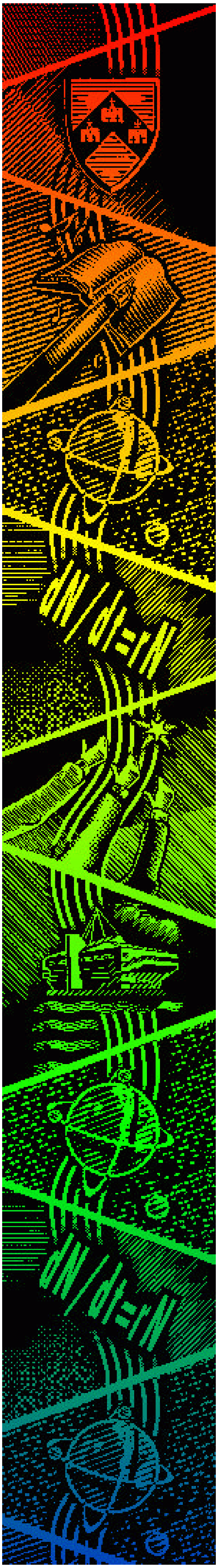

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Convergence Analysis of Health Care Expenditure in the EU Countries Using Two Approaches

by

John Nixon

Department of Economics and Related Studies
University of York
Heslington
York, YO10 5DD

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Abstract

Convergence analysis in economics has largely been confined to macro-indicators such as GDP income and applied within identifiable regions of the world or between developing and developed countries. This paper reports on the application of adapted methods within this discipline to the area of health care expenditure in the countries of the European Union in order to determine if differences in health care spending are diminishing over time. In answering this question we utilise two distinct approaches. The first tests for the presence of *σ-convergence* using cross-sectional data over the period 1960-95 which provides an overall measure of change in dispersion for two chosen variables; total health expenditure as a share of GDP and per capita health expenditure. The second method utilises a panel of data for 1980-95 and tests for the presence of *β-convergence* in the same variables but also includes per capita income in the derivation of a regression model. Both methods confirm the presence of statistically significant convergence over the periods examined. Our results also identify sub-groupings based on health system typology and graphical representations illustrate which countries are contributing to the observed convergence. Our findings are important as they confirm that greater integration in health expenditure is occurring in the EU.

[1] Centre for Reviews and Dissemination and Department of Economics and Related Studies, University of York, Heslington, YO10 5DD, UK. Tel: +44 (1)904 434564; Email: jn105@york.ac.uk

1. Introduction

Health care expenditure, which in most developed countries was rising sharply for more than three decades, has recently come under pressure for cost containment and budgetary control. In the countries of the European Union (EU)[2], an additional thrust towards expenditure cuts has come about by the need for drastic reductions in government deficits and the public debt to comply with the conditions for entry into the EMU. It is also possible that the EU's move towards closer economic integration accelerates the diffusion of health technology and opens up national markets to competition which tends to equalise prices and to reduce costs. In the context of these policies and trends, we seek in this paper to address the question of whether the health care expenditures of the member states of the European Union exhibit a tendency to converge. In the following section we discuss accepted definitions of convergence and outline the analytical methods used in empirical research using two approaches. In section 3, we test for overall convergence in the EU using the first approach which utilises cross-sectional data and non-parametric analysis for the period 1960-95, and following this in section 5 we test for convergence using a set of panel data for the period 1980-95 and more rigorous parametric analysis. Throughout the analyses we investigate the influence of health system typology as it is thought *a priori* that this will be a factor influencing convergence. In the concluding section we summarise the results of our investigation and illustrate the findings using graphical representations.

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[2] The present 15 countries of the EU, and their abbreviations, are: A (Austria), B (Belgium), D (Germany), DK (Denmark), E (Spain), F (France), FIN (Finland), GR (Greece), I (Italy), IRL (Ireland), L (Luxembourg), NL (the Netherlands), P (Portugal), S (Sweden) and UK (the United Kingdom).

2. Economic Convergence

A number of methods are discussed in the literature which are used to test for the presence of convergence, and two principal concepts have been developed within the study of economic growth.

The first concept concerns 'cross-sectional dispersion' in which convergence exists if, for example, the standard deviation (s.d.) or coefficient of variation (c.v.) of a variable across a group of countries declines over time. This form of convergence is known as *σ-convergence* (Easterlin, 1960; Borts and Stein, 1964; Streissler, 1979; Barrow, 1984; Baumol, 1986; Dorwick and Nguyen, 1989; Barro and Sala-i-Martin, 1991, 1992a, 1992b).

The second approach posits that convergence exists if a poor economy tends to grow at a faster rate than a rich one such that the poor country tends to catch up in terms of per capita income or product. This property corresponds to the concept known as *β-convergence* (Barro, 1984; Baumol, 1986; DeLong, 1988; Barro and Sala-i-Martin, 1991, 1992a, 1992b; Sala-i-Martin, 1994; Boyle and McCarthy, 1997). *β-convergence* is also known as 'regression to the mean' (Barro and Sala-i-Martin, 1995, p. 383), which is a point of focus in the methods adopted in the present paper. Sala-i-Martin (1996) has shown that *β-convergence* implies *σ-convergence* but both approaches are applied in this paper in order to test for, and explain, any observed convergence in health expenditure.

In terms of graphical representations of convergence Leonardi (1995) put forward a useful methodology for the study of economic and social convergence and the various hypotheses and scenarios he provides are described as: 1) The equivalent growth hypothesis, 2) The upward convergence scenario, 3) The downward convergence scenario, 4) The reversal of roles scenario, and 5) the divergence hypothesis. These are illustrated graphically in Figures 1a to 1e.

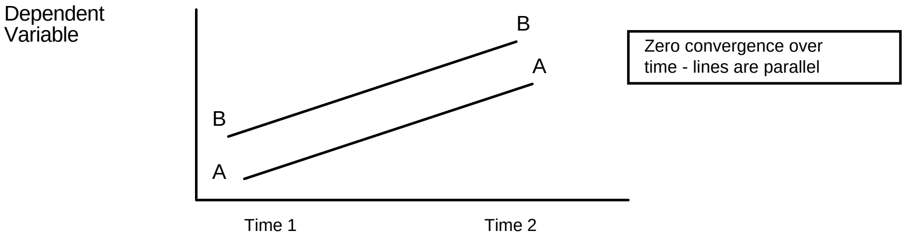

Figure 1a Equivalent Growth Hypothesis

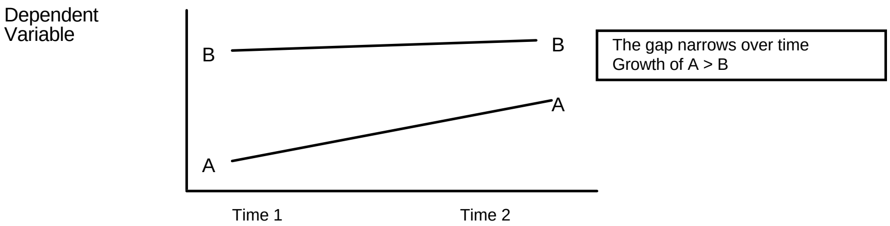

Figure 1b Upward Convergence hypothesis

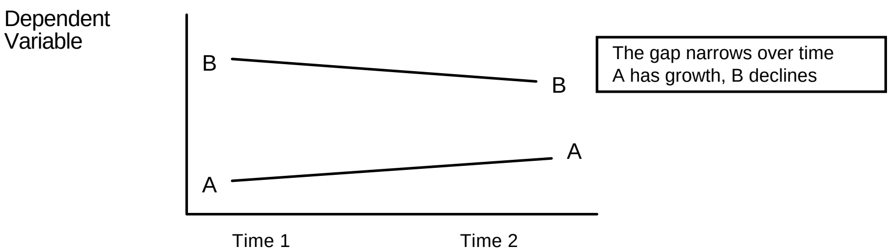

Figure 1c Downward Convergence hypothesis

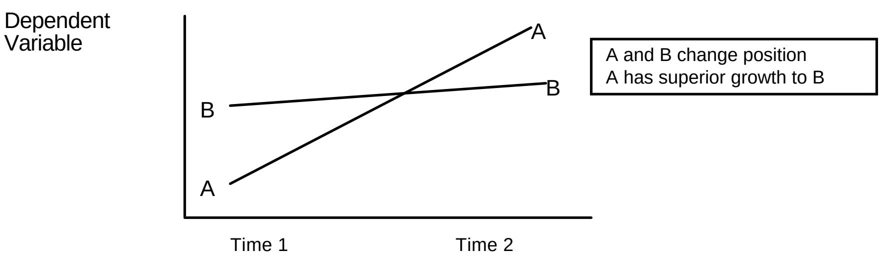

Figure 1d Reversal of Roles Hypothesis

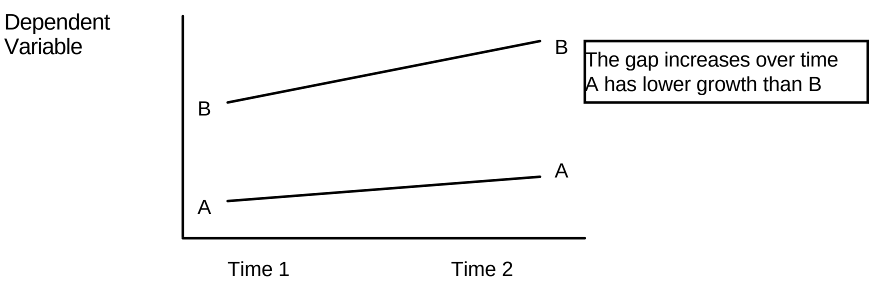

Figure 1e Divergence Hypothesis

2.1 Equivalent Growth Hypothesis

Figure 1a shows that although there is an absolute increase in the dependent variable for both A and B between time periods 1 and 2, there is no relative change between the two. In this case both A and B experience the same growth and convergence does not take place between the two time periods.

