The Dynamic Relationship of Income with Health and Education Spending

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Abstract

The purpose of this study is to analyse the short-run and long-run relationships existing between income and two of the largest categories of social spending: health and education expenditure. According to the endogenous growth theory social expenditure might contribute the formation of human capital and thus stimulate growth. In spite of that, in the recent years we have observed a reduction in social spending due to the austerity measures that have been implemented. If the effect of education and health expenditure affects output then it is of great importance to establish the consequences of these types of measures. On the other hand, the capacity of spending in health and education is constrained by the income so that the reductions in social spending might also be the consequence of adjustments to lower levels of income. The scope of the analysis is to assess the existence, the direction and the intensity of the causal effect. In order to empirically address this issue we collected data from World development Indicators (World Bank) and OECD Health database for 9 OECD countries from 1970 to 2014. This study applies the ARDL approach to cointegration developed by Pesaran et al. (2001) and Pesaran and Shin (1999). We find 9 cointegration relationships indicating that in the long-run an equilibrium exists. In particular, income is a strong determinant of education and health expenditure. This indicates that health and income have a strong consumption component even in the long-run. The only exception is Norway where social expenditure significantly promotes growth. On the opposite, social expenditure has a predominantly negative influence on income in the short-run. According to the literature this could be due to the crowding-out of other productive expenditure possibilities.

CONTENTS

Introduction

The world has never been so rich, prosperous and technologically advanced as it is now. However the inequalities among countries and even within countries persist and seem to increase. For example in 2013 the income per capita of the United States was 130 times larger than Congo. The causes for these differences are numerous. According to economic growth theory, human capital is a decisive element to explain the economic performance of country and world income inequalities. Therefore in this study we look at the most tangible of human capital inputs: health and education expenditure. It has been stated that education and health have a direct impact on growth through productivity. But does education and health expenditure generate growth as well? And to what extent increasing social spending enhances growth? Or on the contrary, is social expenditure a consequence of the process of economic growth? So far no definite answer has been provided. The aim of this study is to investigate the relationship between health and education spending with income, and establish the nature, the intensity and the direction of the causal relation.

In the last 50 years, both the income and the volume of public expenditure rose dramatically as it had never previously done in history. One consequence of this is a notable increase also in social expenditure (figure 1). Nowadays social expenditure typically represents an important share of government spending. As an illustration for the OECD countries on average it constitutes 21.7% of GDP and 47.9% of total government spending (OECD 2014). Income and social spending exhibit substantial correlation across time, and the impact of these categories of welfare expenditure on economic activity has been persistent throughout time (Alam et al. 2010). Many channels of action have been proposed by the theoretical and empirical literature; in particular it has been advanced that these categories of spending have a direct effect on productivity, foster innovation and emanate positive externalities for the rest of the society (Monteiro and Turnovsky 2008, Barro 2013). According to the endogenous growth theory, education and health contribute to the formation of human capital, defined as the set of intrinsic stock of knowledge, abilities, capacities, that are peculiar to a population and positively influence the productivity or the technological capacity of an economic system. In addition to that, social spending is also paramount in building social institutions that are capable of shaping a favourable environment for innovation, inciting investments and promoting a collaborative relationship between capital and labour (Beraldo et al. 2009). This last idea is linked with the key role of social spending in the redistribution of resources across the society. However, if on the one health and education expenditure are beneficial for the economy, it is also true that when the size of social spending becomes too large this may provoke distortions in the markets and hamper economic growth.

