the divergent behaviour of Norway and the US in per capita health expenditures.
2. There is no full convergence in the ratio of health care expenditures to GDP (s_{it}) as suggested by the negative and statistically significant estimated value of b ($\hat{b} = -0.85$). The implementation of the club convergence algorithm reveals that Ireland and the US diverge from the remaining 17 countries following a different path each. To be more specific, Ireland moves below but close to the 17 countries, while the US is well above the panel average. Interestingly, the divergence of the US from the other OECD countries increases over time. This is illustrated at the left-hand side plot of Figure 2 that presents the position of Ireland and the US relative to the other OECD countries (for s_{it}). It is therefore clear that the divergence of the US per capita health care expenditures from the other countries

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5 under scrutiny comes from its divergence in s_{it} .
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8 3. Similarly, there is no full convergence in labour productivity ($\hat{b} = -0.562$). The
9 countries form two convergence clubs. The first club includes Iceland, Japan, New
10 Zealand, Portugal, Spain and Switzerland, while the remaining countries form the
11 second club. The relative position of the two clubs is revealed in the right-hand
12 side plot of Figure 2 that also shows the position of Norway in a separate line. We
13 observe that over the recent years Norway displays an upward tendency moving
14 away from the panel average. We therefore suspect that the divergence of Norway
15 from the other countries in per capita health care expenditures is mainly caused
16 by the labour productivity component.
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26 4 Convergence in Health Outcomes

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29 The analysis so far has shown that OECD countries broadly converge as far as per
30 capita health expenditure is considered (with the exception of the US and, to a lesser
31 degree, Norway). Does this convergence imply convergence in health outcomes as well?
32 The link between additional health expenditure and patient benefits, i.e. improved
33 health outcomes is one of the fundamental and yet unresolved issues in health policy.
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38 Employing a cross-section of 18 developed countries, Cochrane *et al.* (1978) examine
39 the relationship between mortality rates, GNP and consumption of inputs such as
40 health care provision. They find that health care inputs are not in general associated
41 with health outcomes, such as mortality rates. To avoid international heterogeneity,
42 Cremieux *et al.* (1999) examine the relationship between expenditure and outcomes
43 across 10 Canadian provinces over the 15-year period 1978–1992. Their results point
44 to a significant link between lower health-care spending and a significant increase in
45 infant mortality along with a decrease in life expectancy. Or's (2001) study of the
46 determinants of variations in mortality rates across 21 OECD countries between 1970
47 and 1995 reveals that health expenditure is significant on health for women proxied by
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5 potential years of life lost, but not for men. In a detailed review, Nixon and Ulmann
6 (2006) refer to 16 studies that have examined the issue providing a variety of results.
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8 In their own study, they employ data for 15 EU countries over the period 1980–1995
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10 and three health outcomes measures – life expectancy at birth for males and females,
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12 and the infant mortality rate – and conclude that although health expenditure and the
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14 number of physicians have made a significant contribution to improvements in infant
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16 mortality, ‘... health care expenditure has made a relatively marginal contribution to
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18 the improvements in life expectancy in the EU countries over the period of the analysis’.
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20 More recently, Martin *et al.* (2008) take advantage of a major new dataset developed in
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22 English health care, in the form of programme budgets, which enables them to address
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24 some of the difficulties associated with estimating the impact of health care expenditure
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26 on health outcomes in two of the largest programmes of health care: circulatory disease
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28 and cancer. Their study shows that health care expenditure has a strong positive effect
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30 on outcomes in the two programmes of care investigated.

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32 Following the extant literature, we proxy health outcomes with the following vari-
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34 ables: life expectancy (females), life expectancy (males), life expectancy (total pop-
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36 ulation), crude mortality rate, infant mortality and potential years of life lost.³ For
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38 each one of the aforementioned health outcomes we implement the log t test to examine
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40 convergence among the countries under scrutiny. When testing for convergence of the
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42 full panel of 19 countries, the results, reported in Panel A of Table 3, suggest that
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44 convergence occurs only for infant mortality. For all the other variables the null hy-
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46 pothesis of convergence is rejected. In general, the main conclusion drawn from Panel
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48 A of Table 3 is that the existence of convergence among 17 of the 19 countries under
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50 examination in per capita health expenditures does not lead to convergence in health
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52 outcomes.