2.2. Upward Convergence Scenario

Figure 1b illustrates the case of upward convergence. Between time periods 1 and 2 B experiences low growth in real terms but A experiences real and upward growth towards the value attained by B. This scenario is therefore classified as *upward convergence* as the initially inferior position of A is increasing at a faster rate than B.

2.3. Downward Convergence Scenario

In this scenario, as illustrated in Figure 1c, the relative gap between A and B reduces between time periods 1 and 2 , with A, the inferior, increasing in value and B, the superior, decreasing in value. In spite of this the initial ranking of A and B is unaltered by the convergence process.

2.4. Reversal of Roles Scenario

As the title implies, over time periods 1 and 2 there is a reversal in the rank order of the two values, A and B, as shown in Figure 1d. This may be due to the dynamics of either growth or decrease in the value attained by A, or a growth or a decline in the value attained by B. The result is that absolute differences still exist between A and B.

2.5 The Divergence Hypothesis

Figure 1e depicts this situation in which, over time, the absolute gap between A and B increases, even though growth may be taking place for both A and B. In this scenario the rate at which growth is occurring is sufficiently different such as to create a widening gap between the inferior and the superior.

3. Non-parametric testing for σ-convergence

In this study use is made of OECD data on health (OECD/CREDES, 1997) which provides a reliable source for analysis. In this case the variables, total health expenditure as a percentage of GDP and per capita PPP$ are recorded for the earliest and latest years for which a complete set of OECD data are available, separated by a 10-year period for the first four and a 5-year period for the last two; 1960, 1970, 1980, 1990, 1995. For each year the mean is calculated which is used to determine the multiplier required to convert all the data to an index based on a mean of 100. In so doing it is possible to retain the original variation and proportionality in the data but at the same time allow changes in the dependent variables to be examined from a common reference point over time.

Having standardised the data for each of the years examined the standard deviation was calculated and used for trend analysis in determining the presence, or otherwise, of σ-*convergence*. The F-test (one-sided), which is calculated by dividing the variance of one sample by the variance of a second sample, is used to test the null hypothesis, $\mathbf{H_o}$**:** $\sigma^2_{60} \leq \sigma^2_{95}$ against the alternative hypothesis, $\mathbf{H_A}$**:** $\sigma^2_{60} > \sigma^2_{95}$ at the $\alpha = 5\%$ level of significance. In this case the F-test

$= \frac{s_{60}^2}{s_{95}^2}$, where s_{60}^2 is the standard deviation squared for 1960 of observations n = 15, and s_{95}^2 is the standard deviation squared for 1995 of observations n = 15. The rejection rule is to reject the null hypothesis if $F > F(n-1, \alpha)$ Where appropriate, this analysis is conducted for intervening years between 1960 and 1995 as guided by the plot of standard deviations[3].

Where differences are observed based of typology (NHS versus social insurance countries)[4] statistical significance is tested by means of a one-way ANOVA test at the 5% level of significance.

Finally, to provide an overall measure of change for each country over the period examined, the indexed values for 1995 were subtracted from the 1960 figure, with positive values indicating a net increase in spending on health care relative to the mean and negative values indicating a reduction.

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[3] Note in this case the population and the sample are equivalent, thus σ and s are equivalent.

[4] The health care system different EU countries operate is ether *National Health Service (NHS),* which is characterised by universal coverage, tax financing and public provision; or *Social Insurance (SI),* which is characterised by compulsory universal coverage, financed by employer and employee contributions through non

4. Results

The raw data for health spending as a percentage of GDP and per capita spending in PPP$, along with the mean, multiplier, indexed scores and standard deviation for all 15 current members of the EU are shown in Tables 1 and 2, respectively. As noted in the tables, the raw data are presented in the first column for each year examined and the second years provide the data in its indexed form which is based on the mean and the multiplier. Taking an example for 1960 in Table 1 the raw mean is 3.4 from which it is possible to calculate the multiplier, which equals 100/3.4 = 29.6. All other data are then multiplied by this figure to obtain the indexed scores which are recorded in the second column for 1960, and so on. This method is consistent with the estimate of coefficient of variation, $c.v. = \frac{s.d.}{\bar{x}} \times 100$, as the mean, $\bar{x}$, is 100 giving the condition c.v. = s.d. of the indexed values. This step avoids misrepresentation according to Galton's falacy (Friedman, 1992) as the data have a stable reference, in this case a standardised mean of 100.

profit insurance funds, and public and/or private providers. Of the 15 EU member states, nine operate the NHS system (DK, E, GR, I, IRL, FIN, S, P,UK) and six the SI system (A, B, D, F, L, NL).

Table 1 Health care spending as a percentage of GDP and indexed scores - 1960-95

	Year (first year = raw data, second year = standardised values)										
Country	**1960**	**1960**	**1970**	**1970**	**1980**	**1980**	**1990**	**1990**	**1995**	**1995**	**95-60**
A	4.4	130.4	5.4	109.0	7.9	114.5	7.1	98.3	7.9	102.2	-28.2
B	3.4	100.8	4.1	82.8	6.6	95.7	7.6	105.3	8.0	103.5	2.7
D	4.3	127.5	5.7	115.1	8.1	117.4	8.2	113.6	10.4	134.6	7.1
DK	3.6	106.7	6.1	123.1	6.8	98.6	6.5	90.0	6.4	82.8	-23.9
E	1.5	44.5	3.7	74.7	5.7	82.6	6.9	95.6	7.6	98.4	53.9
F	4.2	124.5	5.8	117.1	7.6	110.1	8.9	123.3	9.9	128.1	3.6
FIN	3.9	115.6	5.7	115.1	6.5	94.2	8.0	110.8	7.7	99.7	-16.0
GR	2.4	71.1	3.3	66.6	3.6	52.2	4.2	58.2	5.8	75.1	3.9
I	3.6	106.7	5.2	105.0	7.0	101.4	8.1	112.2	7.7	99.7	-7.1
IRL	3.8	112.6	5.3	107.0	8.8	127.5	6.6	91.4	6.4	82.8	-29.8
L	1.6	47.4	3.7	74.7	6.2	89.9	6.6	91.4	7.0	90.6	43.2
NL	3.8	112.6	5.9	119.1	7.9	114.5	8.3	115.0	8.8	113.9	1.2
P	1.5	44.5	2.8	56.5	5.8	84.1	6.5	90.0	8.2	106.1	61.7
S	4.7	139.3	7.1	143.3	9.4	136.2	8.8	121.9	7.2	93.2	-46.1
UK	3.9	115.6	4.5	90.8	5.6	81.2	6.0	83.1	6.9	89.3	-26.3
mean	3.4	100.0	5.0	100.0	6.9	100.0	7.2	100.0	7.7	100.0	
multiplier	29.6		20.2		14.5		13.9		12.9		
s.d. (c.v.)		32.2		24.4		21.1		17.2		16.3	

Source: OECD/CREDES (1997). *OECD Health Data 97* **-** *A software for the Comparative Analysis of 27 Health Systems. Paris: OECD/CREDES* for the first year given.

Table 2 Per capita spending on health and indexed scores 1960-95

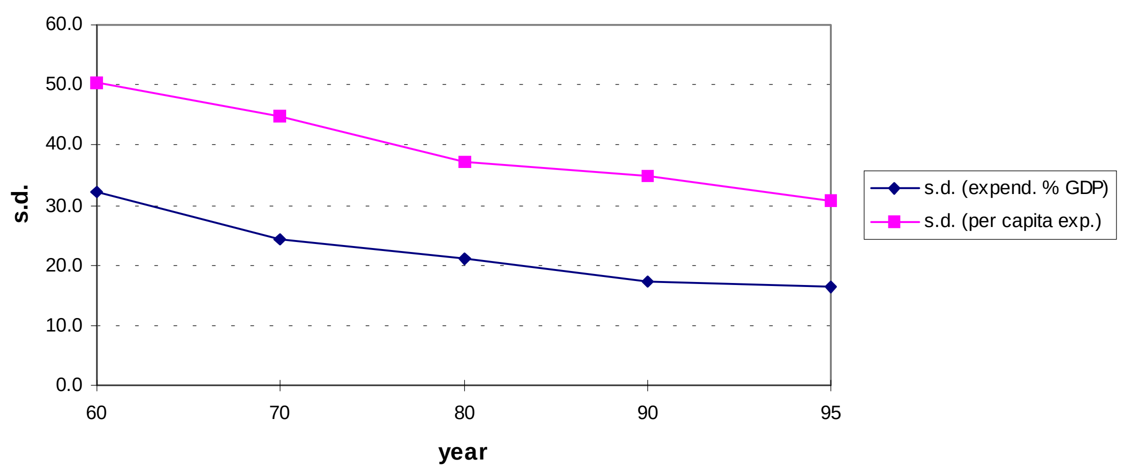
	Year (first year = raw data, second year = standardised values)										
Country	**1960**	**1960**	**1970**	**1970**	**1980**	**1980**	**1990**	**1990**	**1995**	**1995**	**95-60**
A	67.0	122.6	166.0	106.6	697.0	123.7	1180.0	103.3	1634.0	110.8	-11.7
B	53.0	97.0	131.0	84.1	588.0	104.4	1247.0	109.2	1665.0	112.9	16.0
D	91.0	166.5	230.0	147.7	860.0	152.6	1642.0	143.8	2134.0	144.8	-21.7
DK	67.0	122.6	215.0	138.1	595.0	105.6	1069.0	93.6	1368.0	92.8	-29.8
E	14.0	25.6	83.0	53.3	332.0	58.9	813.0	71.2	1075.0	72.9	47.3
F	73.0	133.5	208.0	133.6	716.0	127.1	1539.0	134.8	1972.0	133.8	0.2
FIN	55.0	100.6	165.0	106.0	521.0	92.5	1292.0	113.1	1373.0	93.1	-7.5
GR	16.0	29.3	60.0	38.5	190.0	33.7	389.0	34.1	703.0	47.7	18.4
I	50.0	91.5	157.0	100.8	591.0	104.9	1322.0	115.8	1507.0	102.2	10.8
IRL	37.0	67.7	98.0	62.9	468.0	83.1	748.0	65.5	1106.0	75.0	7.3
L	50.0	91.5	150.0	96.3	617.0	109.5	1499.0	131.3	2206.0	149.6	58.2
NL	68.0	124.4	205.0	131.6	693.0	123.0	1325.0	116.0	1728.0	117.2	-7.2
P	12.0	22.0	45.0	28.9	264.0	46.9	616.0	53.9	1035.0	70.2	48.3
S	90.0	164.6	274.0	175.9	867.0	153.9	1492.0	130.6	1360.0	92.3	-72.4
UK	77.0	140.9	149.0	95.7	453.0	80.4	957.0	83.8	1246.0	84.5	-56.3
mean	54.7	100.0	155.7	100.0	563.5	100.0	1142.0	100.0	1474.1	100.0	
multiplier	1.83		0.64		0.18		0.09		0.07		
s.d. (c.v.)		50.23		44.79		37.25		34.76		30.61	