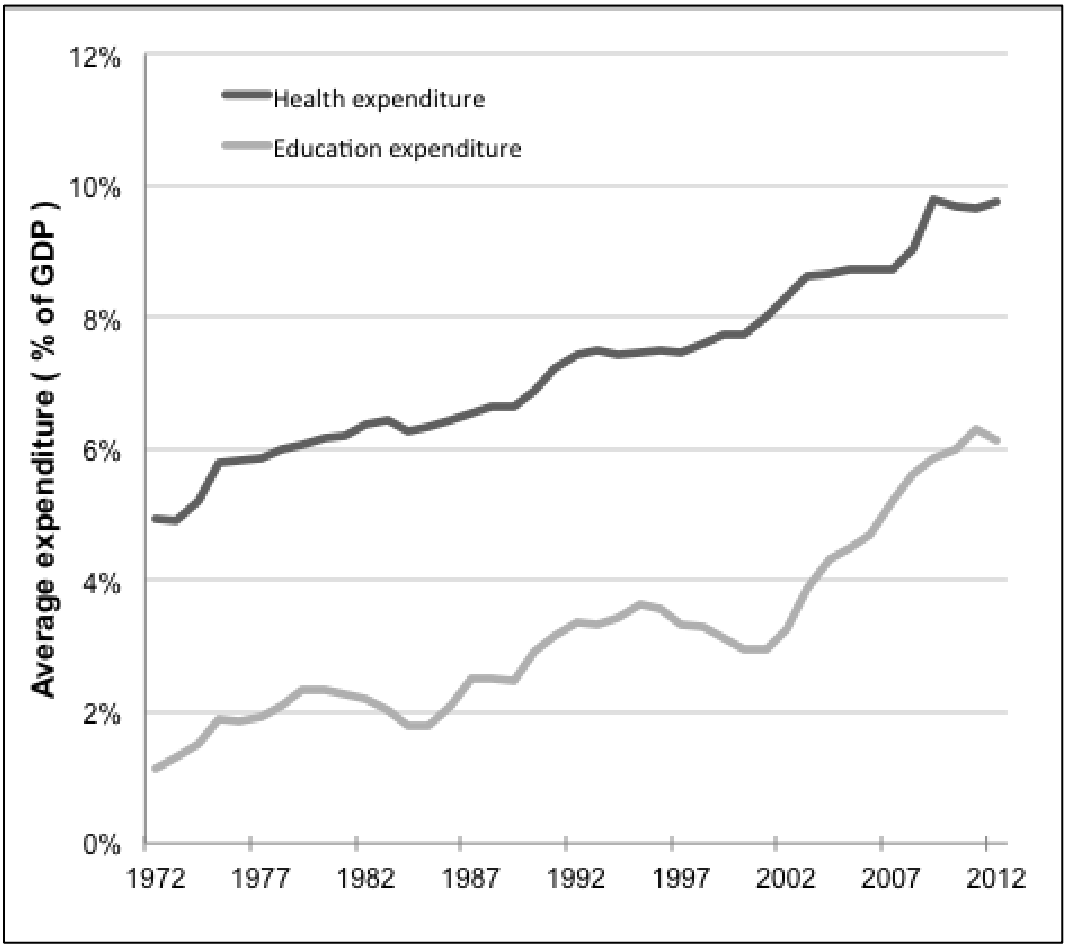


FIGURE 1 – Average Health and Education expenditure in the OECD countries as a percentage of GDP (1972-2012)

Notes: The data for health expenditure is from OECD health database, education expenditure is extracted from WDI. The average expenditure rate is computed as an unweighted mean for 25 out of 34 countries of the OECD. The countries excluded are Chile, Check Republic, Estonia, Germany, Hungary, Israel, Poland, Slovak Republic and Turkey.

Despite the notable impact that social expenditure has on growth it is also possible for the causality to run in the opposite direction, i.e. education and health expenditure are a function of income. As a matter of fact, social expenditure increased over time because higher income made possible for nations to afford higher social spending (Hartwig 2008). So that in this case the holding long-term relation is inverted: social expenditure is a consequence of the growth process. In our analysis we tackle the risk of reverse causality by taking into account both possible directions and carefully identify the dominant one.

Health and education are among the largest categories of public expenditure in advanced economies and therefore it is indispensable to fully understand the implications of policies that affect them. To address this issue, we employ two Autoregressive Distributed Lags (ARDL) models relating health expenditure with income and education expenditure with income, in an attempt to investigate the possible existence of cointegration relationships. If cointegration is confirmed we estimate long-run form and the respective Error Correction model in order to explore both the short-run and long run dynamics. The empirical analysis is applied to 9 OECD countries with time-series annual data ranging from 1970 to 2014. The outcome of our analysis provides further insights on the functioning of the economy and the relationship of income with the above-mentioned social variables.

This study is divided in 5 sections. In the first section we review the link between health and education expenditure with income, dedicating a particular attention to the findings and conclusions of the theoretical and empirical literature on the topic. We end the literature review with a specific focus on the direction of the causality between social spending and income. Subsequently we discuss the methodology and the data that are applied to the issue. The first step in the empirical analysis is to investigate the order of integration and Granger causality of the series. Then we move to the bounds test and ARDL approach to cointegration. In the last section we discuss the findings and draw some conclusions.