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54 Moreover, the implementation of the club convergence algorithm leads to the formu-
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56 lation of various convergence clubs that differ for each one of the variables considered

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³The variable definitions are given in Table 1 (Panel B).

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5 in this study. Our findings of the club convergence algorithm, reported in Figure 3,
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7 may be summarised as follows:
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10 1. There is a core group of six countries that converge for all the variables considered
11 in this section. This group contains Austria, Canada, Germany, Norway, Spain
12 and the UK. Furthermore, Finland and Ireland deviate from this core group only
13 in the case of life expectancy of males. Similarly, New Zealand does not belong
14 to this core group only for the total life expectancy variable.
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18 2. In most cases, Japan behaves in a totally different way compared to the other
19 OECD countries. A typical example is the mortality rate where 17 of the 19
20 countries form two convergence clubs while Japan (and Sweden) diverges following
21 its own different path. On the whole, Japan's health outcomes are better off
22 compared to the panel average. Specifically, Japan belongs to above average
23 groups for all life expectancy measures, below average for the mortality rate and
24 the middle group for the potential years of life lost variable.
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28 3. Contrary to Japan and despite the high per capita health expenditure level, US
29 health outcomes are worse off compared to the other OECD countries. More in
30 detail, the US are below the panel average with respect to all life expectancy
31 measures and above the panel average when mortality rate and potential years
32 of life lost are considered.
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35 36 37 38 39 40 41 42 43 44 **5 Convergence in Health Determinants** 45 46

47 'What determines the quantity of resources a country devotes to medical care?' Pro-
48 fessor Newhouse (1977) asked some 30 years ago. Employing a cross-section regression
49 of per capita health expenditure on per capita GDP in 13 OECD countries, he inferred
50 that per capita GDP accounted for 92% of the sample variation in health expenditure.
51 Moreover, the estimated elasticity (greater than one) implied that health care is a "lux-
52 ury" good, rather than a necessity. Since this seminal paper, attention has been paid on
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the integration and cointegration properties of health expenditure and GDP (see, inter alia, Hansen and King, 1996; Hitiris, 1997; McCoskey and Selden, 1998; Gerdtham and Lothgren, 2000; MacDonald and Hopkins, 2002; Jewell *et al.*, 2003; Clemente *et al.*, 2004). Another strand of the literature focuses on revealing the determinants of health expenditures (see, inter alia, Hitiris and Posnett, 1992; Hansen and King, 1996; Di Matteo and Di Matteo, 1998; Karatzas, 2000; Herwartz and Theilen, 2003). The key variables employed in the literature as determinants of health expenditure can be broadly categorised as economic, health stock, institutional, demographic and life-style variables.

In this section, we attempt to reveal cross-country disparities among the OECD countries with respect to the basic determinants of health expenditure. Our choice of variables is limited by data availability. For example, health stock variables are not included in our analysis as we could not get a sufficient number of cross-section and time-series observations.

With respect to the economic variables, the variables we employ are (i) per capita GDP, (ii) income equality measured by the share of nominal wages in nominal GDP, (iii) the inflation rate measured by the growth rate of the GDP deflator as wages in the health sector will rise proportionally and (iv) the ‘Baumol variable’ measured by the difference between wage increases and labour productivity.⁴ Health care expenditure also depends on the nature of the health system. We expect public reimbursement systems to raise health spending. A proxy for the nature of the health system of each country is the proportion of public health expenditure in total health expenditure. The results of the log *t* test, presented in Table 3 (Panel B), suggest convergence among the OECD countries for all economic determinants except for income equality. In the latter case, the countries form three convergence clubs, while Ireland diverges.⁵

Furthermore, the demographic structure of the population affects health expen-

⁴Baumol (1988) argues that the health sector is a service sector and as such, productivity gains may be lower than the rest of the economy. For a detailed analysis, see Hartwig (2008).

⁵To reserve space we do not report club convergence results for health determinants. These are available from the authors upon request.