Source: OECD/CREDES (1997). *OECD Health Data 97* **-** *A software for the Comparative Analysis of 27 Health Systems. Paris: OECD/CREDES* for the first year given.

4.1. Overall Measurement of σ-Convergence

The results for *σ-convergence* for both health care spending as a percentage of GDP and per capita spending are shown, by means of the trends in standard deviation of the indexed scores, in Figure 2.

Figure 2 - Standard deviation of health expenditure as a percentage of GDP and per capita PPP$ - 1960-95



In the case of spending as a percentage of GDP it can be seen that from 1960 the s.d. (c.v.) fell continuously from a figure of 32.2 in 1960 to 16.3 in 1995. For per capita PPP$ spending a similar trend is observed with the standard deviation falling from a figure of 50.23 in 1960 to 30.61 in 1995. Again this provides evidence to support the hypothesis of *σ-convergence* in per capita spending over the period examined. Moreover, it is interesting to note that even though both sets of data were standardised on a value of 100 there is a greater spread of data as shown by the standard deviation differences, in other words greater inequality, in per capita spending than % of GDP. This might indicate different preferences concerning health expenditure and that the purchasing power of currencies in terms of the 'basket of health care' that can be obtained within EU countries is rather different, which also implies that use of health care spending as a percentage of GDP has some limitations as a cross-national comparator of health expenditure. Expenditure per head in standard units of money is therefore perhaps a better indicator of real convergence.

The F-test results indicate that the null hypothesis can be rejected and the alternative hypothesis that $\sigma^2_{60} > \sigma^2_{95}$ ($p = 0.008$) for % of GDP and ($p = 0.039$) for per capita spending be accepted. These results thus provide statistically significant evidence to show that convergence occurred between 1960 and 1995 in both measures of health care expenditure.

Moreover, analysis of variance of health care expenditure shows that countries in 1995 (Tables 1 and 2) with NHS modes of delivery, had a lower mean value than those of social insurance models operated by other countries in the EU (NHS countries = 7.1%, s.d = 0.74; social insurance countries = 8.67%, s.d. = 1.29 for percentage of GDP, significant at $p<0.05$; NHS countries = 1197 PPP$, s.d. 244.63, social insurance countries = 1889.8 PPP$, s.d. 248.4, significant at $p<0.05$ level for per capita PPP$) and as such, are more effective in controlling public expenditure on health care. This is supported by the data findings in Figures 3 and 4 for 1995 as the majority of EU countries with NHS typologies are below the EU mean for percentage of GDP (Denmark, Finland, Greece, Italy, Spain, Sweden and the UK) and per capita PPP$ (Denmark, Finland, Greece, Portugal, Spain, Sweden and the UK). In contrast all social insurance countries except Luxembourg are above the EU mean (Austria, Belgium, France, Germany and the Netherlands) for % of GDP and all are above the EU mean for per capita spending.

4.2. Graphical Representation

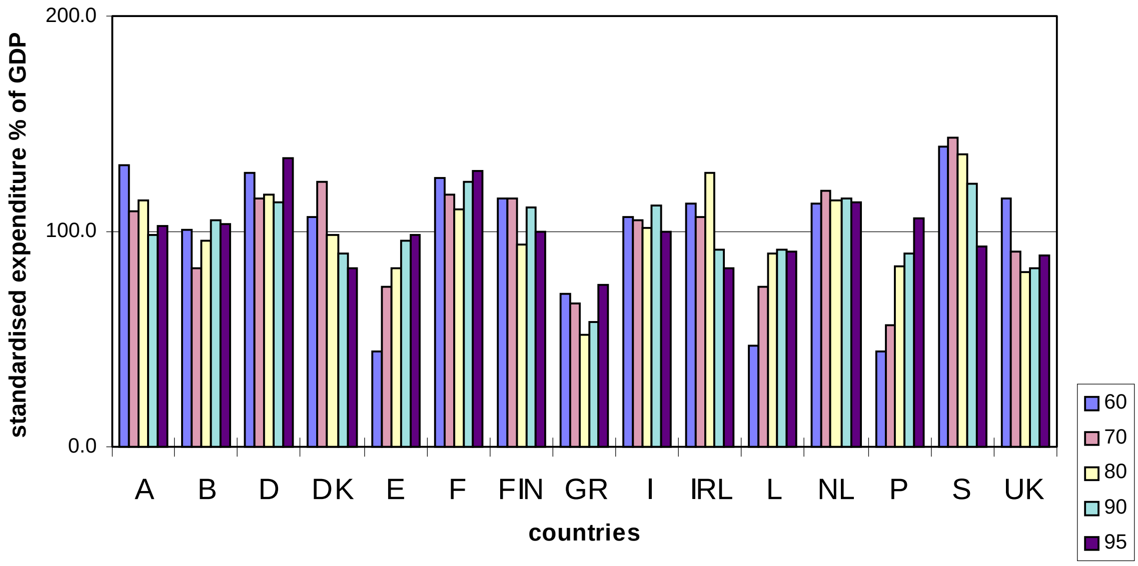
The results are illustrated graphically in Figures 3 and 4 below which show which countries have been contributing most to the observed convergence.

As can be seen from Figure 3, the principal countries conforming to the upward convergence scenario for % of GDP include Belgium, Spain, Greece, Luxembourg and Portugal. Belgium and Portugal also conform to the reversal of roles scenario as their values have gone from below the mean to above the mean in 1995. When examining countries which conform to the downward convergence scenario we see that this has occurred for Denmark, Ireland and Sweden, all of which achieved the reversal of roles scenario from a position above to a position below the EU mean. Although all other countries exhibit periods of convergence or divergence, the above countries present themselves as being the ones to explain the majority of the observed σ-*convergence*.

If we now examine the situation for per capita expenditure, as shown in Figure 4, we observe similar trends but to varying degrees compared with % of GDP.

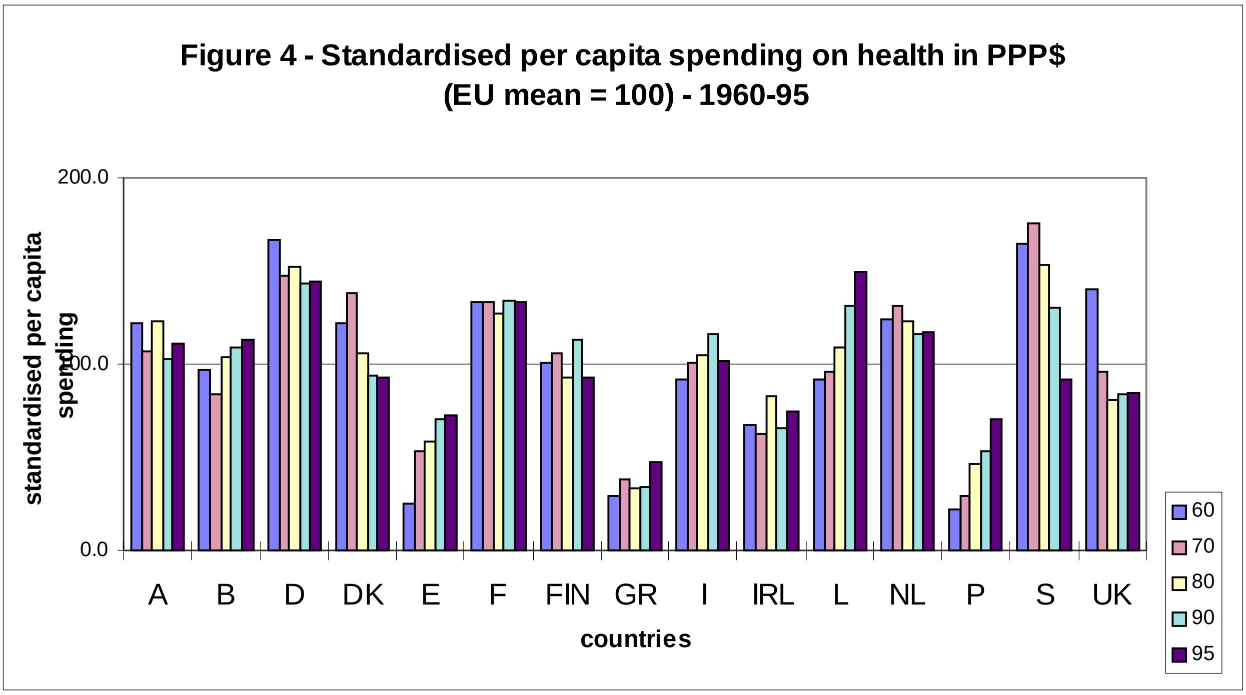
Again, the countries conforming to upward convergence towards (and above) the mean are Belgium, Spain, Greece, Ireland (to a lesser extent), Luxembourg and Portugal. However, for Spain, Greece, Ireland and Portugal the achieved convergence is less as their values in 1995 still remain well below the EU mean. In stark contrast, Luxembourg has per capita expenditure well above the EU mean after achieving the reversal of roles scenario. This reflects the relative strengths and weaknesses of member states' currencies relative to the size of their populations and their per capita GDP incomes although these should be diminished in time within the EU upon final implementation of the European single currency, the Euro.

