Education and health: welfare state composition and growth across country groups

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Abstract

When analysing the Welfare State-economic growth nexus, the importance of health and education expenditures and their impact on human capital accumulation is often neglected. In this study, we claim that the Welfare State composition matters for growth, making it necessary to assess the impact of education and health (public) expenditures on educational attainment and health status, as well as their effect on the real output across countries. To better account for the influence of differences across countries we consider three groups over the period 1960-2012: high income (non-EU) OECD countries, the EU member states before the 2004 enlargement and the EU enlargement (2004 and 2007) new member states. The contribution of the study is twofold. First, we identify long-run relationships for the main variables using the DOLS estimator corrected for cross-sectional dependence. Secondly, we estimate short-run relationships that include an ECM term from the associated long-run equation by applying fixed effects and pooled mean group estimators and identify the direction of causality. The results of the estimation of the long-run equilibrium relationships point to a positive, direct or indirect, influence of (public) education expenditures and (public, private or total) health expenditures on the output in all the groups. However, causality analysis presented mixed results concerning our policy variables, education and health expenditures, within and between country groups. These results can have important implications for Welfare State policy design in the EU and its OECD partners. For the high-income OECD (non EU) group, the results unequivocally support the use of social policy variables as a means to foster economic growth. However, for both EU country groups, educational and health expenditures react to disequilibrium relative to the long-run equilibrium path, so that they are endogenously determined with output, which undermines their use as growth enhancing policies.

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1. Introduction

There is a long-standing debate in the economic literature on the influence of the Welfare State on economic performance and controversies still remain on the sign of this relationship. For some authors, according to Hoareau-Sautieres and Rascle (2005), public social spending is an impediment to a good economic performance because: it discourages savings and investment; its funding uses scarce resources and introduces distortions in economic activity, it hampers job creation and increases unemployment, and it is more inefficient than the market in covering certain social responsibilities. Arguments in the opposite direction suggest that the Welfare State cannot be understood only in terms of the economic costs that it entails since the services it offers have important benefits, namely in terms of output and productivity growth as well as generating positive externalities. An often cited author in defence of the Welfare State, Peter Lindert, argues that the Welfare State has, among others, allowed countries to achieve higher levels of equality without leading to a slowdown in output growth, a situation which the author designates as the „free lunch puzzle" (Lindert, 2002; 2004; 2006a). According to the same author, the adverse effects of state intervention in economic performance result from other forms of action such as design of legal framework and regulation of certain markets (Lindert, 2006b).

From an economic growth perspective, two important dimensions of the Welfare State are public expenditures on education and health, to the extent that they lead to the accumulation of human capital, which plays a central role in growth models, both exogenous and endogenous. Human capital can be described as „(...) the knowledge, skills, competencies and other attributes embodied in individuals that are relevant to economic activity" (OECD, 1998). A healthier and more educated population/workforce corresponds in principle to a higher availability of human capital in the economy, thereby improving productivity and increasing output in this way (Mankiw *et al*., 1992; Lucas, 1988). In advanced economies, it increases the respective innovation capability (Romer, 1990; Jones, 1995; Jones, 2005) and in those that are below the technological frontier, it allows the diffusion and transmission of knowledge in order to process new information and implement successful technologies developed by the leaders (Nelson and Phelps, 1966; Abramovitz, 1986; Benhabib and Spiegel, 1994; Benhabib and Spiegel, 2005). Investment in education and health can thus generate substantial returns over time, not just at the individual level, but especially for the economy as a whole, and the Welfare State can play a crucial role in this dynamic process.

The main objective of this work is to contribute to the debate on the economic impact of the Welfare State by focusing on two of its dimensions, the provision (direct or indirect) of education and health services, and the assessment of their importance for long-run macroeconomic performance. For this purpose, we apply panel data methodologies that allow us to identify long-run equilibrium relationships and to also test for causality. We first test for the presence of panel unit roots and in this way check the resilience of health and education variables, correcting for the presence of cross-sectional correlation. Next, we estimate growth regressions to identify long-run equilibrium relationships. Finally, based on the previous results, we analyse causality between education and health variables and output, as well as between the former and different social indicators that influence the welfare levels of the population. We consider three samples of countries listed in the World Development Indicators database of the World Bank over the period (maximum) 1960-2012. The first group (EU_1) includes the European Union member states before enlargement to the East (except Luxembourg), the second group (EU_2) is composed of the countries that joined the EU after 2004 (enlargement countries) and the third group (OECD_w) includes the wealthiest OECD, non-EU, countries. There is no overlapping between the three groups. All the countries included in the three groups are classified as developed countries by the World Bank. In any case, the three groups present sufficient variation in the respective income levels to make it possible to accommodate the hypothesis that the impact of education and health expenditures on economic growth varies according to income levels.

The remainder of this work is structured as follows. Section 2 contains a brief review of the literature on the relationship between the Welfare State and economic growth, with particular emphasis on some empirical results on the effects of public spending on education and health. In section 3, we review some applied studies that have used panel causality methodologies in order to better locate our methodology within some related applied econometrics literature. In section 4, we describe the data used and the methodology applied. Section 5 presents and discusses the results. Finally, section 6 outlines the main conclusions.

2. The Welfare State - economic growth nexus: theory and facts with a focus on public expenditure on education and health

The Welfare State is a difficult concept to define since its design and implementation can take many different forms, as seen in the different models adopted by European countries. For instance, in OECD countries, Adema *et al.* (2011) point to an average public social expenditure[1] of 19.2% of GDP in 2007 and 22.5% in 2009, the most important items relating to pensions (representing on average 7% of GDP in 2007) and health spending (on average 6% of GDP in 2007). However, the figures for each country can vary greatly: in the cases of Mexico and South Korea, public social expenditure corresponds to 7% of GDP, while in France,

[1] According to the OECD definition, public social spending includes the amounts spent by governments with pensions, social benefits and health.

it represents 28% and in Sweden 27%, values for the year 2007. As a general definition, we can say that the Welfare State is a state in which the government uses a significant portion of national resources to provide services that benefit individuals or families (who meet certain criteria) in order to protect and promote their economic and social well-being, so that they are intended to be consumed individually, as opposed to collective consumption goods such as national defence or internal security[2]. The services associated with public social spending can be directly provided by the state, such as education and health, or may take the form of transfers, such as pensions or unemployment benefits, which allow individuals and families to have access to certain services essential to their subsistence with a decent quality of life.

Following the economic crisis that hit the world economy in 2007-2008 and the ensuing public fiscal sustainability problems faced by many European countries, the relationship between the Welfare State and economic performance returned to the policy agenda and public discussion, although this is not a recent debate within the economic literature (see e.g., Barr, 1992; Atkinson, 1995; Hassler *et al*., 2003; Lindert, 2004). In broad lines, the fundamental question that has been asked is whether an extensive Welfare State and sustained economic growth are incompatible goals, i.e. whether it is necessary to reduce the first to stimulate the second. One of the main arguments used in defence of the reduction of the size of the Welfare State is based on its negative effects on incentives. On the one hand, income taxes used to finance the Welfare State discourage a greater effort from workers and investment in innovations by firms since the government will retain part of their earnings and profits, respectively. Moreover, unemployment benefits discourage labour supply, since they guarantee an income for the unemployed workers and also serve as a protection to active workers, which are thus discouraged from higher working effort. But the potential costs of the Welfare State can be neutralized or even compensated by the associated benefits. Thus, the Welfare State does not necessarily hamper economic performance, particularly as far as output growth in the long run is concerned. It is not possible to determine universally whether the Welfare State as a whole stimulates or reduces economic growth. There will be some measures that have a positive influence, while others will have a negative impact, which makes empirical analysis fundamental to identify the existing relationship[3]. One way to

[2] See *A Glossary of Political Economy Terms*, Paul M. Johnson, Department of Political Science, Auburn University (http://www.auburn.edu/~johnspm/gloss/welfare_state).

[3] This debate is part of a wider one on the optimal size of government in terms of economic growth. For instance, Barro (1990) argues in favour of the existence of productive public expenditures, those that contribute to an increase in investment in the economy, and unproductive ones, with the former allowing the acceleration of economic growth. Devarajan *et al.* (1996) conducted an empirical study on the impact of the composition of public expenditure on economic growth based on two classifications: economic category (current and capital expenditures) and functional (education, health, defence, transport and

move forward in the understanding of this relationship has been through applied studies that investigate the relationship between certain dimensions of the Welfare State and economic growth, in particular the study of the relationship between public spending on education and/or health and output growth[4].

The Welfare State can play a very important role in terms of economic growth to the extent that public spending on education and health provide the services necessary for the accumulation of human capital, a key ingredient in modern growth theory. In what is known as the augmented Solow model, Mankiw *et al.* (1992) introduce human capital as an input into final goods production, along with physical capital and labour, with its accumulation explained by the decisions of economic agents in terms of consumption and savings. In a neoclassical framework, the authors show that differences in human capital availability are decisive in explaining the differences in income levels across countries, with higher human capital accumulation also leading to faster growth, at least in the short to medium-run. But in growth models known as endogenous, the main source of growth is not capital accumulation but technological change, and human capital is also considered fundamental for knowledge production. In the models of Romer (1990), Jones (1995)

communications, etc.). Based on the latter classification, the authors were not able to find any relationship between expenditures on education and health and the growth rate of real GDP per capita in the 43 countries analysed between 1970 and 1990. Andrade *et al.* (2006), on the other hand, concluded that in the EU, between 1960 and 2002, the optimal size of government was still far from being reached. In a recent survey on the general topic of government size and growth, Bergh and Henrekson (2011) highlight the lack of consensus on the sign of the relationship, which the authors attribute to differences across studies on the measurement of government size and the sample of countries under analysis. However, the authors argue that: "(…) on studies that examine the correlation between growth of real GDP per capita and total government size over time in rich countries (OECD and equally rich), the research is rather close to a consensus: the correlation is negative (..)" (p.873). They also suggest that economies with big governments, such as the Scandinavian countries, can still register high growth rates because of (associated) higher social trust levels or by implementing market-friendly policies in other areas.