The Dynamic Relationship of Income with Health and Education Spending

1) How health and education expenditure affect income

Health and education spending prompt income and economic growth through a multitude of channels. In this chapter we review the theoretical and empirical literature surrounding these relationships. We first look at how social spending is connected with income in the theoretical models of growth. Then, we analyse the main findings of the empirical literature together with the issues and fragilities that have been identified so far.

1.1. The theory of economic growth

In 1956 Solow - and simultaneously Swan (1956) - gave birth to the modern economic growth theory. Despite the simplicity of its formulation the Solow model successfully explains a number of observed facts concerning economic growth. The model predicts that two countries that have the identical saving rates, population growth rates and production functions tend toward the same equilibrium (or steady-state) on the long run and any difference in income per capita is due to the initial endowment of the factors of production (Jones 2001). As a further matter, countries that lie more distant from the equilibrium move faster toward the steady-state so that there is convergence conditionally to the parameters that we mentioned above (Barro and Sala-i-Martin 1991). According to the Solow model once the steady-state has been reached the only growth in income per capita is induced by technological progress; an exogenous variable.

The shortcomings of the Solow model are overcome by the development of the endogenous growth theory notably by Romer (1986) and Lucas (1988). The notion of capital is broadened to include human capital, which is the stock of skills and knowledge belonging to the individuals or population (Barro 2013) and the issue of the exogeneity of the technological growth is addressed by modelling the accumulation of knowledge. In addittion, the endogenous growth theory stimulated a plethora of cross section studies that sought to identify the determinants of growth (e.g. Barro 1991, Hall and Jones 1997, Sala-i-Martin 1997).

In the Keynesian theory government expenditure has a short-run effect on income because it is a component of the effective demand, but government spending also has a long run effect if it affects the economic institutions (Hall 1996). We expect this to be especially true for social expenditure since it is connected with human capital. The empirical findings corroborate the idea that the role of the public sector goes beyond the mere provision of public goods; in fact the state can influence the accumulation of physical and human capital as well (Acemoglu and Robinson 2007). According to this theory the Institutions, defined as the set constraints and principles that regulate the economic activity, are the fundamental determinant of long run growth. The political and economic power possessed by the government strongly influences the distribution of resources and the behaviour of economic agents (Acemoglu et al. 2004). For example in another paper Acemoglu et al. (2014) study the link between human capital, institutions and economic growth; they show that the success of United States compared to other former colonies is partially attributable to the fact that in settling colonies Europeans erected institutions that later stimulated schooling and the creation of human capital.

1.2. The theoretical literature on health and education expenditure

Although the relationship between social expenditure and growth has been broadly investigated in empirical studies, it has not received a similar treatment in theoretical papers. In fact, the models treating the effects of health and education on growth often use other variables to represent human capital, such as life expectancy or school enrolment (e.g. Ashraf et al. 2009, Bloom and Cannings 2005). At the same time it is possible to find social spending as a key determinant of income in some endogenous growth model where human capital is accumulated through health or education expenditure. In this shred of literature the effect of education and health expenditure on growth is positive in the long run, thanks to the favourable influence they exercise on human capital.

In Barro (2013) health is a form of private capital included in the production function, having diminishing returns to scale and subject to depreciation in the same way as physical capital. Health expenditure regulates the accumulation of health capital and economic growth. The level of spending is an endogenous variable determined in a utility maximisation framework, but due to the presence of externalities, health services are underprovided. Consequently, Barro (2013) establishes health as a public good in order to internalise the externalities stemming from health and concludes that the effect of public expenditure is uncertain and could be offset by the negative effect of taxes. Bloom and Cannings (2005) and Ehrlich and Yin (2013) undertake a similar approach. They try to determine the long run health expenditure equilibrium in an endogenous growth model with three overlapping generations. The fundamental difference is that Bloom and Cannings (2005) relates workers' productivity to health expenditure. On the other hand, in Ehrlich and Yin (2013) human capital is constituted by health and education, where the former has a positive impact on growth because it enhances productivity, whereas the latter increases the probability of survival and eases knowledge accumulation. Health spending permits to accumulate health capital, influence returns to educations and as a consequence also affect growth.