Figure 3 - Standardised health expenditure as a percentage of GDP (EU mean = 100) - 1960-95



Spain, Greece and Portugal in particular exhibit relative weakness in this respect, whilst Luxembourg provides a good example of a country with a strong currency and high per capita income.

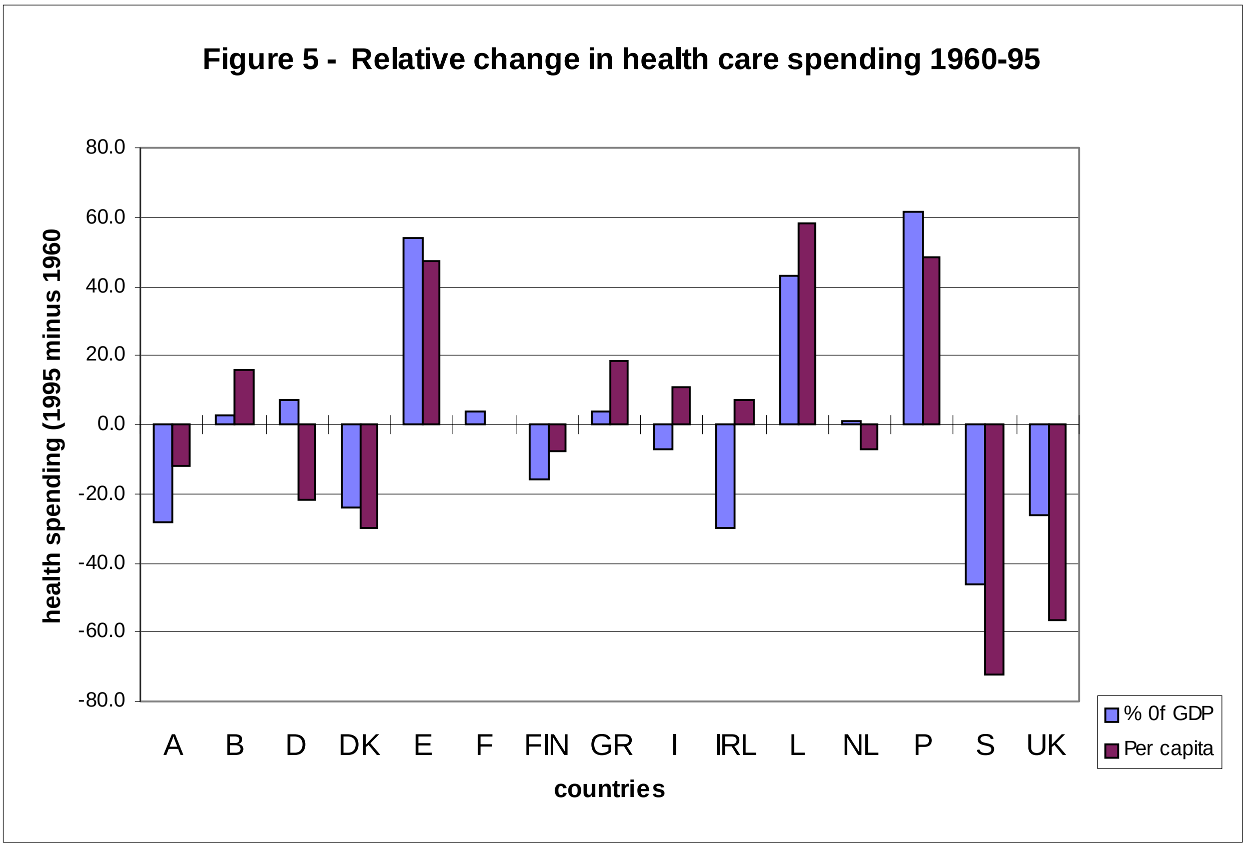
In a similar fashion to % of GDP, the countries which conform to the downward convergence scenario include Denmark and Sweden, which also achieved reversal of roles over the period of analysis. In the early stages, this also applies to the UK but this trend has been reversed to upward convergence towards the mean between 1980 and 1995.



4.3. Relative change 1960-95

Finally in this section, Figure 5 provides a snapshot of the relative changes that took place between 1960 and 1995 for spending as a percentage of GDP and per capita PPP$ values with respect to the EU mean.

The findings show that, with reference to the EU mean, there are countries which have reduced their expenditures, those which have increased their expenditures and those which have remained close to the EU mean. Countries which have achieved increased spending in both percentage of GDP and per capita PPP$ include Belgium, Spain, France, Luxembourg and Portugal. Countries which have achieved net reductions for both variables include Austria, Denmark, Finland, Sweden and the UK. Both Italy and Ireland achieved a reduction in percentage of GDP spending but an increase in per capita PPP$.



The countries, from these data, which achieved the smallest changes and therefore greatest stability would appear to be France and the Netherlands.

Having obtained strong evidence for convergence over this period and examined some of the reasons why it has occurred, the following sections seek, by more rigorous parametric testing, to confirm the existence of β convergence. This is necessary as a principal criticism of analysis of σ-*convergence* is that it is disproportionately influenced by outliers and the cross-sectional data approach over relatively long time periods cannot reflect trends in intervening years.

5. Parametric Testing for β-Convergence.

The concept of economic convergence is associated with the neoclassical growth model which produces the result that all countries tend to a common level of capital and income per head. This model leads to a relationship similar to

$$y_{t+k} = f[y_t] \tag{1}$$

where y_{t-1} is the logarithm of income, and there is a unique stable value of $y = y^*$, such that $y^* = f[^*]$. In empirical studies on convergence a common practice is to take a linearised form of equation (1) such as

$$y_{t+k} - y_t = f[y_t] - y_t = \alpha + \beta y_t \tag{2}$$

and regress $y_{t+k} - y_t$ on y_t using country cross-section data of two periods separated by a time interval of k-years. Following Baumol (1986), the literature has defined *β-convergence* as requiring that the estimated coefficient β is negative, $\beta < 0$, treating $\beta \geq 0$ as the no convergence null hypothesis. This implies that the difference of logarithms in the left-hand side of equation (2), which is the growth rate in (per capita) income over the k-year period, is negatively correlated with the starting level of incomes[5]. However, $\beta<0$ does not necessarily guarantee that the variance of dependent variable is lower at the end of the period than at the beginning (Chatterji, 1992). The condition that the variance is lowering and the set of countries will converge to a steady state where y is equalised requires that $-2<\beta<0$. Therefore, two types of β-convergence are identified: weak convergence with $\beta<0$ and strong convergence with $-2<\beta<0$.

[5] For conceptual problems associated with this type of regression see Bliss (1999).

The literature also makes a further distinction between absolute (unconditional) and conditional convergence. Absolute convergence pertains to the coefficient β of the bivariate equation (2) which is based on the assumption that all countries in the sample converge to the same steady state. Conditional convergence pertains to the coefficient β of the variable y (partial derivative) in an equation which includes additional explanatory variables reflecting differences across countries which direct each economy to converge to its own steady state. In both cases, the convergence hypothesis is that the growth rate of an economy will be positively related to the distance that separates it from its steady state. However, in empirical research, since *a priori* and objectively it is not known which countries are homogeneous or heterogeneous with regard to convergence, both types of convergence are estimated (and in general both are confirmed: Sala-i-Martin, 1996). Our sample consists of the EU countries which aspire to establish an economic union without regional or national boundaries. But at the moment the EU members differ both in their initial conditions and in their potential for reaching a steady state which will be common to all of them. Therefore, both types of *β-convergence* are the relevant concept for examination.

The empirical literature usually begins with the values of the variable under study, such as GDP, at a base year, t, and examines whether convergence has occurred at the end of subsequent time intervals, t+k, t+2k, etc. This procedure may give rise to inconsistencies and spurious results arising from the arbitrary choice of a base year and the untraceability of the path of convergence through the time interval k-t and the inability of the employed technique to distinguish different patterns of convergence and no-convergence for different members of the cross-sectional set (Bernard and Durlauf, 1996). Our empirical research takes into account both of these points.