[4] Examples of recent empirical studies that take a more aggregate perspective of the Welfare State by considering the impact of public social spending as a whole on economic growth include Fica and Ghate (2005), Im *et al.* (2011) and Ding (2012) Fica and Ghate (2005), use as an indicator of the size of the Welfare State spending on public transfers relative to public investment spending and conclude, for the 19 developed countries studied between 1950 and 2001, for a negative impact of the expansion of the Welfare State on economic growth. Im, Cho and Porumbescu (2011) compare the influence in developed and developing countries over the period 1990-2007, using as a proxy for the Welfare State public spending on social protection, education and health relative to GDP. The results point to a positive correlation in developing countries, which becomes negative in developed countries. Finally, Ding (2012) analyses the OECD countries from 1980 to 2005, considering the impact of social spending, as officially defined, on the growth rate of real GDP per capita. The author found a negative relationship between these variables.

and Jones (2005), for instance, human capital is essential for the production of new ideas, while in the models of Nelson and Phelps (1966), Abramovitz (1986), Barro and Sala-i-Martin (1997) and Rogers (2003), human capital is a key determinant of the ability to absorb new technologies by economies further away from the technological frontier. For these economies to be able to carry out imitation activities and thus recover from their technological backwardness, they need a workforce that can incorporate, adapt and use new technologies. Benhabib and Spiegel (1994) pioneer empirical study of the different human capital transmission mechanisms – both as a factor of production of final goods and as a crucial input in the creation of new ideas (inventions), but also for the imitation and absorption of existing technologies - concluded that the relative importance of these different channels depends mainly on the level of development of countries, with the role of human capital as a source of technological change more important for advanced economies, as expected.

Human capital accumulation can occur through different sources such as formal education, training, learning-by-doing or health care, according to the OECD (1998). A more educated and healthier worker can work more efficiently and effectively, can think better, becoming more productive, and devote more time to productive activities. The source of human capital that has most often been investigated in empirical growth studies is formal education, with the majority of studies confirming its importance for economic growth, although some unresolved issues remain (see e.g. Sianesi and van Reenen, 2003). As for the influence of health status indicators on economic growth, the empirical analyses are scarcer, pointing in any case to the existence of a positive correlation (see e.g. Bloom, Canning and Sevilla, 2004). In this sense, public expenditure on education and health can be an important vehicle for human capital accumulation and contribute positively to economic growth.

The empirical analysis of the relationship between education and health spending and economic growth has relied on the estimation of growth regressions in which the dependent variable is the growth rate of real GDP, total or per capita, and expenditure on education and/or health services appear as the main explanatory variables, along with a number of other independent variables, the so-called control variables, which have proved to be important in explaining output growth in previous empirical studies (see Sala-i-Martin, 1997; Doppelhofer *et al.*, 2004; Durlauf *et al.*, 2005). These studies explore information for a wide range of countries over different time periods. An example of a recent study that follows this approach is Beraldo *et al.* (2009) who analyse the simultaneous impact of expenditure on education and health on output growth and also differentiate between the impact of public and private expenditures. The sample includes 19 OECD countries over the period 1971-1998. Both variables show a positive influence on the rate of growth of output, but stronger in the case of health expenditures. Another interesting result concerns the greater influence of public spending on health and education relative to private spending.

A methodological problem that can be assigned to the previous study is that it does not properly take into account the possibility of reverse causality, that is, the fact that output growth could lead economies to spend more on health and education[5]. The approaches followed to incorporate this hypothesis include studies focusing on the situation of single countries, exploiting only time series information, and studies that apply the concerns of time series econometrics to groups of countries, using methodologies for cointegration and causality analysis specific for panel data. In this latter context, Erdil and Yetkiner (2009) focus on the study of the direction of causality between the growth of real GDP per capita and real per capita health expenditure growth for a set of 75 countries between 1990 and 2000, split according to income levels. The estimation of a VAR model with two variables and panel data allows the authors to conclude for the existence of causality in both directions for 46 out of the 75 countries analysed. In the group of high income economies, composed of 24 countries, the influence that seems to prevail is the positive impact of health expenditures on output, which the authors attribute to the greater dependence of these countries on human capital given the more advanced technologies they use in production activities. In the case of middle and low-income countries, the direction of causality that stands out is the opposite one, from output to health spending, also with a positive sign. Wang (2011) focuses on the influence of (total) health expenditures on output growth in 31 OECD countries between 1986 and 2007. The panel cointegration tests carried out indicate the existence of a long-run relationship between total GDP and, alternatively, three measures of health expenditure: total expenditures, per capita expenditures, and individual health care expenditures. The author goes on to estimate the relationship between output and health expenditures applying FMOLS (fully modified ordinary least squares) that allows to take into account the possible endogeneity of health expenditures, concluding for the existence of bi-directionality between these and output. The application of a Granger causality test for panel data also leads to a positive influence from health spending growth to output growth, but negative from the second to the first. Finally, Wang (2011) tries to identify the existence of differences in the impact of health spending growth on output growth according to the distribution of the two variables using the method of quantile regressions. From this analysis, the author concludes that in countries with low output growth rates, the growth of health spending has a negative impact on output growth. In countries with higher output growth rates (over 5 %), the sign of the relationship becomes positive. On the other hand, considering the

[5] Baltagi and Moscone (2010) test for the influence of the level of income on health expenditures for a sample of 20 OCDE countries over the period 1971-2004 and conclude that real GDP per capita causes per capita health expenditures, but the respective income elasticity is lower than one.

impact of output growth across the distribution of health expenditures growth, the impact is negative when health expenditures growth is either rather low or rather high. Hartwig (2008) also tests, using panel data, for the existence of Granger causality between the growth of real GDP per capita and the growth of health spending per capita for 21 OECD countries between 1970 and 2005 based on the estimation of a VAR model. The results support the existence of a negative influence of the growth of health spending on output growth, while output growth has a positive influence on health expenditures growth.

Hartwig (2012) applies a methodology similar to that in Hartwig (2008) but he estimates a growth regression to test the relationship between growth in education and health expenditures per capita, together and separately, and the growth of real GDP per capita in a sample of 18 OECD countries between 1970 and 2005. The only other determinant of growth considered is the rate of growth of investment in physical capital. The results regarding the influence of health and education expenditures growth on the growth rate of real GDP per capita depend on whether or not the influence of the investment rate is considered and on the inclusion of Japan in the sample. In the first case, when the author considers the investment rate as an explanatory variable, he does not find any influence for health and education expenditures on growth. However, the exclusion of Japan from the sample makes this influence negative.

The question of the direction of causality can also be addressed based on the individual situation of each country, i.e. by exploring the information of the relevant time series. Devlin and Hansen (2001) provide an example of such an approach for 20 OECD countries, concluding that in six of the countries analysed between 1960 and 1987, there is no confirmation, according to the Granger causality test, that real per capita health expenditures and real GDP per capita influence each other. In eight countries, the causality occurs from health expenditures to output, in another eight countries causality occurs only in the opposite direction, and thus in only two countries, Denmark and Iceland, is there a simultaneous influence. Maitra and Mukhopadhyay (2012) analyse in turn a group of twelve developing countries in Asia and the Pacific between 1981 and 2011 (maximum), trying to identify causality relationships between public expenditure on education, public expenditure on health and output. Also, in this case, the results differ depending on the country in question. In nine countries, public spending on education has a positive influence on output, while the positive influence of public spending on health occurs in only five countries. In one case, public spending on education has a negative influence on output and in three countries the impact of public spending on health is also negative on output. An interesting result highlighted by the authors is that the public spending on education and health positive impact on output is not immediate that it takes some time before they produce the desired effect on GDP, and the lags are generally higher in the case of education.

Another empirical approach is that of Baldacci *et al.* (2004) who analyse the relationship between social spending, human capital and economic growth for 120 countries between 1975 and 2000 by estimating a simultaneous equations model, a methodology that allows to take into account the cross-influences between the variables under analysis. The estimated model consists of four equations (growth, investment, education and health), with social spending on education and health as determinants of the availability of human capital in the form of education and health, respectively. The authors analyse in this way the mechanisms of transmission of such expenses, verifying that they effectively contribute to the accumulation of human capital in the countries under analysis. The results show a positive and significant impact of expenditures on education and health in human capital accumulation, which in turn is confirmed as a major influence of the growth rate of real GDP per capita.

From the empirical studies reviewed, regardless of the empirical approach applied, it is clear that it is possible to find different impacts of public spending on education and health on economic growth depending on the level of development of countries. The studies that focused on developed countries, as is the case of most OECD countries, seem to indicate the existence of a negative relationship, while studies with samples from developing countries or analysing wider samples and respective subsamples point to a relationship with the opposite sign. However, even within groups of countries with the same level of development, the behaviour is not homogeneous. This study seeks to contribute to clarify the sign of the relationship between both types of public expenditure and output growth as well as the sign of the relationship between education and health indicators and education and health expenditures in the context of the three samples already mentioned. Additionally, we also want to provide some clarification as to the direction of causality between the main variables. For this purpose, we first review some previous applied studies that use panel causality methodologies in order to better understand how the methodology we apply relates to that used in other studies and to better locate our study within related literature.