A number of endogenous growth models attempt to introduce government sector with the purpose of exploring the effect of government activity on long run economic growth. For example, Basu and Bhattaria (2010) redesign Lucas' (1988) model by changing the way human capital is accumulated. Human capital is accumulated through education spending instead of devoting time to the formation of skills. The necessary tax burden to fund such expenditure is borne by the producers of physical goods so that the investments on education reduce the aggregate savings. Nevertheless the overall impact of an increase in education spending is favourable for growth, especially in countries with good infrastructures and complementary technologies since they capture the externalities and spillovers of education more effectively (Basu and Bhattaria 2010, Aghion et al. 2009). In the growth model of Blankenau and Simpson (2003), the share of public education spending on output has a positive effect on growth but with diminishing returns to scale due to the increasingly distortionary effect of taxation. Similarly, Agenor and Neandis (2006) build a growth model with government sector. In this case the government optimises the spending on infrastructures, education and health. Health expenditure facilitates the accumulation of knowledge and increases the productivity of workers while education fuels investment and stimulates innovation on the balanced growth path. Finally, in Monteiro and Turnovsky (2008) government can invest on education and infrastructures but infrastructure expenditure enters in the production function as an input together with human and physical capital and education spending accumulates human capital as in Basu and Bhattaria (2010).

A slightly different approach, but with similar conclusions, is adopted by Aghion et al. (2009). Aghion et al. (2009) construct a Schumpeterian growth model where human capital enters in three different processes: production, imitation and innovation. Countries that lie far from the technological frontier concentrate on imitation while developed countries actively engage in innovation. Education expenditure promotes growth both in advanced and developing countries, In addition Aghion et al. (2009) empirically testing on 48 US states, find that spending on high education is particularly fruitful for advanced states, but not so much for the ones that are further from the technological frontier. Conversely, public investment on primary and secondary education fosters growth in less advanced states probably because it enhances the absorption of new technologies.

In some models the causality between spending and income is inverted in the short-run. Hall and Jones (2007) build a neoclassical model that connects private health expenditure and income per capita. They posit that as individuals get richer they increasingly value health (defined as a commodity), consequently higher income per capita is associated to a higher fraction of resources allocated to health. Income is also the main determinant in models reformulating the Baumol (1967) cost-disease thesis. For example, Hartwig (2008) assumes that the economy is divided in 2 sectors: health care sector which is more labour-intensive and the non-health sector with higher productivity. Since the marginal product of labour determines wages, the economic growth in the non-health sector drags up wages in the health sector and thus increases health expenditure. The low productivity is further aggravated by longevity. Indeed Aisa and Pueyo (2013) highlight that longevity causes an increasing share of workers to shift to health related sectors that exhibit lower productivity, as a consequence population ageing has a negative repercussions on income and growth. In these two models social expenditure does not generate income, rather, the growth of income over time determines the level of expenditure.

1.3. The empirical literature on the relationship between income and social expenditure

Over the last twenty years the empirical analysis has been bounded by the availability of data. As a consequence, the majority of the studies use a similar sample so that we can mainly distinguish on the basis of the approach that has been chosen. A group of papers looks at the isolated relationship between health or education expenditure with income (e.g. Jewell et al. 2003, Chang and Yin 2005, Blankenau et al. 2007), while a second group places social expenditure in a general equilibrium framework to capture the macroeconomic interactions of variations in expenditure (e.g. Bose et al. 2003, Ashgar et al. 2011, Gurgul et al. 2012). Regardless of this separation, the effect is found to be positive both for health and education while several reasons can be advanced to explain this.

We expect health expenditure to affect growth and income through a multitude of mechanisms that take advantage of the sensibility of productivity and human capital to government action (Figure 2). Firstly, health improvements normally increase endurance, strength and physical capacities of workers (Bloom and Cannings 2005). Such an argument is strongly supported by microeconomic evidences that also stress that the relationship significantly varies across countries; As a matter of fact, in developing countries a marginal improvement in health condition raises productivity of workers more than it would in a developed country (Dogan et al. 2014). We can come to the conclusion that a first direct nexus from spending to productivity exists. Moreover, health influences a series of demographic and macroeconomic variables. For example, better health conditions decrease idleness related to illness hence ensuring higher labour participation (Erdil and Yetkiner 2009, Rahman 2011). Also, improvements in health conditions tend to reduce fertility and children mortality along with increasing life expectancy. Taken together, these changes generate an increase in population and available labour stock. Even though this reduces the capital per worker and income per worker in the short-run (Hansen 2013); on the long run the negative effect of capital shallowing is offset by the accumulation of