6. Convergence of Health Expenditure in the EU

The available data set of health care expenditure and other health and macroeconomic statistics of the EU countries consists of annual observations. We examine the period 1980-95. Therefore, we have a panel data set which consists of 16 time-series observations for each of the 15 cross-sectional units, the EU member states. To take account of both the intertemporal pattern of convergence and the cross-sectional variety of the EU countries we specify absolute convergence by the equation

$$X_{t+1,i} - X_{t,i} = \alpha + \beta X_{t,i} + \gamma D_i + \delta X_{t,i} D_i + \varepsilon_i$$

or $$X_{t+1,i} = \alpha + (1+\beta)\, X_{t,i} + \gamma D_i + \delta X_{t,i} D_i + \varepsilon_I \qquad (3)$$

and conditional convergence by the equation

$$X_{t+1,i} = \alpha + (1+\beta)\, X_{t,i} + \zeta \mathbf{Y}_{t,i} + \gamma D_i + \delta X_{t,i} D_i + \varepsilon_i \qquad (4)$$

where $X_{t,i}$, and $X_{t+1,i}$ are the natural logarithms of a measure of health care expenditure of an EU member state, $\mathbf{Y}_{t,i}$ is a vector of variables that hold constant the steady state, subscript i=1, ...15 denotes the country and subscript t denotes the year. The set of dummy variables, D_i, for each cross-sectional unit, i, are included both as shift parameters, γ, and as slope parameters, δ, to reflect the potential spatial heterogeneity between the EU countries, that is differences in preferences and national health care expenditure policies. In our case, the variable Y_i denotes real income per head which previous research has confirmed as the most important determinant of health care expenditure (e.g., Newhouse, 1977). Since, equations (3) and (4) are standard difference equations, stability requires $-2<\beta<0$ which is the condition for strong *β-convergence*.

Estimates of β=0 would imply a unit root process with the t-statistic having an asymmetric nonstandard distribution (Abadir, 1995), while β>0 would signify divergence.

We test for absolute and conditional convergence of two measures of real expenditure: X^y = health care expenditure as a share of GDP, which is independent of the units of measurement and therefore most appropriate for international comparisons; and X^h = health care expenditure per head. Both variables are taken as ratios of the EU average. For the estimation, we pooled the time-series data of the 15 EU countries to form a sample of 240 observations (15-countries x 16-annual observations in real PPP$ 1990 values: OECD/CREDES, 1997), thus making use of both cross-section/long-run and time-series/short-run information[6]. However, lagging once for the calculation of $X_{t,i}$ reduces the sample used in the estimation to N=225 observations.

6.1. Convergence of health care expenditure as a share of GDP

Given the limited size of the data set, we started from a general specification of unconditional convergence, equation (3), containing the basic explanatory variable $X_{t,i}$ and 14 shift dummy variables D_i, one for each of the EU member states, with the UK as the 15th country standing for

[6] An alternative approach for the analysis of the times series tendency for convergence could test the stationary process of the relevant variable across countries, Bernard and Durlauf (1995). However, while this technique can be implemented fruitfully to the available long time series of income, the health care time series are too short to allow for valid application of these asymptotically based tests, Blomqvist and Carter (1977).

the intercept). After the first round of estimations[7], we simplified the model on the basis of the estimated coefficients of the dummy variables, their t-statistics and acceptability of other diagnostic tests inserted the slope dummy variables and continued the process of elimination to arrive at a parsimonious model which provided the estimated equation (1) in Table 3. Overall, the estimation yielded high goodness-of-fit statistics[8] and statistically significant coefficients of the explanatory variables. In particular, the β coefficient is negative and statistically significant with value β = - 0.107 and 95% confidence interval - 0.148 <- 0.107 < - 0.066. The Wald test statistic also confirms that $\beta<0$. Therefore, strong convergence is confirmed. The statistical significance of the shift dummy variables presented provides evidence of some diversity across the EU countries in the steady state but not in the speed of convergence since the slope dummies are found non-significant. On the whole, our results satisfy the strong conditions for convergence in the share of health expenditure on national income across the fifteen members of the European Union over the time period estimated[9]. Equation (2) in Table 3 presents the estimates for conditional convergence of the same dependent variable. The estimated coefficient

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[7]We used the econometric software package SHAZAM and a method of estimation which takes account and corrects econometric problems arising from the nature of the data in the pooled set of country data which is expected to be cross-sectionally correlated and time-wise autoregressive (Kmenta, 1986).

[8] For the estimation, the data are transformed and, therefore, the usual goodness of fit statistics are inappropriate. We have used instead R_1^2, the Buse R-square which measures the part of the generalised sum of squares attributable to the influence of the explanatory variables (Buse, 1973), and R_2^2, the R-square between observed and predicted values of the dependent variable.

[9] Our results contrast with those reached by other authors, such as Hitiris (1997), who have argued that the real differences in the health care policies of the EU member states mean that convergence in health care is still some way off and, therefore, economic integration in health care expenditure must be speeded up by harmonisation.

of the income variable is statistically non-significant. Therefore, conditional convergence is rejected: the EU countries are moving towards a common steady state of health care expenditure as a ratio of national GDP.

6.2. Convergence of Health Care Expenditure per head

A similar procedure was followed in the estimation of absolute convergence of health care expenditure per head and the parsimonious equation (3) in Table 3 was obtained. Once again, the overall explanatory power of our model is high and the estimated coefficients are statistically significant.

The statistically significant shift dummy variables identify only France (F) and Luxembourg (L) as deviating from the general pattern of the EU countries. On the whole, the results provide evidence of strong absolute convergence of health care expenditure per head across the EU countries with $\beta = -0.027$ and 95% confidence region $-0.044 < -0.027 < -0.009$. Therefore, the speed of convergence is rather low: starting from the 1995 expenditure levels and EU mean, it would take Greece 28 years to come up, and Luxembourg 15 years to come down to the EU average. The results for conditional convergence are presented in Table 3, equation (4). They are also statistically significant with value of β within the confidence region $-0.092 < -0.064 < -0.036$. Therefore, the health care expenditure per head also displays strong conditional convergence across the EU countries[10].

[10] Our finding that both absolute and conditional convergence occurs in the EU is not contradictory if the common steady state and the national steady states follow a parallel course. Income per head, Y, which is the variable we

7. Health Care System and Convergence

As indicated in section 3, the health care system different EU countries operate is ether *National Health Service (NHS)*, which is characterised by universal coverage, tax financing and public provision; or *Social Insurance (SI)*, which is characterised by compulsory universal coverage, financed by employer and employee contributions through non profit insurance funds, and public and/or private providers. The former is more centralised than the latter and, therefore, potentially effective with regard to controlling the growth of health care expenditure. In refining earlier classifications, of the 15 EU member states, six operate the NHS system (DK, I, IRL, FIN, S, UK) and six the SI system (A, B, D, F, L, NL), while the three poorer member states (E, GR, P) have adopted the NHS system but rather lately and, due to their limited availability of resources, are still in the process of developing it[11]. In this section, we propose to examine whether convergence is associated with the health care system under this tripartite classification of the EU countries. Given the nature of the two systems and the current pressures for controlling health care expenditure, which is mainly determined by the level of per capita income, we would expect that the NHS countries display lower health care expenditure than the SI countries, while the group of the poorer countries, which belong to the NHS group, might be still striving to allocate more resources to health care.

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have chosen to reflect the differences among the EU countries, also displays strong convergence with $\beta = -0.019$ (standard error 0.009). This is comparable to the results obtained by other investigators who have found speed of convergence 2% per year ($\beta = -0.020$) for the OECD countries (Mankiw et al.,1995; Barro et.al, 1995; Sala-i-Martin, 1996).

[11] Ireland (IRL) is also included among the developing EU countries with regard to income per head but its NHS system is quite advanced.

The results of our estimations, which are presented in Table 4, on the whole confirm our expectations: the Social Insurance (SI) and Lower Income (LI) NHS groups of countries are shown with a higher steady state level of health care expenditure (shift dummies) than the National Health System (NHS) countries. Otherwise, the speed of convergence, the β coefficient, is common to all the groups with none of the slope dummies found to be statistically significant. The health care expenditure as an income share verifies that absolute convergence is occurring (equation 1) while conditional convergence is not (equation 2). The shift dummy for the Lower Income NHS countries, LI, is statistically significant in both cases (but not different from that of the SI countries under absolute convergence). Similar results were obtained for expenditure per head. Both absolute and conditional convergence occur but without a significant difference between the LI NHS group and the NHS group. The speed of absolute convergence is β = - 4.4 per cent annually. The results for conditional convergence (equation 4) confirm the patterns already detected, that the SI group of countries spend on health care more than the LI NHS and the NHS groups. This result might be the outcome not only of the inherent centralisation and controllability of the NHS system of health care but also of the opportunities it offers for the exploitation of economies of scale.