3. Panel causality: some insights from the applied literature

To study the links between investment and economic growth, Nair-Reichert and Weinhold (2001) proposed a variant of the fixed effects model with instrumental variables applied to dynamic models (Hsiao, 1989; Weinhold, 1999). However, this methodology does not solve the problem of co-integration. Al-Iriani (2006) used GMM estimators applied to the first differences of the values of energy consumption and output even though, as is the case, the variables do not allow to reject the presence of a unit root. The author also tested for the existence of a cointegration relation between the variables under analysis. Canning and Pedroni (2008) applied the FMOLS estimator (Pedroni, 1999; 2004) to investigate the influence of the stock of infrastructures on output as a first step. Additionally, they also estimate error correction mechanisms (ECM). They considered the Granger representation theorem (Engle and Granger, 1987) according to which cointegrated series can be represented by a dynamic error correction model. The theorem implies that at least one of the short-run adjustment factors (λ) must be non-zero. The results of these short-term estimations are then analysed in terms of causality and these estimations use only stationary variables. The authors assumed heterogeneous coefficients and thus applied mean group estimators to identify the relevant coefficients. Leea and Chang (2008) analyse the relationship between tourism and output. They first study the order of integration of the variables. Next, they estimate a cointegrated heterogeneous system and, afterwards, a dynamic ECM with heterogeneous equations. The authors also test for long run and short run exogeneity but the issue of cross-sectional dependence is not addressed. When we perform cross-country studies, we should be aware of the potentially strong interdependency between countries (cross-sectional units) caused by greater financial and economic integration around the world. In our empirical analysis we should thus account for the presence of common shocks, with no identified pattern of common components, as well as unobserved components becoming part of the errors of the model and, additionally, for spatial dependence. These phenomena can produce misleading inference and even inconsistent estimators with the robustness of the usual panel estimators being influenced by cross-section dependence and the source of this dependence, Pesaran (2006), Chudik and Pesaran (2013), and De Hoyos and Sarafidis (2006). This problem also applies to unit root tests.

Lin and Ali (2009) applied two alternative methodologies after studying the degree of integration of military spending and inequality. In the first approach, they assumed that the variables were stationary and they used them without transformation. In the second approach, the authors considered that the order of integration is one and under this assumption, they used the variables in first differences. They applied dynamic heterogeneous models without an ECM and the issue of cross-sectional dependence was not analysed. This last omission is important in a study involving military spending since military expenditures present common patterns across countries. To determine the income elasticity of healthcare expenditures, Baltagi and Moscone (2010) propose to correct for cross-sectional dependence with two different errors structures. In the first one, the errors are assumed to follow an observed common effect based on the Common Correlated Effects (CCE) built by Pesaran (2006). In the second, the errors are assumed to follow an autoregressive process on spatial weights applied to cross-sectional units. Hartwig (2010) studied the relationship between health care expenditures and output using five-year growth rates. Assuming that the growth rates of the variables are stationary, the author suggests using the one-step and the two-step System GMM estimators. However, cross-sectional dependency and cointegration relations are not taken into account. Bangake and Eggoh (2011) used the DOLS panel cointegration methodology to test for the no-exclusion of causality between financial development and output. These variables are proved to be I(1). They also introduce some control variables in the estimated equations. The non-exclusion of the adjustment variable of the ECM is taken as representing long run causality of the coefficient of the lags as evidence of short run causality and the non-exclusion of both as evidence of strong causality. The authors consider heterogeneous coefficients since they assume that there is no reason to accept the hypothesis of homogeneous coefficients. They also consider the same lag order for all the variables in the ECM dynamic equations. Three studies that address the issue of non-causality using the SUR methodology and assuming heterogeneous coefficients are Chu (2012) who studies the link between oil consumption and output, Chu and Chang (2012) who investigate the relationship between nuclear energy, oil consumption and output, and Kar *et al.* (2011) who study the financial development-economic growth nexus. All three studies claim that this methodology solves the problem of cross-sectional dependence, as well as the problem of the existence of a unit root in the series, but this is not the case. The SUR methodology solves a problem of estimator efficiency when error terms are correlated. However, the SUR methodology does not solve the problems of cross-sectional dependence, nor spurious regressions.

Gries and Redlin (2012) apply causality analysis to examine the link between trade openness and growth. They used the GMM methodology to estimate two dynamic ECM equations where the coefficient of each independent variable (in levels) is set equal to 1. The authors correct for the small-sample bias of Banerjee *et al.* (1998) but doing so they lose information on the long and short run coefficient values. Çaglayan and Sak (2012) implemented what they called a three stage process for the study of causality between output and tourism. If the unit root variables are cointegrated, the analysis of the ECM dynamic equation will be informative about the presence of causality. If the variables are not cointegrated, then a system of equations in first differences is used. The authors consider heterogeneous coefficients with mean group estimators. Akkemik and Göksal (2012) identify 47 studies on causality between energy consumption and income. They are very critical of the use of homogeneous coefficients dynamic methods in the majority of those studies. They also recommend the correction of the omitted variable bias through the consideration of other variables correlated with the dependent variable. The authors studied the order of integration of the variables but limited their analysis to dynamic homogeneous and heterogeneous models without any reference to cointegration.

Dumitrescu and Hurlin (2012) proposed a mean group Granger (1969) non-causality test. This test was applied to originally stationary data. Chen *et al.* (2013) studied causality between output per capita and the infant mortality rate by using fixed causal and random causal analysis, as well as mean group estimators. They assume both homogeneous and heterogeneous regression coefficients. The question of non-stationary variables is not considered. Ahamada and Coulibaly (2013) proposed the use of a methodology attributed to Kónya (2006) to study causality from remittances to output. This methodology consists in the estimation of heterogeneous coefficients using the SUR methodology with correction of cross-sectional dependence. To investigate causality between energy consumption and output, Chang *et al.* (2013), have taken into account the existence of cross-sectional dependence and apply the SUR methodology to obtain dynamic systems of two equations with heterogeneous coefficients. However, no reference is made to the order of integration of the variables, energy consumption and output, nor to the use of non-stationary estimation techniques. Nazlioglu *et al.* (2011) studied causality between foreign direct investment and growth and tested for cross-sectional dependence, but they have limited their estimations to SUR methodology and applied Wald tests for non-causality to individual equations only. They also applied the Toda and Yamamoto (1995) methodology to individual countries. In fact, this study is not a panel analysis but a time series analysis without the study of stationarity and the corresponding Ganger tests.

To investigate financial liberalization and capital flight, Yalta and Yalta (2012) used a time-stationary VAR model. They proposed to solve the endogeneity problem by estimating a model in first differences by applying GMM techniques. To these equations, the authors performed nullity tests of the coefficients. The issue of a unit root or stationarity of the series as well as the long-run behaviour of the variables is not considered. Yilgör *et al.* (2014) study the link between defence and economic growth considering the presence of cross-sectional dependence in the unit root test. The authors concluded that the variables are I(1) and also they tested the non-exclusion of cointegration relation with the Pedroni (1999) test. Finally, they applied the Granger traditional tests to the variables in levels, that is, to variables with a unit root.

To sum up, an overview of the empirical literature that applies panel causality reveals that the majority of studies apply methods that deal with sectional heterogeneity but stationary methods are dominant, even when unit root analysis is implemented. Both the SUR method of estimation and the GMM dynamic system are often used literature. The problem is that these methods are inappropriate to solve cross-sectional dependence and should not be applied when the variables are non-stationary. In some studies, besides the main cause and effect variables under analysis, control variables are added in order to improve model specification. However, the information content of the models with and without the causal and control variables is not provided. In this study, we try to overcome these issues applying suitable methodologies to study the relationship between education and health expenditures, output and welfare.

4. Data and methodology

The main aim of this paper is to empirically investigate the link between health and education expenditures, output and welfare indicators. Our variables of interest thus refer to the different dimensions under analysis. Annual data from 1960 to 2012, when possible, were obtained from the World Development Indicators (WDI) database of the World Bank. Our database is an unbalanced panel. Table 1 describes the variables in the database, where column (1) contains our notations, column (2) contains the WDI notation and column (3) the definitions of the variables.

Table 1. Variables in the database

(1)	(2)	(3)
x	NE.EXP.GNFS.ZS	Exports of goods and services (% of GDP)
gfc	NE.GDI.FTOT.ZS	Gross fixed capital formation (% of GDP)
py	NY.GDP.DEFL.ZS	GDP defluator (base year varies by country)
yrpc	NY.GDP.PCAP.PP.KD	GDP per capita, PPP (constant 2005 international $)
es	SE.SEC.ENRR	School enrollment, secondary (% gross)
et	SE.TER.ENRR	School enrollment, tertiary (% gross)
eep	SE.XPD.TOTL.GD.ZS	Public spending on education, total (% of GDP)
hepr	SH.XPD.PRIV.ZS	Health expenditure, private (% of GDP)
hep	SH.XPD.PUBL.ZS	Health expenditure, public (% of GDP)
mi	SP.DYN.IMRT.IN	Mortality rate, infant (per 1,000 live births)
leb	SP.DYN.LE00.IN	Life expectancy at birth, total (years)

Note: (1) our notation; (2) WDI notation and (3) WDI variable description.