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diture as certain categories of the population tend to consume more health related products. Among the demographic variables employed in the literature are the following: (i) the dependency ratio measured by the ratio of the population under 14 and over 65 over the population aged 15-64, (ii) the ratio of the population aged under 14 to total population, (iii) the ratio of the population aged over 65 to total population, and (iv) the female labour force participation rate. Table 3 (Panel C) reports the results for the convergence tests for the aforementioned demographic variables. The results suggest full convergence for the dependency ratio and the female labour force participation rate. In both cases, convergence is fast since the estimated value of b is positive (b equals 0.915 and 1.156 for the dependency ratio and the female labour force participation rate respectively) and statistically different from zero. On the other hand, there is divergence among the OECD countries for the other two demographic variables considered in this study. In both cases, the countries form two clubs that converge to different steady states.

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Lastly, countries differ with respect to lifestyle and consumption behaviour and in this respect they are exposed to different types of diseases. This means that the probability for all types of illnesses will differ from country to country leading countries to target specific types of diseases. Altering the lifestyle and consumption behaviour of people is feasible through spending more on preventive health care. For the purpose of our analysis we employ the following variables: (i) sugar consumption, (ii) fruits & vegetables consumption, (iii) tobacco consumption and (iv) alcohol consumption. The results, reported in Table 3 (Panel D), indicate convergence in alcohol consumption among the OECD countries under scrutiny (at a slow rate as suggested by the estimate of b that is not statistically different from zero). On the other hand, the OECD countries diverge for the other three variables considered in our analysis. Specifically, in the case of tobacco consumption the countries form three convergence clubs. Finally, the results for the nutrition-related variables (i.e. sugar consumption and fruits & vegetables consumption) suggest that the OECD countries are, in general, divided into two groups

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5 with different nutrition habits.
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8 **6 Conclusions**