TABLE 3 Estimated Coefficients of Health Care Expenditure Convergence Models

Coefficient	**(1)** $\mathbf{X^y}$	**(2)** $\mathbf{X^y}$	**(3)** $\mathbf{X^h}$	**(4)** $\mathbf{X^h}$
constant α	- 0.011	- 0.011	- 0.001*	0.002*
	(0.003)	(0.003)	(0.002)	(0.002)
coefficient $(1+\beta)$	0.893	0.893	0.973	0.936
	(0.021)	(0.021)	(0.009)	(0.014)
income ζ		- 0.004*		0.091
		(0.011)		(0.018)
Dummy Variables	0.023 B	0.023 B	0.012 F	- 0.020 DK
	(0.008)	(0.008)	(0.006)	(0.005)
	0.044 D	0.042 D	0.026 L	0.033 P
	(0.011)	(0.012)	(0.007)	(0.016)
	0.041 F	0.041 F		
	(0.008)	(0.008)		
	0.026 NL	0.026 NL		
	(0.007)	(0.007)		
R^2 (Buse)	0.613	0.614	0.727	0.773
R^2 (observed/predicted)	0.967	0.967	0.987	0.985
β- coefficient	- 0.107	- 0.107	- 0.027	-0.064
	(0.021)	(0.021)	(0.009)	(0.014)
Wald $\chi^2_{(1)}$ test for $\beta=0$	25.715	25.766	9.056	20.39

Notes: standard errors in parentheses. Estimates with a * indicate non-significance at the 0.05 level. Equations (1) and (2) refer to health care expenditure as a share of GDP, X^y; equations (3) and (4) refer to health care expenditure per head, X^h. The country dummy variables (as in footnote 2) are shift dummies.

TABLE 4 Health Care System and Convergence

Coefficient	**(1)** $\mathbf{X^y}$	**(2)** $\mathbf{X^y}$	**(3)** $\mathbf{X^h}$	**(4)** $\mathbf{X^h}$
constant α	- 0.010	- 0.010	- 0.007	- 0.013
	(0.004)	(0.004)	(0.003)	(0.004)
coefficient $(1+\beta)$	0.953	0.953	0.956	0.917
	(0.017)	(0.019)	(0.016)	(0.019)
income ζ		- 0.015*		0.079
		(0.018)		(0.019)
Dummy, SI	0.017	0.013	0.018	0.022
	(0.008)	(0.006)	(0.006)	(0.006)
Dummy, LI	0.017	0.024	0.009*	0.015*
	(0.005)	(0.011)	(0.013)	(0.013)
R^2 (Buse)	0.608	0.626	0.688	0.754
R^2 (observed/predicted)	0.958	0.957	0.987	0.987
β- coefficient	- 0.046	- 0.047	- 0.044	-0.083
	(0.017)	(0.018)	(0.016)	(0.019)
Wald $\chi^2_{(1)}$ test for β=0	7.374	6.323	7.595	19.994

Notes: standard errors in parentheses. Estimates with a * indicate non-significance at the 0.05 level. Equations (1) and (2) refer to health care expenditure as a share of GDP, X^y; equations (3) and (4) refer to health care expenditure per head, X^h. The countries in the shift dummies are: SI=A, B, D, F, L, NL; and LI=E, GR, P. Country abbreviations as in footnote 2.

8. Graphical representations of convergence analysis

The trends relating to the observed convergence are represented in Figures 6 to 20 which show % of GDP, per capita health spending and per capita income for each of the 15 countries in the EU. In addition, Figures 21 to 23 show the % of GDP for all social insurance countries, LI (NHS) countries (Greece, Spain and Portugal) and NHS countries (Denmark, Finland, Italy, Ireland, Sweden and the UK). Figures 24 to 26 show the same groupings of countries for per capita spending. These latter groupings are chosen as it has been shown that they are statistically different from each other.

When examining the graphs for each individual country in relation to Leonardi's classifications the countries which conform most closely to the equivalent growth hypothesis are Austria (Figure 6), the Netherlands (Figure 17) and the UK (Figure 20). It is interesting to note that in the case of the Netherlands, per capita income is below both expenditure as a % of GDP and per capita health expenditure, whilst for the UK this situation is reversed with per capita income being above both variables for health expenditure. The per capita income of Greece (Figure 13) also displays almost parallel growth with the EU mean.

The upward convergence scenario is evident for Spain (Figure 10), Greece (Figure 13), Ireland (Figure 15) (per capita income and per capita health expenditure) and Portugal (Figure 18). For per capita income and per capita expenditure all these countries have values well below the EU mean for the majority of the period examined. It can be seen from Figure 15 that Ireland has achieved considerable upward convergence in per capita income, indicating a strengthening economy from the mid 1980s.

The downward convergence scenario is evident for Sweden for all three variables, achieving reversal of roles in the case of per capita expenditure and % of GDP in the mid 90s. In terms of % of GDP, Ireland (Figure 15) experienced downward convergence until 1988 when reversal of roles occurred. From 1993, Belgium experienced downward convergence towards the mean for all three variables and France also experienced this scenario for per capita income.

From 1991, Finland (Figure 12) also converged down towards the EU mean for % of GDP and achieved reversal of roles to a position below the mean for both per capita expenditure and a little earlier for per capita income. Italy (Figure 14) has also converged down towards the mean for all three variables since 1991. Finally, the UK (Figure 20) experienced downward convergence for per capita income from 1997 and reversal of roles occurred in 1991.

When we examine expenditure as a share of income for the SI countries (Figure 21), LI (NHS) countries (Figure 22) and NHS countries (Figure 23) it can be seen that LI (NHS) countries (Spain, Portugal and Greece) are all converging upwards towards the mean (in the case of Portugal reversal of roles also occurs), whilst the NHS countries are converging mostly downwards to a position on or below the EU mean.

The most striking differences, however, are apparent in per capita expenditure as shown in Figures 24-26. Figure 24 shows that all the SI countries achieve per capita expenditures above the EU mean. In contrast, LI(NHS) countries are well below the mean although they are all converging towards the mean over the period examined. Again, NHS countries are converging to a point on or below the EU mean with Sweden experiencing the greatest degree of convergence over the period of analysis.

This appraisal supports the finding that within the EU there is a good degree of heterogeneity with three distinct groupings in evidence. The majority of convergence would appear to be derived from movements in the countries with NHS modes of delivering health care.