We consider three groups of countries (Table 2) that we identify as Eu_1, Eu_2 and OECD_w. The first group (Eu_1) corresponds to the European Union before enlargement to the East in 2004 (except Luxembourg) and is composed of fourteen countries; the second group (Eu_2) contains the thirteen new member states that joined the EU after 2004; and the third group (OECD_w) the wealthiest OECD non-EU countries in a total of ten countries.

Table 2. Groups of Countries

Eu_1	Austria, Belgium, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Italy, Netherlands, Portugal, Sweden
Eu_2	Bulgaria, Cyprus, Czech R., Estonia, Croatia, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovenia, Slovak R.
OECD_w	Australia, Canada, Switzerland, Israel, Iceland, Japan, S. Korea, Norway, New Zealand, U.S.A.

Table 3 contains some descriptive statistics for the different variables in our database across the three different groups of countries. Table 3 illustrates that the variables present different characteristics across the three groups in terms of the coefficient of variation and the median. For exports (x), the group Eu_2 records a higher median value than the other two groups. Median investment (gfc) and median GDP inflation (dpy) are not very different across groups. Inflation stability is obvious for Eu_1 compared with the two other groups. In terms of GDP per capita, Eu_1 is the most homogeneous and Eu_2 has a median value that corresponds to half of the value for the other two groups. In what concerns education and health variables (es, et, eep, hep and hepr), Eu_2 has lower median values than the other groups. However, the infant mortality rate (mi) and life expectancy (leb) values are relatively more stable for the Eu_2 group, while the median values are clearly worse than for the other two groups.

Table 3. Some descriptive statistics for the three groups

	Eu_1		Eu_2		OECD_w	
Variable	**VC**	**Med**	**VC**	**Med**	**VC**	**Med**
x	0.506	28.03	0.302	49.46	0.411	28.42
gfc	0.163	21.58	0.198	23.00	0.201	23.60
dpy	0.700	0.038	2.480	0.041	2.360	0.043
yrpc	0.148	25428	0.348	12948	0.305	27294
es	0.135	98.97	0.068	90.78	0.135	95.65
et	0.202	34.74	0.431	23.76	0.470	40.02
eep	0.238	5.09	0.236	4.41	0.220	5.35
hep	0.191	6.78	0.237	4.78	0.248	6.24
hepr	0.303	2.13	0.470	1.88	0.672	2.49
mi	0.803	8.80	0.537	14.55	0.558	8.10
leb	0.047	74.98	0.039	70.90	0.058	75.86

Notes: VC- coefficient of variation; Med – median

The empirical strategy we apply aims at implementing a coherent methodology to overcome the drawbacks of some of the previous empirical literature that uses panel causality, which were outlined and discussed in section 3. In particular, we want to analyse long-run equilibrium relations between our variables by identifying differences across groups and use estimators and models suitable for non-stationary variables, while at the same time controlling for problems of cross-sectional dependence.

Our empirical strategy is implemented in two stages. The first stage includes two steps, (A) and (B), and the second the stage consists in step (C). In the first stage, we start by studying the stationarity characteristics of the variables by taking into account the phenomena of cross-sectional dependence (step A). Next, we estimate long-run equilibrium relations by applying non-stationary methods to regressions that include both state and policy variables (step B). The latter are control variables that might be used by policymakers as instruments in the short-run since they are weakly-exogenous variables, although they are endogenous in the long-run.

We estimate a benchmark model that considers only state variables. Next, we compare the results of estimating models with state and policy variables added with the former one. These models are retained if the associated level of information is higher than the one for the benchmark model. Finally, in the second stage of our empirical strategy (step C), we identify the 'error correction mechanism' (ECM) from the corresponding long-run relations and define the dynamic short run equations that allow us to test for the existence of weak-exogeneity. The fact that we cannot reject the null hypothesis of weak-exogeneity means that the dependent variable of the short-run model is not caused by the other variables in the long-run relationship.

We will further describe the tests applied and the models estimated in more detail. In step (A) of the first stage of our empirical strategy, we apply unity root tests considering the presence of cross-sectional dependence. We use an ADF test specific for panel data with a null hypothesis (H0) of the presence of a unit root in all series, against the alternative that at least one of the series is stationary. This test is built as a combination, based on the inverse of the Normal distribution, of the significance levels of the ADF tests, Choi (2001). For N fixed individuals and T observations sufficiently numerous ($T \to \infty$), in the case of H0:

$$Z = \frac{1}{\sqrt{N}} \cdot \sum_{i=1}^{N} \Phi^{-1}(p_i) \xrightarrow{d} N(0,1)$$

In this formulation, the test assumes cross-sectional independence. Costantini and Lupi (2013) propose to correct for cross-sectional dependence based on Hartung (1999) and Demetrescu *et al.* (2006) and a suitable formula for test computation Demetrescu *et al.* (2006) is used:

$$\hat{Z}_H = \frac{\sum_{i=1}^{N} \Phi^{-1}(p_i)}{\left\{ N \cdot \left[1 + \left(\hat{\rho}^* + 0.2 \cdot \sqrt{\frac{2}{N+1}} \cdot (1 - \hat{\rho}^*) \right) \cdot (N-1) \right] \right\}^{1/2}}$$

where $\hat{\rho}^*$ is a convergent estimator of ρ, and $\Phi^{-1}(p_i)$ denotes the common correlation:

$$\hat{\rho} = (1 - (N-1)^{-1} \cdot \sum_{i=1}^{N} \left(\Phi^{-1}(p_i) - N^{-1} \cdot \sum_{i=1}^{N} \Phi^{-1}(p_i) \right)^2$$

We apply this test with or without trend. We also apply the covariate augmented Dickey-Fuller test (CADF) proposed in Costantini and Lupi (2013) and based on Hansen (1995) and Hanck (2013). Originally, it tests for the presence of a unit root in panel data with or without sectional correlation, Pesaran (2004). This test performs better than the ordinary ADF test. Following Hansen's (1995) demonstration, the power of the CADF test is improved when a stationary variable is included in the augmented equation. Thus, at the individual level the new equation is:

$$a(L) \cdot \Delta Y_t = \delta \cdot Y_{t-1} + b(L) \cdot \Delta x_{t-1} + e_t$$

where a(L) and b(L) are polynomial lags, Δx is the added covariate and the errors (e) have the usual properties. Costantini and Lupi (2013) suggest using as a stationary variable the average of the first difference applied to all individuals or the first difference of the first principal component of the variable. This change allows an increase in the power of the test when compared to the usual averages of ADF tests. The correction of cross-sectional correlation assumes that the significance level of the Pesaran (2004) test is less than the typical value, so that 10% is considered an acceptable choice. We use a test based on Hartung (1999) and Demetrescu *et al.* (2006) that automatically corrects for sectional correlation with the threshold at 10% and considering the first difference of the variable under analysis as covariate. We will also perform the above mentioned tests with a constant and with a constant and a trend. These four tests will be identified as Zh, Zh(t), pCADF and pCADF(t), respectively, where (t) stands for the presence of a trend, Lupi (2011; 2013).

In the second step, (B), of the first stage, we begin our analysis of the long-run relations between our variables of interest by considering an equilibrium model including state and policy variables (1):

$$Y_{i,t} = \alpha + \beta_j \cdot X_{i,t} + \gamma_l \cdot Z_{i,t} + \epsilon_{i,t} \quad (1)$$

where *X* is a (*kx1*) set of state variables, β_j the (*1xk*) set of corresponding coefficients and *Z* and γ_h a set of (*lx1*) and (*1xl*) policy variables and coefficients, respectively; *i* and *t* denote individuals and time indices, respectively.

We first consider what we call a benchmark equation (1) that considers only state variables (*py*, *x*, *gfc*) and where *yrpc* is the dependent variable. We next consider equations (2), (3) to jointly inspect the influence of the two dimensions of human capital, - education (secondary and tertiary levels) and health (life expectancy and infant mortality including at birth) on (*yrpc*). Afterwards, we examine the influence of the social policy variables, - education expenditures and health expenditures on *yrpc*. The former analysis corresponds to equation (4) and the latter to equations ((5), (6), (7), (8), (9)), in order to assess the influence of (public, private and total) health expenditures on (*yrpc*) equations. Since our main aim is to test for the influence of the education and health expenditures variables, as social policy variables, we also estimate equations (10), (11), (12) and (13), to test for their impact on the education levels ((*es*), (*et*)) and on the health status welfare variables ((*mi*), (*leb*)).

To correctly estimate equation (1), we have to consider the presence of cross-sectional correlation and that the variables are integrated of order 1. To solve the first problem, we included the individual (sectional) averages of each of the variables in equation (1), $\bar{W}^a$, Pesaran (2006). To overcome the second problem, we added lags and leads of order *s* of the first difference of the independent variables, ΔW, with *s=1*, following Saikkonen (1991) proposition to apply DOLS. Our estimated parameters β_j and γ_h correspond to the expected long-run parameters in equation (1a).

$$\text{(1a)} \quad Y_{i,t} = \alpha + \beta_j \cdot X_{i,t} + \gamma_l \cdot Z_{i,t} + \sum_{h=-s}^{s} \phi_l \cdot \Delta W_{i,t} + \omega_m \cdot \bar{W}^{a}_{i,t} + \varepsilon^{*}_{i,t}$$

where *W* contains the sets of variables *X* and *Z* and $\bar{W}^{a}$ contains the sets of variables *W* and *Y*.