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11 The issue of health care expenditure has attracted the interest of many researchers
12 over the last 30 years. This study contributes to the existing literature by examining
13 convergence in per capita health care expenditure among 19 countries for the period
14 1972-2006 by means of a new methodology introduced by Phillips and Sul (2007a).
15 From an empirical point of view, the main advantage of this methodology (in addition
16 to its robustness to the stationarity properties of the series under scrutiny) is the
17 provision of a simple algorithm that can be used to identify groups of countries that
18 converge to different equilibria when the full panel of countries under examination
19 diverges.
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24 Our results support the existence of convergence in per capita health care expendi-
25 tures for 17 countries, while the US and, to a lesser degree, Norway follow a different
26 path with substantially higher per capita health expenditures. We then decompose per
27 capita health expenditures into five components and examine convergence among the
28 OECD countries for each one of the components. In this way, we are able to identify
29 what causes the divergent behaviour of Norway and the US. It turns out that divergence
30 of the US comes from the divergence in the ‘ratio of health care expenditures to GDP’
31 component, while Norway’s divergence is probably caused by the ‘labour productivity’
32 component.
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37 Moreover, we investigate whether convergence in per capita health expenditures
38 among the majority of the OECD countries under scrutiny is accompanied by con-
39 vergence in health outcomes. Specifically, we use six different health outcomes. With
40 the exception of infant mortality, there is divergence of the full panel of OECD coun-
41 tries for all the health outcomes considered in this study, although we can still identify
42 groups of countries that converge to different steady states. We, therefore, conclude
43 that convergence in per capita health expenditures does not lead to convergence in
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4 health outcomes. Finally, we examine convergence in various determinants of health
5 expenditures. Our findings support (i) convergence in all economic determinants ex-
6 amined in this study with the exception of income equality and (ii) club convergence
7 in most of the demographic and life-style variables under investigation.
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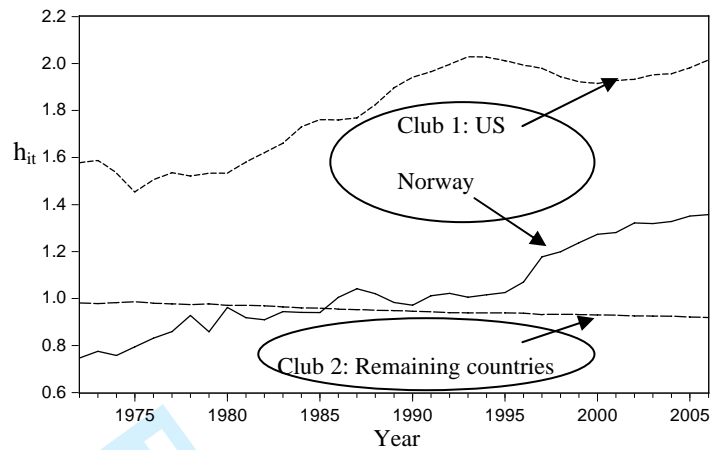
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14 **Acknowledgements:** We would like to thank Donggyu Sul for making the Gauss
15 code available to us. We are also grateful to an anonymous referee for useful comments
16 and suggestions. Finally, the authors would like to thank the University of Crete for
17 financial support under the KA 2877 research grant of the “Program of Financing Basic
18 Research”.
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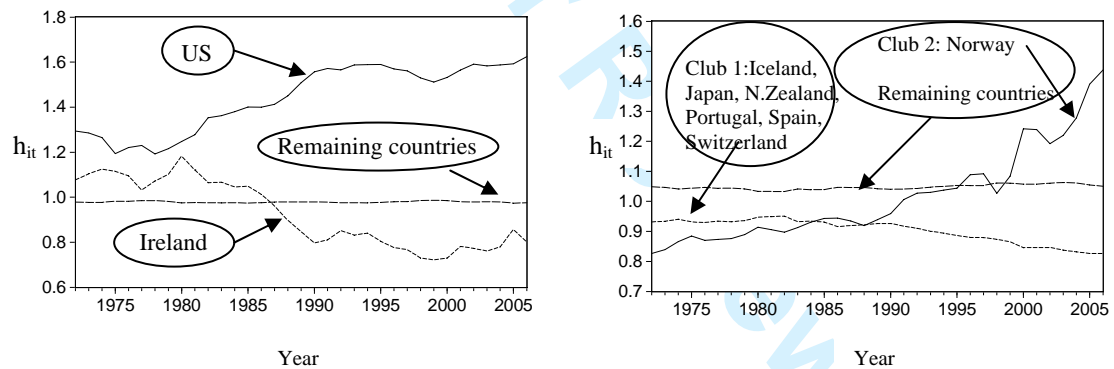
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Figure 1. Relative transition paths for per capita health expenditure

Note: Each oval represents a convergent club. Each line (i.e. transition path) shows the position of the country or club relative to the panel average. The 19-country average corresponds to the unity level. A transition path below unity indicates that the level of the country or club is below the panel average, while a transition path above unity indicates that the level of the country or club is above the panel average.

Figure 2. Relative transition paths for ‘health care expenditure as a share of GDP’ (left-hand side) and ‘labour productivity’ (right-hand side)

Note See Figure 1.

Figure 3. Club convergence - Health outcomes

Life Expectancy (females)



Life Expectancy (males)

Life Expectancy (total)

Mortality Rate*

Potential Years of life lost (<70)*

Notes: (*) Belgium and Denmark are excluded from the analysis due to data unavailability.

Each oval represents a convergent club. The order of the clubs shows the ordering of the relevant transition curves. Moving to right suggests moving from high-level to low-level club. Bold indicates membership to the core group of countries that belong to the same club for all the variables at hand.

Table 1. List of countries and variables

Panel A: List of countries			
Australia	Austria	Belgium	Canada
Denmark	Finland	Germany	Iceland
Ireland	Japan	Netherlands	New Zealand
Norway	Portugal	Spain	Sweden
Switzerland	UK	US	