Figure 6 - Health expenditure and per capita income - Austria

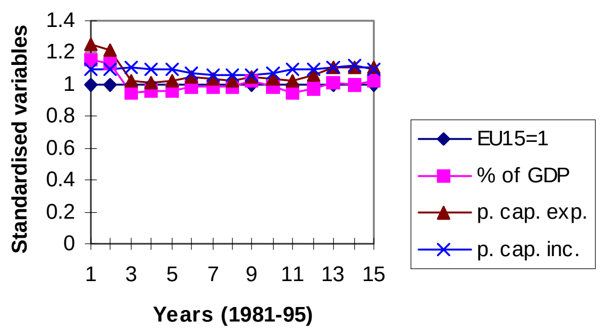


Figure 7 - Health expenditure and per capita income - Belgium

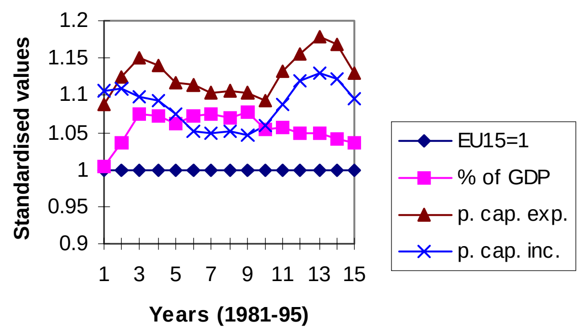


Figure 8 - Health expenditure and per capita income - Germany

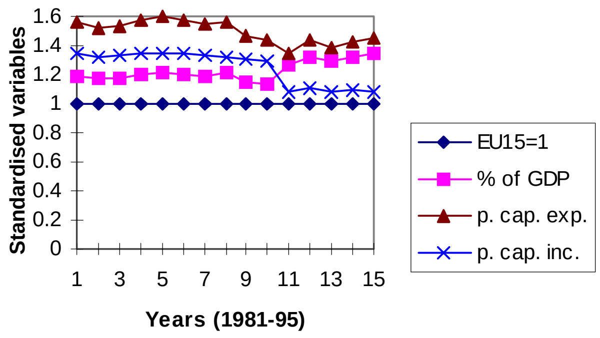


Figure 9 - Health expenditure and per capita income - Denmark

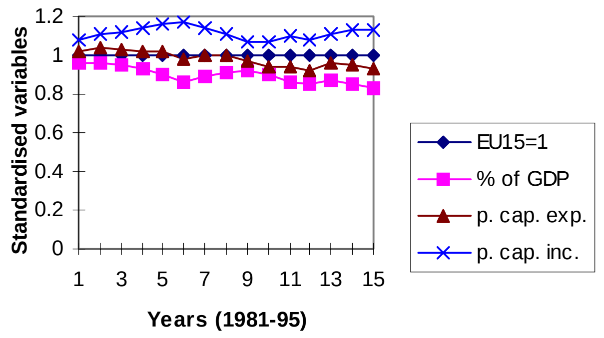


Figure 10 - Health expenditure and per capita income - Spain

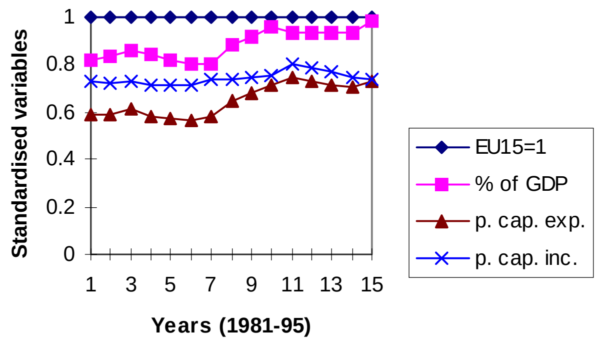


Figure 11 - Health expenditure and per capita income - France

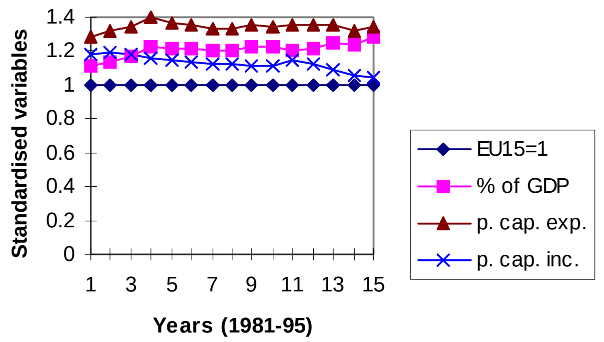


Figure 12 - Health expenditure and per capita income - Finland

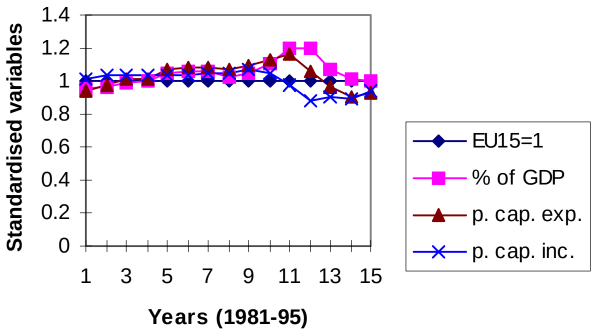


Figure 13 - Health expenditure and per capita income - Greece

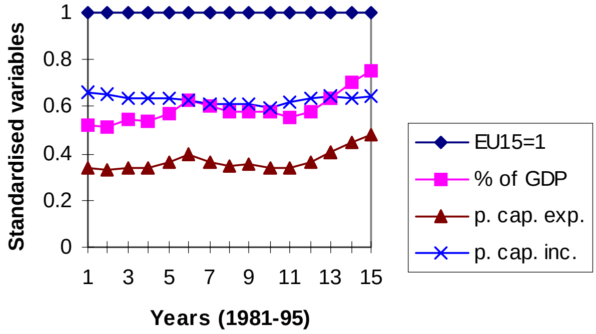


Figure 14 - Health expenditure and per capita income - Italy

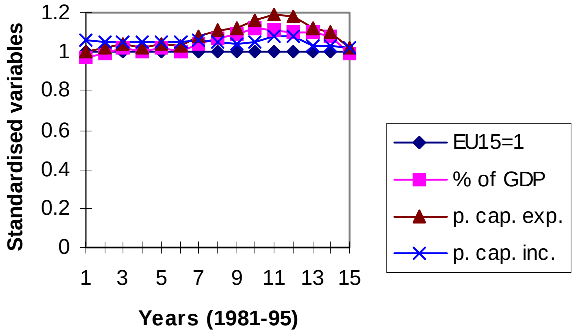


Figure 15 - Health expenditure and per capita income - Ireland

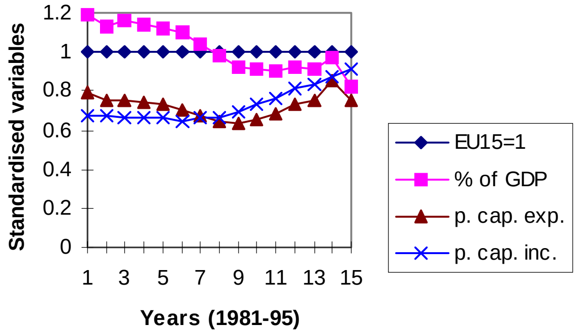


Figure 16 - Health expenditure and per capita income - Luxembourg

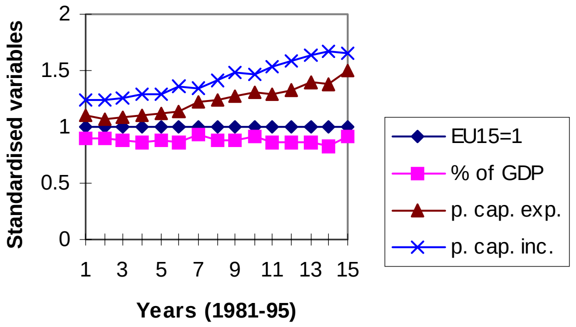


Figure 17 - health expenditure and per capita income - Netherlands

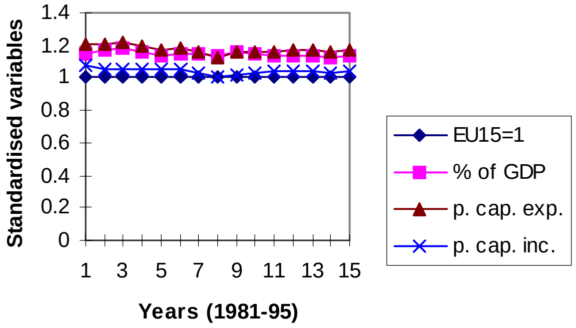


Figure 18 - Health expenditure and per capita income - Portugal

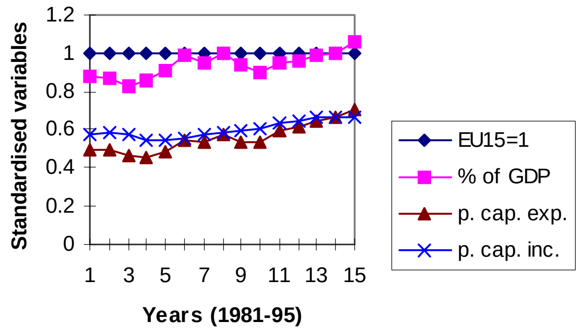


Figure 19 - Health expenditure and per capita income - Sweden

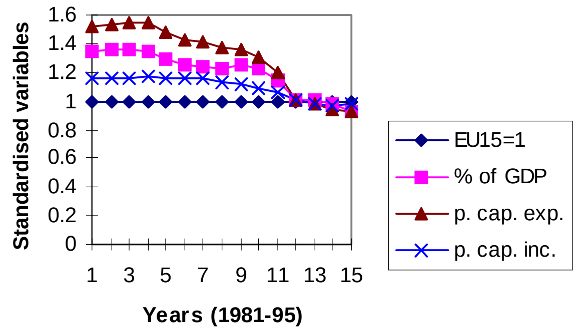
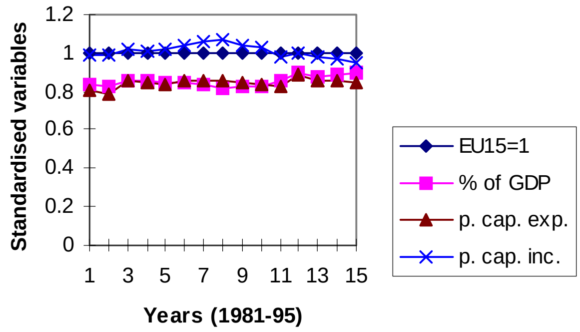


Figure 20 - Health expenditure and per capita income - The UK



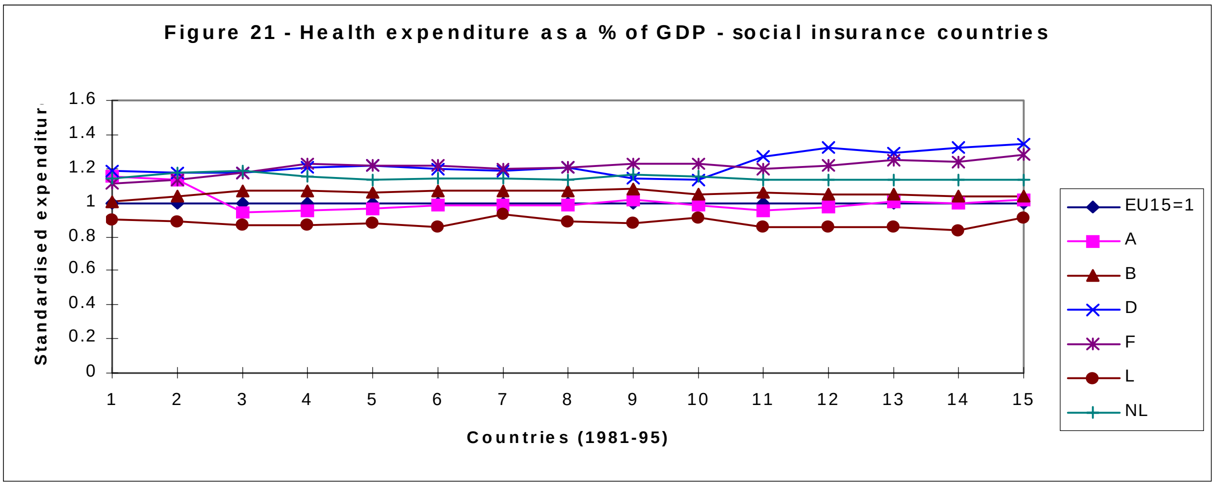


Figure 21 - Health expenditure as a % of GDP - social insurance countries
Standardised expenditur
Countries (1981-95)
EU15=1
A
B
D
F
L
NL