Finally, the second stage (step C) of our empirical strategy consists in the estimation of the dynamic short-run equations and using the results to test for weak causality.

We can define our dynamic short-run equation, with $\varepsilon_{i,t-1} = \mathrm{ECM}_{i,t}$ from equation (1), as:

$$\text{(2)} \qquad \Delta Y_{i,t} = \alpha^{*}_{i} + \lambda \cdot ECM_{i,t} + \sum_{l=1}^{k+h} \theta_l(L) \cdot \Delta W_{i,t} + \mu_{i,t}$$

where $\theta_l(L)$ represents a lag polynomial of some order. We have simplified our estimations by imposing a lag polynomial of degree one. We consider two hypotheses for the short-run dynamic behaviour. According to the first one, which we call *intercept heterogeneity* behaviour, we assume that institutional differences and other omitted variables are important determinants of the equilibrium path. The second hypothesis assumes that the long-run equilibrium path is even more dependent on institutional variables and consequently, we cannot only assume *intercept heterogeneity,* we have to consider heterogeneity of all coefficients. To investigate the first hypothesis, we apply the Fixed Effects estimator and for the second one we use the Pooled Mean Group Estimator. Since the concept of Granger (1969) causality implies that the variables are stationary, the second stage of our empirical strategy is appropriate for this analysis but we restrict our analysis to what is sometimes named 'long-run causality' (weak-exogeneity).

5. Results

The results for the unit root tests (step A) can be found in Tables 4, 5 and 6, for each of the three groups of countries under analysis. All the variables are in logs and the notation used for the first difference of variable K is 'dK'. The statistics corrected for cross-sectional dependence is in italics and corresponds to the majority of cases. According to the results presented in Tables 4-6, for all the variables in each of the groups, we cannot reject the presence of a unit root for the variable in levels but we reject it for the variable in first differences.

Table 4. Unit Roots tests results for Eu_1

Var:	1	2	3	4
x	*1.05*	*-1.19*	*-0.07*	-3.18 ***
dx	*-6.09* ***	*-5.96* ***	10.19 ***	*-4.44* ***
gfc	*-0.69*	*-1.15*	-2.36 ***	-2.54 ***
dgfc	*-7.44* ***	*-9.98* ***	*-10.78* ***	*-8.90* ***
py	*-1.05*	*-1.36*	0.94	1.80
dpy	*-0.33*	*-0.80*	-1.80 **	*-1.73* **
yrpc	*-0.46*	*4.00*	*0.16*	*3.75*
dyrpc	*-6.35* ***	*-5.72* ***	*-1.94* **	*0.68*
es	*-0.80*	*1.19*	-0.99	-1.14
des	*-5.01* ***	*-4.51* ***	-7.85 ***	*-9.07* ***
et	*1.29*	*0.23*	*2.19*	-0.78
det	*-10.70* ***	*-8.74* ***	*-8.28* ***	*-6.68* ***
eep	*-0.79*	*-0.27*	*-5.99* ***	*-1.06*
deep	*-12.26* ***	*-10.71* ***	-8.49 ***	-6.90 ***
hepr	*0.08*	*-0.72*	*1.90*	-1.31 *
dhepr	*-2.34* ***	*-1.79* **	*-6.51* ***	*-7.07* ***
hep	*2.08*	*-2.24* **	0.75	-3.96 ***
dhep	-2.90 **	-1.56 *	-7.28 ***	-6.78 ***
mi	*1.70*	*0.41*	1.93	-1.71 **
dmi	*-1.38* *	*-0.69*	-3.02 ***	-3.06 ***
leb	*8.15*	*-0.08*	*5.04*	*-0.01*
dleb	*-18.40* ***	*-20.40* ***	*-7.57* ***	*-21.50* ***

Notes: Columns 1) to 4) contain the values of the tests Zh, Zh(t), pCADF and pCADF(t), respectively, where (t) stands for the presence of a trend. Zh, Zh(t), pCADF and pCADF(t) have as the null hypothesis (H0) the presence of a unit root in all the series against the alternative that at least one of the series is stationary. The stars have the usual interpretation, *** if the null is rejected at the 1% significance level, ** for 5% and * for 10%.

Table 5. Unit Roots tests results for Eu_2

Var:	1		2		3		4	
x	*-2.60*	***	*-2.32*	**	*-2.75*	***	*-2.67*	***
dx	*-5.59*	***	*-4.78*	***	-7.40	***	-7.99	***
gfc	*-0.89*		*-0.53*		*-4.24*	***	*-4.36*	***
dgfc	*-10.76*	***	*-9.30*	***	*-7.45*	***	*-2.50*	***
py	*-5.19*	***	*-4.81*	***	-0.26		-3.34	***
dpy	*-8.35*	***	*-6.10*	***	*-4.51*		*-4.23*	***
yrpc	*0.24*		*2.16*		*0.08*		-1.29	*
dyrpc	*-1.90*	**	*-1.66*	**	-2.53	***	-2.09	**
es	-1.57	*	-2.27	**	*-4.36*	***	-5.89	***
des	-11.34	***	-9.32	***	-8.94	***	-5.96	***
et	*2.84*		0.41		*-6.82*	***	-3.46	***
det	*-5.78*	***	-4.00	***	-3.54	***	-5.49	***

eep	*-1.09*		*-1.89*	**	*-2.54*	***	*-1.52*	*
deep	*9.57*	***	*-7.60*	***	*-4.26*	***	*-3.00*	***
hepr	*-0.38*		*-1.34*	*	*0.77*		*-3.90*	***
dhepr	*-3.25*	***	*-2.85*	***	-8.40	***	---	
hep	*-0.98*		*-0.67*		-1.93	**	-1.17	
dhep	*-4.03*	***	*-1.56*		-7.64	***	-6.19	***
mi	*5.93*		*0.10*		*1.54*		*-3.31*	
dmi	*-0.09*		*0.09*		*-1.47*	*	-1.87	**
leb	*8.42*		*3.84*		*5.08*		*0.04*	
dleb	*-14.68*	***	*-15.04*	***	*-9.94*	***	---	

See Notes to Table 4.

Table 6. Unit Roots tests results for OECD_w

Var:	1		2		3		4	
x	*-2.18*	**	*-3.01*	**	-1.14		-2.16	**
dx	*-7.00*	***	*-6.55*	***	-13.09	***	-11.25	***
gfc	*-2.63*	***	*-1.63*	*	-1.98	**	-1.95	**
dgfc	*-4.39*	***	*-4.10*	***	-11.26	***	-9.60	***
py	*-1.47*	*	*1.60*		*-2.41*	***	*-3.84*	***
dpy	*-3.59*	***	*-4.94*	***	*-7.37*	***	*-6.17*	***
yrpc	*0.73*		*-0.12*		*1.42*		-1.36	*
dyrpc	*-2.93*	***	*-2.72*	***	-7.90	***	-6.97	***
es	*-0.79*		*-0.01*		-1.45	*	*-0.86*	
des	*-8.85*	***	*-7.55*	***	*-6.04*	***	*-4.81*	***
et	*0.21*		*0.48*		4.05		0.35	
det	*-10.35*	***	*-9.48*	***	-6.41	***	*-5.77*	***
eep	*-0.18*		*-0.58*		-2.82	***	-4.01	***
deep	*-11.31*	***	*-9.84*	***	-8.80	***	*-8.37*	***
hepr	*1.04*		*-1.10*		*-0.56*		-1.72	**
dhepr	*-2.81*	***	*-2.27*	***	*-12.41*	***	*-4.96*	***
hep	*0.41*		*-1.28*		*0.49*		-3.26	***
dhep	*-3.04*	***	*-2.78*	***	-8.67	***	*-7.36*	***
mi	-1.46	*	3.02		-1.88	**	-0.98	
dmi	*-0.25*		*-0.93*		-1.80	**	-1.94	**
leb	*3.71*		*-2.52*	***	2.59		-1.15	
dleb	*-14.80*	***	*-14.24*	***	*3.81*		*-17.90*	***

See Notes to Table 4.

The results of the estimation of the long run relations with the variables integrated of order 1 (step B) are presented in Tables 7, 8 and 9, for the groups Eu_1, Eu_2 and OECD_w, respectively. The overall conclusions in terms of long-run behaviour are the following: educational attainment and health status matter for output growth and education expenditures are an important determinant of educational attainment, while health expenditures are an important determinant of health status welfare. The first equation that appears in all Tables, 7-9, is our benchmark equation.

For the EU_1 group (Table 7), our benchmark equation (1) with output (*yrpc*) as the dependent variable considers as state variables prices (*py*), exports (*x*) and investment (*gfc*). Equations 2 and 3 examine the importance of human capital for output behaviour proxied, respectively, by secondary education attainment levels, (es), and life expectancy at birth (leb), and tertiary education attainment levels, (et)6,7. These equations present a better level of information (BIC) than the benchmark equation, which means that the models with these education and health variables fit the data better than the benchmark equation. Equation (4) considers education expenditures, eep, as an explanatory variable and the estimated coefficient presents a negative sign. However, since the BIC value for this equation is higher than the one for the benchmark equation, we do not retain this equation. The results for output equations (5-9) with health expenditures as explanatory variables reveal a positive effect of these expenditures on output, either taken in isolation or together.