Panel B: List of variables / definitions			
Variable	Definition - Expressed in	Availability	
Per capita health expenditure	Total expenditure on health /capita - US\$ PPP	1972-2006	
Health care expenditure as a share of GDP	Total expenditure on health - % gross domestic product	1972-2006	
Labour productivity	Gross domestic product - Million US\$, PPP /Total employment - Thousands of persons *100	1972-2006	
Employment rate	Total employment - Thousands of persons/ Labour force - Thousands of persons	1972-2006	
Activity rate	Labour force - Thousands of persons/ Population: 15-64 years - Thousands of persons	1972-2006	
Ratio of working-age population to total population	Population: 15-64 years - Thousands of persons/ Total population - Thousands of persons	1972-2006	
Life expectancy (females)	Females at birth - Years	1980-2005	
Life expectancy (males)	Males at birth - Years	1980-2005	
Life expectancy (total)	Total population at birth - Years	1980-2005	
Mortality rate	All causes - Deaths /100000 population	1972-2003 excl. Belgium & Denmark	
Infant mortality	Infant mortality - Deaths /1 000 live births	1972-2005	
Potential years of life lost (<70)	All causes - <70 year /100 000 population	1972-2003 excl. Belgium & Denmark	
GDP per capita	Gross domestic product /capita - US\$ PPP	1972-2006	
Inflation	% change in GDP deflator (Gross domestic product - Price index (2000=100))	1973-2003	
Income equality	Compensation of employees - % gross domestic product	1972-2005 excl. Germany	
Baumol variable	Growth in Compensation of employees – Growth in labour productivity	1973-2005 excl. Germany	
Public health expenditure	Public expend. on health - % total exp. on health	1972-2006 Excl. Belgium	
Dependency ratio	Age dependency ratio - Population 0-14 & 65+/pop.15-64	1972-2006	
Ratio of under-14 population to total population	Population: 0-14 years - % total population	1972-2006	
Ratio of over-65 population to total population	Population: 65 and over - % total population	1972-2006	
Female labour force participation rate	Labour force - % females in labour force	1975-2002 excl. Belgium & Iceland	
Sugar consumption	Sugar consumption - Kilos per capita	1972-2003	
Fruits & vegetables consumption	Fruits and vegetables - Kilos per capita	1972-2003	
Tobacco consumption	Tobacco consumption - Grammes /capita (15+)	1980-2001 excl. Austria, Belgium, Ireland, Japan, Portugal & Spain	
Alcohol consumption	Alcohol consumption - Liters /capita (15+)	1972-2003 excl. Germany	

Table 2. Per capita health-care expenditure decomposition – Convergence tests

	\hat{b}	t_b -stat
Per capita health expenditure	-0.471*	-5.024
Factor Decomposition		
	\hat{b}	t_b -stat
Health care expenditure as a share of GDP	-0.850*	-16.498
Labour productivity	-0.562*	-7.624
Employment rate	0.838	2.535
Activity rate	0.118	0.679
Ratio of working-age population to total population	0.887	4.806

Notes: * indicates rejection of the null hypothesis of convergence at the 5% level.

Table 3. Health outcomes, economic variables, demographic variables, life-style and behavior - Convergence Tests

Panel A: Health outcomes		
	\hat{b}	t_b -stat
Life expectancy (females)	-0.772*	-17.752
Life expectancy (males)	-0.476*	-6.613
Life expectancy (total)	-0.554*	-8.555
Mortality rate	-0.619*	-12.776
Infant mortality	-0.201	-0.743
Potential years of life lost (<70)	-0.597*	-8.869
Panel B: Economic variables		
	\hat{b}	t_b -stat
GDP per capita	-0.034	-0.489
Income equality	-1.524*	-13.213
Inflation	-0.008	-0.030
Baumol variable	-1.678	-1.174
Public health expenditure	-0.037	-0.369
Panel C: Demographic variables		
	\hat{b}	t_b -stat
Dependency ratio	0.915	4.451
Ratio of under-14 population to total population	-0.377*	-6.538
Ratio of over-65 population to total population	-0.337*	-6.091
Participation in labour force of females	1.156	17.270
Panel D: Life-style and behavior		
	\hat{b}	t_b -stat
Sugar consumption	-1.004*	-17.770
Fruits & vegetables	-0.368*	-2.107
Tobacco consumption	-1.573*	-18.823
Alcohol consumption	-0.042	-0.580

Notes: * indicates rejection of the null hypothesis of convergence at the 5% level.