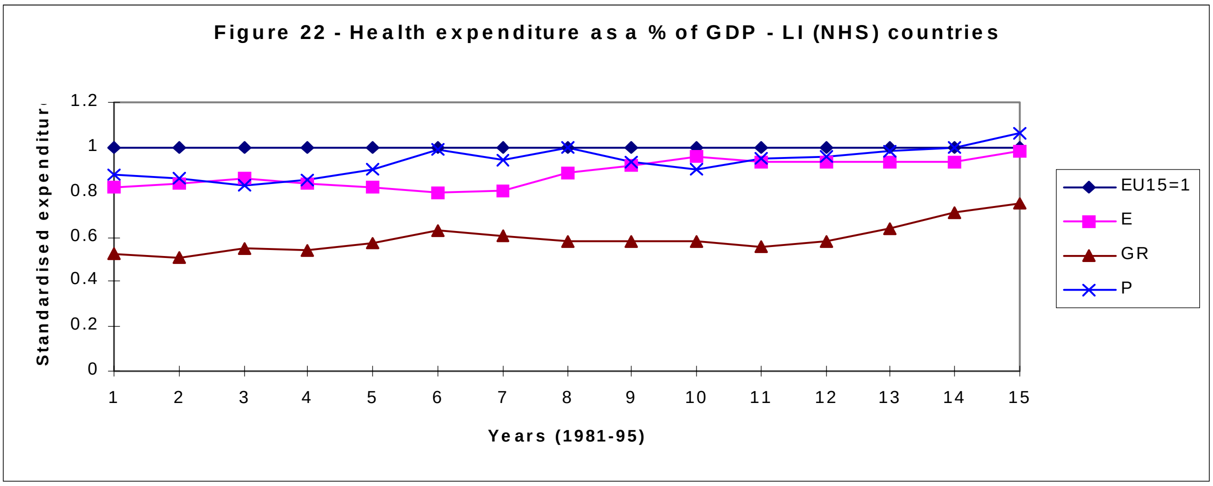


Figure 22 - Health expenditure as a % of GDP - LI (NHS) countries
Standardised expenditur
Years (1981-95)
EU15=1
E
GR
P

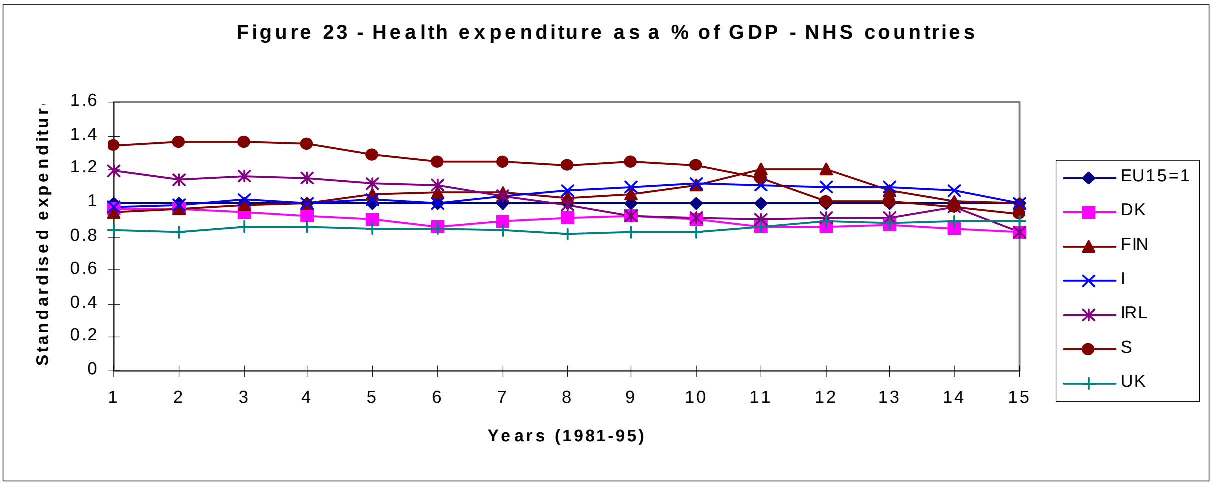


Figure 23 - Health expenditure as a % of GDP - NHS countries
Standardised expenditur
Years (1981-95)
EU15=1
DK
FIN
I
IRL
S
UK

Figure 24 - Per capita health expenditure - social insurance countries

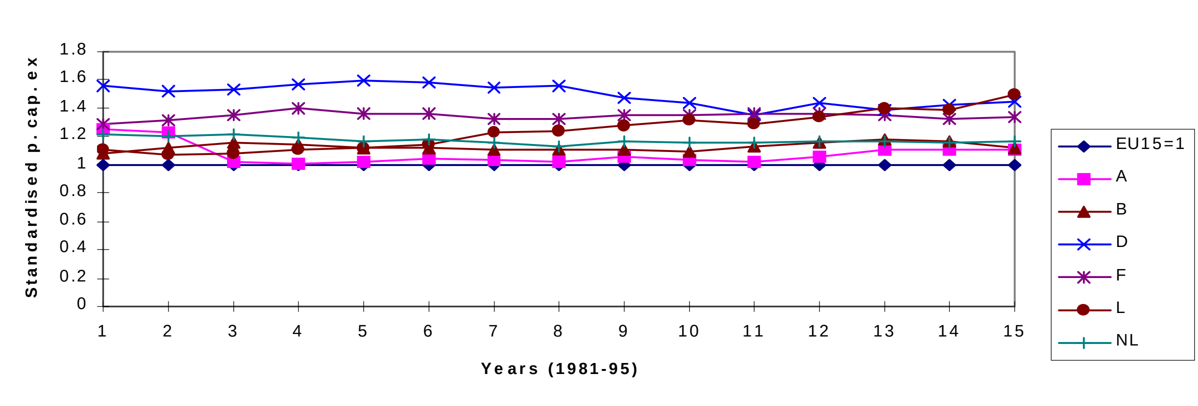


Figure 25 - Per capita health expenditure - LI (NHS) countries

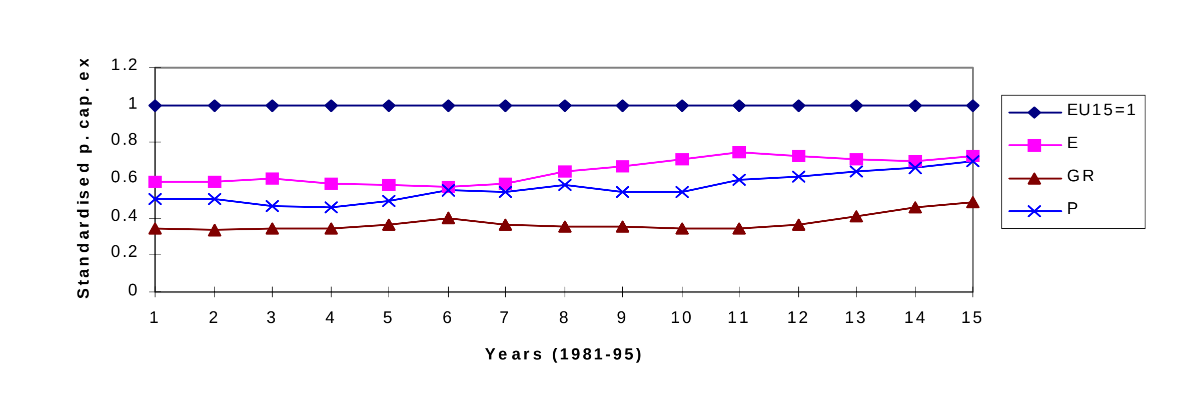
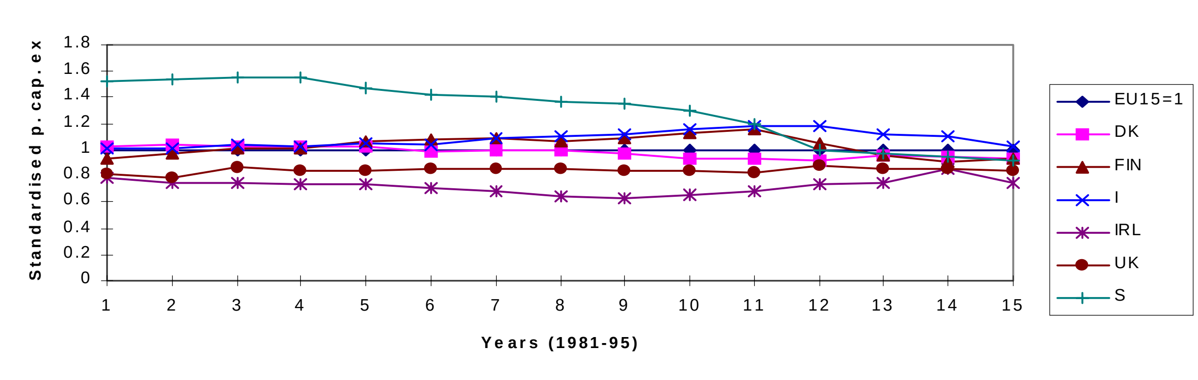


Figure 26 - Per capita health expenditure - NHS countries



9. Conclusions

This paper has employed both cross-sectional and panel data to examine whether the pattern of relative health care expenditure in the EU countries over the period 1960-95 and 1980-95 is consistent with the convergence hypothesis. Our findings support the notion of both σ- and β-*convergence* for both health care expenditure per head and as a share in national income. The parametric testing has shown that the further away health care expenditure is from its steady state the faster it approaches. Heterogeneity is a feature of health expenditure within the countries of the EU, with social insurance countries sharing common characteristics which place them above the EU mean for both share of GDP and per capita expenditure, whilst two sub-groups of NHS countries also exist which exhibit a north-south divide based on GDP income. However, the low income NHS countries of the south (Spain, Portugal and Greece) are all converging upwards towards the EU mean. In the second group of NHS countries, Sweden is prominent in achieving a high level of downward convergence. These results are important in that they represent the first detailed study confirming that the general move towards closer economic integration in the European Union extends also to the health care sector where strong forces are at work for convergence of the health care expenditure towards EU-wide standards.

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