Table 7. DOLS estimation results for Eu_1

Var.	Eq. Nr.	Const.	py	X	gfc	es	et	leb	eep	hep	hepr	hept	yrpc	see/bic
yrpc	1	1.417 *	0.252 ***	0.457 ***	0.189 ***									0.080
		0.766	0.022	0.026	0.047									-4.900
	2	-3.920 ***	0.099 ***	0.061 *	0.172 ***	0.112 **		4.391 ***						0.061
		1.181	0.020	0.033	0.039	0.035		0.314						-5.264
	3	0.601	0.082 ***	0.119 ***	0.129 ***		0.315 ***							0.064
		0.697	0.022	0.034	0.044		0.023							-5.224
	4	0.588	0.223 ***	0.530 ***	0.198 ***				-0.159 ***					0.077
		0.815	0.024	0.032	0.054				0.042					-4.832
	5	2.600 ***		0.087 **						0.378 ***				0.061
		0.348		0.039						0.046				-5.332
	6	3.334 ***		0.152 ***							0.234 ***			0.068
		0.482		0.042							0.047			-5.120
	7	-0.231	0.623 ***		0.082 *						0.070 *			0.047
		0.707	0.044		0.043						0.036			-5.760
	8	1.861 ***										0.574 ***		0.061
		0.280										0.055		-5.438
	9	2.515 ***								0.398 ***	0.248 ***			0.056
		0.298								0.040	0.038			-5.511
es	10	1.030 **							0.109 **				0.481 ***	0.107
		0.514							0.050				0.044	-4.300
et	11	-2.060 ***							0.525 ***				1.952 ***	0.141
		0.684							0.067				0.051	-3.747
mi	12	1.489 ***					-0.493 ***			-0.976 ***	-0.252 ***			0.111
		0.561					0.083			0.118	0.088			-3.992
leb	13	1.592 ***								0.104 ***	0.042 ***			0.009
		0.188								0.006	0.006			-9.239

Notes: The dependent variable is identified in the first column. Below the coefficient values we present the standard deviations. The stars have the usual interpretation, *** if the null is rejected at the 1% significance level, ** for 5% and * for 10%. In the last column, in each line the first the value refers to the standard error of the regression and the second value to the Schwarz information criteria (BIC).

[6] Notice that we have also estimated equations (2) and (3) with the welfare variable, infant mortality at birth, (*mi*), instead of (*leb*) but the coefficient was never statistically significant for any of the three country groups.

[7] In the case of equation (3) we started by estimating an equation with (*leb*). However, since the coefficient was not statistically significant, we next estimated the equation reported in Table 7 that includes only the education indicator (*et*), and we adopted the same procedure for equations 2 and 3 in the case of the two other country groups whenever necessary.

The level of information is lower for these equations than for the benchmark equation. Turning to the equations that consider educational attainment, es and et - as dependent variables - equations (10-11), we can observe a positive effect of education expenditures (eep) and output (yrpc). Finally, as far as the health status welfare is concerned, equations (12-13), education (*et*) and health expenditures (*hep* and *hepr*) exert a positive influence on the infant mortality rate and the latter variables also impact positively on life expectancy. Private health expenditures are always less important for health status welfare (*mi* and *leb*) than public health expenditures.

As far as the second group of countries, Eu_2, is concerned (Table 8), the benchmark equation is the same as the one for Eu_1 and again, all the equations that consider the education and health variables on the right hand side present a better level of information relative to the benchmark equation. For this group, education expenditures (*eep*) present an estimated coefficient with a positive sign and the BIC value for the respective equation is better than for the benchmark equation. Contrary to the results for EU_1, equation (3) includes the health status indicator (*leb*), statistically significant at the 1% level. The results for the equations that consider educational attainment or the health status as a dependent variable are similar to those of the EU_1 group. The exception is the equation with the infant mortality rate as a dependent variable, equation (11), where results do not support the existence of a relationship with educational attainment (*et*), and the opposite applies to output.

Table 8. DOLS estimation results for Eu_2

Var.	Eq. Nr.	Const.	py	x	gfc	es	et	leb	eep	hep	hepr	hept	yrpc	see/bic
yrpc	1	0.942	0.043 ***	0.410 ***	0.162 **									0.185
		0.598	0.010	0.072	0.080									-3.101
	2	-3.333	0.034 ***	0.128 ***	0.223 ***	0.904 ***		5.222 ***						0.108
		3.394	0.006	0.048	0.057	0.120		0.437						-4.003
	3	-2.377		0.112 ***	0.333 ***		0.252 ***	2.519 ***						0.096
		2.443		0.040	0.043		0.019	0.502						-4.328
	4	1.444 ***	0.042 ***	0.454 ***	0.311 ***				0.510 ***					0.169
		0.596	0.010	0.076	0.090				0.073					-3.151
	5	-0.876 **		0.431 ***						0.792***				0.157
		0.392		0.070						0.142				-3.425
	6	-0.685 **		0.298 ***							0.416***			0.141
		0.349		0.068							0.049			-3.638
	7	-0.772 **										1.251***		0.154
		0.384										0.127		-3.581
	8	-0.704 **								0.611***	0.425***			0.139
		0.343								0.126	0.047			-3.665
es	9	1.110 **							0.107 ***				0.171***	0.067
		0.504							0.027				0.023	-5.195
et	10	0.374							0.896 ***				1.899***	0.314
		0.805							0.127				0.107	-2.103
mi	11	7.674 ***								-0.344**	-0.111*		-0.895***	0.154
		0.939								0.150	0.064		0.088	-3.354
leb	12	-0.859 ***								0.029**	0.010**		0.052***	0.012
		0.252								0.014	0.005		0.007	-8.503

See Notes to Table 7.

The results for the OECD_w group (Table 9) point to a benchmark equation for output with only prices (*py*) and exports (*x*) as state variables, leaving out investment, which was statistically significant for the other two groups. For the equations with output as a dependent variable there is an information gain when educational attainment and health status variables are included as explanatory variables. Concerning equations (2) and (3), OECD_w exhibits somewhat different results when compared with those of the EU_1 group since (*leb*) is only statistically significant in equation (2). The overall remaining results are similar to those found for the first and second groups. The exception is that the coefficient for education expenditures (*eep*) is not statistically significant in this group. The results for the equations with educational attainment and health status as dependent variables are also similar to those for the first group. However, in this case, we cannot compare the effects of private and public health expenditures because we were not able to reject the null hypothesis of their joint influence being equal to zero in equations (10 and 11).

Table 9. DOLS estimation results for OECD_w

Var.	Eq. Nr.	Const.	py	x	es	et	leb	eep	hep	hepr	hept	yrpc	see/bic
yrpc	1	-2.125***	0.216***	0.439***									0.166
		0.404	0.022	0.060									-3.404
	2	-3.350***	0.137***	0.253***	1.015***								0.147
		0.496	0.022	0.061	0.135								-3.559
	3	-8.861 ***	0.020*			0.127***	5.052***						0.080
		0.905	0.012			0.029	0.383						-4.782
	4	-0.368	0.240***	0.074**					0.431***				0.051
		-0.326	0.033	0.036					0.046				-5.479
	5	0.445	0.268***	0.322***						0.372***			0.063
		0.306	0.038	0.042						0.079			-5.040
	6	-0.654**	0.250***	0.234***							0.501***		0.047
		0.327	0.031	0.027							0.057		-5.621
	7	-1.525***	0.268***	0.137***					0.293***	0.245***			0.040
		0.298	0.026	0.031					0.043	0.059			-5.815
es	8	1.129***						0.187***				0.213***	0.060
		0.189						0.031				0.022	-5.410
et	9	2.307***						0.638***				1.428***	0.183
		0.473						0.099				0.064	-3.185
mi	10	-2.664***			-0.675***				-0.498***				0.125
		0.470			0.176				0.111				-3.806
leb	11	1.452***									0.065***	0.095***	0.011
		0.254									0.018	0.018	-8.626

See Notes to Table 7.

If we jointly analyse the results for the different groups, we must take into account that the state variables retained in the output equations are the same for the EU_1 and the Eu_2 groups but not for the OECD_w group. In terms of educational attainment, for the EU_2 and for the OECD_w, (*es*) is quantitatively more important than (*et*) but for EU_1, the opposite applies. The three groups show marked differences concerning the statistically significant human capital indicators added to the respective benchmark equations. Only for the EU_2 group is there a statistically significant relationship between the health status indicator (*leb*) and (*yrpc*) regardless of the education indicator included in the benchmark equation ((*es*) or (*et*)). For the EU_1 group, a similar relationship is only confirmed with (*es*), and for the OECD_w group with (*et*). In all the groups, public health expenditure is quantitatively more important for output than the respective private counterpart. In terms of educational attainment, for (*es)* the effects of education expenditures are higher for the OECD_w group, and for (*et)* the effects are higher for the EU_2 group relative to the other two groups. Concerning the results with infant mortality rate as the dependent variable, these are not directly comparable since the regressors are not the same in all groups, but we can conclude that the effects of health expenditures are quantitatively more important for EU_1 relative to the other two groups. The same applies to the equations with life expectancy as the dependent variable.

Tables 10, 11 and 12 contain the results of the estimation of the short-run equations (step C). From the inspection of the results, it is possible to confirm that λ, the short-run adjustment parameter, has the appropriate sign in all equations, which implies that in the original model, the associated variables in levels are cointegrated.

As far as the causality relations between our variables of interest for the three groups of countries are concerned, Table 10 presents the results associated with the long-run equations estimated for the EU_1 group that are described in Table 7. The first column of Table 10 contains the number of the long-run equation that appears after the benchmark equation in Table 7. *dY* refers to the equation of the first difference of the dependent variable in the respective long-run equation and *dX1*, *dX2* and *dX3* to the equations for the associated policy variables and, eventually, for *yrpc*, if it is retained as an independent variable, according to the ordering of the variables of the corresponding equation in Table 7. For instance, if we consider equation (2), the null hypothesis that the coefficient λ of the equation with *dY* as dependent variable is zero is rejected at the 1% significance level when using either of the two estimation methods (FE and PMG). Additionally, the null hypothesis that the coefficient λ associated with the short-run equation for *dX1(=es)* is zero is not rejected when using both estimation methods. However, the null hypothesis that the coefficient λ associated with the short-run equation for *dX2(=leb)* is zero is rejected when using both estimation methods. These results imply that in the cointegration relation defined between the variables in equation (2), (*es*) is weakly exogenous, while (*leb*) and *(yrpc)* are endogenous. In the former case, the disequilibrium values do not influence the short run behaviour of (*es*) and so the causality goes from (*es)* to (*yrpc)*. In the latter case, on the contrary, (*lep*) is caused by (*yrpc*). In our causality analysis, we take 5% as the limit significance level for rejection of the null hypothesis that the estimated adjustment coefficient is zero. If rejection of the null hypothesis only applies at the 10% significance level, we identify the variable as neither weakly exogenous nor endogenous since the probability of error is considered too big. A similar interpretation can derive from the results presented in Tables 11 and 12 for Eu_2 and OECD_w, respectively, in what concerns causality analysis.

Table 10. ECM Coefficient λ for Results on Table 7 (Eu_1)

	Fixed Effects				Pooled Mean Group			
Eq.	**dY**	**dX1**	**dX2**	**dX3**	**dY**	**dX1**	**dX2**	**dX3**
2	-0.093***	-0.029	0.008***		-0.287***	0.065	0.022**	
	0.019	0.043	0.002		0.058	0.114	0.010	
3	-0.113***	0.027			0.310***	-0.116*		
	0.017	0.042			0.033	0.066		
5	-0.167***	0.298***			-0.223***	0.456***		
	0.023	0.052			0.032	0.077		
6	-0.152***	0.115			-0.238***	0.176*		
	0.019	0.072			0.038	0.093		
7	-0.128***	0.178			-0.194***	0.488**		
	0.036	0.112			0.067	0.239		
8	-0.157***	0.290***			-0.182***	0.448***		
	0.024	0.041			0.031	0.056		
9	-0.171***	0.330***	0.234***		-0.203***	0.521***	0.303***	
	0.024	0.053	0.084		0.032	0.073	0.116	
10	-0.098***	0.025**	-0.007		-0.114***	0.204***	-0.489***	
	0.023	0.010	0.031		0.031	0.063	0.171	
11	-0.053***	0.040***	0.023		-0.125***	-0.030	-0.007	
	0.019	0.013	0.025		0.018	0.179	0.028	
12	-0.047***	-0.115***	-0.127***	-0.169**	-0.053***	-0.148***	-0.371***	-0.238***
	0.014	0.037	0.047	0.074	0.001	0.054	0.001	0.001
13	-0.006**	0.009	0.233***		-0.020***	0.251***	0.422***	
	0.003	0.045	0.068		0.001	0.001	0.001	

Notes: The first column presents the number of the long-run equation that appears after the benchmark equation in the respective table. *dY* refers to the equation of the first difference of the dependent variable and *dX1*, *dX2* and *dX3* to the equations of the policy variables and, eventually, *yrpc*, if retained as an independent variable, following the ordering of the variables of the associated equation in Table 7. Below the coefficient values we present the standard deviations. The stars have the usual interpretation, *** if the null is rejected at the 1% significance level, ** for 5% and * for 10%.

Table 10.A. Causality Relations Associated with Eu_1

	Fixed Effects		PMG	
	WE	**Non-WE**	**WE**	**Non-WE**
yrpc	es(2), et(3), hepr(6,7)	hep(5),hept(8),hepr(9), hep(9),leb(2)	es(2)	hep(5), hept(8), hepr(7,9), hep(9),leb(2)
es	yrpc(10)	eep(10)		eep(10), yrpc(10)
et	yrpc(11)	eep(11)	eep(11), yrpc(11)	
mi		et(12), hep(12), hepr(12)		et(12), hep(12), hepr(12)
leb	hep(13)	hepr(13)		hep(13), hepr(13)

Notes: this information is a summary of the most relevant information inTable 10. WE and Non-WE denotes weak exogeneity and the opposite, respectively. The numbers in parenthesis represent the associated equation numbers in Table 7.

Tables 10.A, 11.A and 12.A contain a summary of the causality relations between the variables under analysis for the three groups of countries, respectively, Eu_1, Eu_2 and OECD_w. We have investigated so far the best specification for the (*yprc*) long-run equation in order to test for the influence of human capital (both education and health dimensions of human capital) and education expenditures variables, or human capital and health expenditures, on (*yprc)*, after controlling for the usual growth influences. Next, we tested for the influence of education and health expenditures on educational attainment indicators and health status welfare variables, respectively, in order to disantagle in a more accurate way the influence of social policy variables on social variables such as educational attainment and health status variables. We will analyse the causality results following the above described order of presentation of the results in Tables 7-9.

Table 11. ECM Coefficient λ for Results in Table 8 (EU_2)

	Fixed Effects				Pooled Mean Group			
Eq.	**dY**	**dX1**	**dX2**	**dX3**	**dY**	**dX1**	**dX2**	**dX3**
2	-0.144***	0.018	0.002		-0.097**	0.070**	0.009	
	0.023	0.019	0.003		0.049	0.035	0.007	
3	-0.140 ***	-0.062	-0.001		-0.208***	0.130	0.006	
	0.026	0.053	0.003		0.064	0.112	0.009	
4	-0.062***	0.508***			-0.099***	0.452***		
	0.014	0.079			0.026	0.065		
5	-0.088***	0.138***			-0.104***	0.221***		
	0.017	0.032			0.022	0.046		
6	-0.105***	0.066			-0.112**	0.314***		
	0.020	0.065			0.042	0.098		
7	-0.087***	0.133***			-0.091***	0.226***		
	0.017	0.025			0.020	0.036		
8	-0.096***	0.159***	0.064		-0.110***	0.254***	0.158*	
	0.019	0.035	0.061		0.225	0.056	0.087	
9	-0.159***	0.876***	0.003		-0.210***	0.687	0.161	
	0.033	0.244	0.048		0.076	0.600	0.103	
10	-0.009	0.252***	0.041***		0.008	0.247	0.074***	
	0.016	0.049	0.010		0.026	0.166	0.020	
11	-0.001	-0.059	-0.036	0.003	-0.057***	-0.078	0.116	-0.053
	0.009	0.058	0.095	0.026	0.015	0.116	0.167	0.049
12	-0.121***	0.950	-0.676	0.391	-0.107**	2.306**	0.347	0.417
	0.040	0621	1.031	0.303	0.051	0.934	1.464	0.356

Note: The first column has the number of the long-run equation after the baseline equation. *dY* refers to the equation of the first difference of the dependent variable and *dX1*, *dX2* and *dX3* to the equations of the policy variables and eventually *yrpc*, if independent variable, following the order of the variables of the associated equation in Table 8. See also Note to Table 10.

Table 11.A. Causality Relations Associated with Eu_2

	Fixed Effects		PMG	
	WE	**Non-WE**	**WE**	**Non-WE**
yrpc	es(2), et(3), hepr(6,8), leb(2,3)	eep(4), hep(5,8), hept(7)	et(3), leb(2,3)	es(2), eep(4),hep(5,8), hepr(6), hept(7)
es	yrpc(9)	eep(9)	eep(9), yrpc(9)	
et	et(10)	eep(10), yrpc(10)	et(10), eep(10)	yrpc(10)
mi	hep(11), hepr(11), yrpc(11)		hep(11), hepr(11), yrpc(11)	
leb	hep(12), yrpc(12), hepr(12)		hepr(12), yrpc(12)	hep(12)

Notes: this information is a summary of the most relevant information inTable 11. WE and Non-WE denotes weak exogeneity and the opposite, respectively. The numbers in parenthesis represent the associated equation numbers in Table 8.

Table 12. ECM Coefficient λ for Results on Table 9 (OECD_w)

	Fixed Effects			Pooled Mean Group		
Eq.	**dY**	**dX1**	**dX2**	**dY**	**dX1**	**dX2**
2	-0.054***	-0.005		-0.094***	0.006	
	0.009	0.009		0.016	0.020	
3	-0.090***	0.011	0.008*	-0.147***	0.257**	0.016***
	0.018	0.046	0.005	0.030	0.119	0.005
4	-0.191***	0.229**		-0.161**	0.379**	
	0.040	0.089		0.067	0.163	
5	-0.127***	0.091		-0.150***	-0.061	
	0.031	0.081		0.038	0.169	
6	-0.164***	0.106		-0.165***	0.116	
	0.039	0.076		0.049	0.160	
7	-0.125***	0.026	0.069	-0.146***	-0.182	-0.131
	0.031	0.072	0.080	0.042	0.163	0.169
8	-0.096***	0.029	0.048*	-0.115***	-0.050	0.067*
	0.023	0.087.	0.025	0.031	0.095	0.035
9	-0.057***	0.041	0.013	-0.114***	0.016	0.023*
	0.021	0.029	0.008	0.028	0.041	0.013
10	-0.034***	0.020	0.004	-0.084***	-0.062*	-0.230***
	0.009	0.017	0.034	0.022	0.032	0.087
11	-0.387***	0.294	0.045	-0.298***	1.457	0.535
	0.068	0.428	0.238	0.068	1.013	0.570

Note: The first column has the number of the long-run equation after the baseline equation. *dY* refers to the equation of the first difference of the dependent variable and *dX1*, *dX2* and *dX3* to the equations of the policy variables and eventually *yrpc*, if independent variable, following the order of the variables of the associated equation in Table 9. See also Note to Table 10.

Table 12.A. Causality Relations Associated with OECD_w

	Fixed Effects		PMG	
	WE	**Non-WE**	**WE**	**Non-WE**
yrpc	es(2), et(3), hepr(5,7), hep(7), hept(6), leb(3)	hep(4)	es(2), hepr(5,7), hep(7), hept(6)	hep(4), et(3), leb(3)
es	eep(8)		eep(8)	
et	eep(9), yrpc(9)		eep(9)	
mi	es(10), hep(10)			hep(10)
leb	hept(11), yrpc(11)		hept(11), yrpc(11)	

Notes: this information is a summary of the most relevant information inTable 12. WE and Non-WE denotes weak exogeneity and the opposite, respectively. The numbers in parenthesis represent the associated equation numbers in Table 9.

The results concerning EU_1 (Table 10.A) and OECD_w (Table 12.A) imply that (*es*) is weakly exogenous in equation 2 with both the FE and the PMG estimators. However, for EU_2 (Table 11.A), it is (*et*) that is weakly exogenous in equation 3 with both FE and PMG. These results indicate that for the two samples with higher per capita income levels (OECD_w and EU_1), the educational attainment variable (*es*) is a policy variable since it is not caused by (*yrpc)*, which might be the consequence of the compulsory nature of this level of education in these two groups of countries. In what concerns EU_2, the fact that (*es*) is not weakly exogenous, but (*et*) is, might be explained by the fact that these countries had a highly educated workforce under the socialist *regime* and, after the end of the regime, they recorded, simultaneously, a huge decrease in per capita income and a considerable increase in income inequality during the transition period towards a market economy. In what concerns the health status indicator (*leb*) and using comparable human capital proxies, (*leb*) is weakly exogenous for EU_2 and OECD_w, no matter the estimation method used. But if we compare EU_1 with EU_2 by using equation 2 we observe opposite results: (*leb*) is endogenous for EU_1 and weakly exogenous for EU_2.

If we turn now to the results that allow us to identify the causality relations between (*es*) and (*eep*) and (*et*) and (*eep*) in order to ascertain whether (*eep*) might be classified as a policy variable, we find mixed results that are sensitive to the estimators used. The only exception is the OECD_w group for which public spending in education is weakly exogenous for both relations described above and with both estimators that is (*eep*) is not caused by (*es*), nor by (*et*). In what concerns the other two groups, public spending in education is only weakly exogenous for EU_2 using the PMG estimator in the framework of equation (9).

As for the causality relations between (*yrpc*) and health expenditures, the results are those associated with equations (5) to (9) for EU_1 (Tables 7 and 10.A), equations (5) to (8) for Eu_2 (Tables 8 and 11.A) and equations (4) to (7) for OECD_w (Tables 9 and 12.A). For this last group and for both estimators, public, private and total health expenditures (as a % of GDP) are weakly exogenous, meaning that these variables are not caused in the long-run by real GDP per capita. As far as the other two country groups are concerned, we observe opposite results – the variables (*hep*), (*hept*), (*hepr*) and (*hep*) are not weakly exogenous implying that, in the long-run, they are caused by real GDP per capita.

When we inspect the causality relations between health status variables and health expenditures, we observe that for the equations where (*leb*) is the dependent variable, (*hep*) is weakly exogenous only with the FE estimator, in the case of EU_1, whereas (*hepr*) and (*yrpc*) are weakly exogenous for EU_2 and both estimators. Finally, for the OECD_w group (*hept*) and (*yrpc*) are weakly exogenous for both estimators. When we inspect the results concerning the equations where (*mi*) is the dependent variable, we observe mixed results: (*hep*) and (*hepr*) are endogenous for EU_1 and exogenous for EU_2 and *(et)* is endogenous for EU_1, while *(es)* is sensitive to the estimators for OECD_w.

Concluding remarks

In this paper, we empirically assess the impact of public expenditures on education and health on real income and educational attainment and health status indicators. We do this for three groups of countries: a group of high income OECD non-EU economies, the EU before enlargement and the EU enlargement group. This assessment can have important implications for Welfare State policy design in the EU and its OECD partners. Our empirical study is innovative in the sense that we consider cross-sectional dependence not only at the level of unit-root tests but it is also explicitly incorporated in non-stationary estimations. This methodological choice is crucial to obtain robust results given globalization of information and free circulation of capital and technology phenomena that resulted in stronger interdependency between countries (cross-units) leading to the presence of common shocks, with no identified pattern of common components, as well as unobserved components becoming part of the errors of the model and also of spatial dependence. Otherwise, panel data estimation results will be biased and will exhibit size distortions. We first test for the order of integration of the variables, next, we estimate long-run equilibrium relations with state and policy variables and, finally, we perform causality analysis.

Our study is in reality a panel data study in the sense that we impose homogeneous coefficients. Many authors estimate models assuming parameter heterogeneity, which is not very different from applying time-series techniques without benefiting from specific methodologies for panel data analysis. The main aim of this paper is to identify the global behaviour of each group of countries and not the behaviour of individual countries, so assuming homogeneous coefficients is an adequate choice. Additionally, since the concept of Granger (1969) causality implies the presence of stationary variables, the second stage of our empirical strategy is appropriate for this kind analysis, although we restrict our investigation to what is sometimes called 'long-run causality' (weak-exogeneity). Finally, we only retain the long-run empirical models with policy variables added if the respective level of information is higher than the one associated with the model that considers only states variables (benchmark equation). In this way, we are also able to offer insights as to the robustness of our conclusions.

The results concerning the long-run equations reveal a positive, direct or indirect, influence of (public) education expenditures and of (public, private or total) health expenditures on output and hence support the argument that the Welfare State is growth-enhancing for the three groups of countries under analysis. However, these findings are not in line with the evidence found in most other cross-country studies on the subject that point to a negative impact in developed countries. Several reasons might explain the difference, namely the methodology used that, for the reasons stated above, we claim is more robust. In accordance to the literature review, we also find that educational attainment levels matter for output growth although the relevant level for output behaviour in the long-run differs across country groups.

Although the literature usually finds mixed results concerning the influence (sign and magnitude) of health expenditures on output, with the results depending on countries' income levels, we found that, for our three samples, the influence of health expenditures on output is similar – public, private and total health expenditures have a positive influence on output but public health expenditures exert a stronger influence. When we consider the health status welfare as a dependent variable, both public and private health expenditures influence the infant mortality rate and life expectancy at birth in EU_1 and EU_2, and GDP per capita real also has a positive impact. As for the OECD_w group, the influence only applies to total health expenditures. Public health expenditures are again the health expenditures that have a stronger influence on the health status welfare variables (EU_1 and EU_2).

In line with the previous literature, our results reveal causality relationships sensitive to the estimators used and the country group under analysis. The fact that a variable is weakly exogenous implies that although there is a long-run equilibrium relationship between the variables, in the short-run, the weakly exogenous variable causes the other variables, but the opposite does not apply. According to this definition, social policy variables that are weakly exogenous are in reality discretionary policy variables that might be used as policy instruments in the short-run in order to positively influence, directly or indirectly, long-run equilibrium output. According to our results, the OECD_w group undoubtedly exhibits discretionary social policy variables that might be used to foster long-run equilibrium output and health status welfare, but this is not the case for the other two groups. The results for the EU_1 are at odds with the ones for the OECD_w group due to the endogenous nature of its social policy variables and results for the EU_2 group lie in between. In the latter case, health expenditures cause health status welfare but only indirectly cause output. This means that for EU_1 and EU_2 countries, social educational and health policies react to disequilibrium along the long-run equilibrium path, being endogenously determined with output which undermines their use as growth-enhancing policies. The associated policy recommendation is that these social policies should also become discretionary policies in the EU_1 and the EU_2 because, for instance, public health expenditures for both groups and private health expenditures for EU2 only also exert a positive and quantitatively important influence on long-run output and welfare.

However, EU_1 and EU_ 2 consist of countries that have been severely hit by the global financial crisis that started in 2007-2008 in the USA and rapidly spread to the EU, evolving into an economic crisis in 2009 and to a sovereign debt crisis in several EMU countries, starting in Greece, in the Autumn of 2009. Although the sovereign debt crisis is no longer a threat to the Economic and Monetary Union (EMU), in general, EU countries are constrained by fiscal austerity measures. In fact, many European countries are highly indebted and the prospects for EU economic recovery and growth are very dim for the near future, especially in a context of lower bound interest rate like the one currently experienced by the EMU. In the current circumstances, this policy recommendation faces severe impediments but it should be taken seriously by EU governments' since it does not necessarily involve increasing expenditures, it might be done by changing the composition of public expenditure in general, and social expenditure in particular.

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