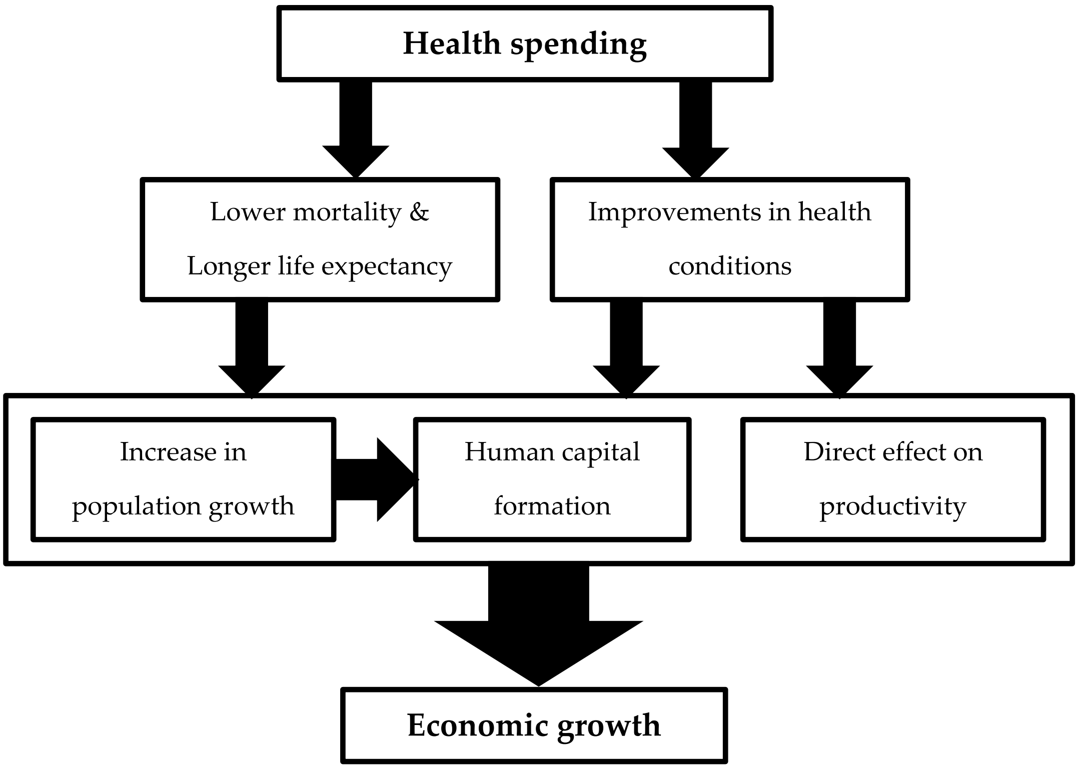


FIGURE 2 – Link between health spending and growth

human capital and the enhancement of the production capacity, that ultimately generate economic growth (Ashgar et al. 2009). According to the economic literature this relation holds especially when the population growth rate is very sensible to health improvements and when health expenditure is associated with education improvements (Ashraf et al. 2007, Acemoglu and Johnson 2007). Mushkin (1962) proposed another possible link between health and economic. This theory sustains that health, for every individual, is a form of capital that slowly declines over time. Since healthier people are expecting to live longer they can capture higher returns from their investments. As a result, the health status of the population influences positively the saving rate and growth (Elmi and Sadeghi 2012).

The returns to education are a fact well documented both in microeconomics and macroeconomics literature with education being the main component of human capital in the endogenous growth theory. In Lucas (1988) the productivity of workers depends on the time spent accumulating skills (i.e. education and training) and in Romer (1986) the accumulation of knowledge allows the diffusion of new technologies and creates positive spillovers. Moreover, education accelerates technologic transfer and increases income per capita by lowering fertility (Sianesi and Renaan 2013). Education expenditure also correlates with physical investment (Musilla and Belassi 2004) and generates positive externalities on health (Baldacci et al. 2004, Chandra 2011). In addition it has been observed that in the same way as health, the benefits of education expenditure do not distribute linearly across countries. In high-income countries an increase in education spending fosters innovation and generate consistent growth while in developing countries the impact is light because it crowds-out productive public investments and infrastructures are unable to fully capture the rewards stemming from human capital investment (Aghion et al. 2009, Erdil and Yetkiner, Basu and Bhattarai 2010). On top of that health and education are strongly interlinked as well; education has significant externalities on health and health has important externalities on education (Baldacci et al. 2004). As matter of fact, Edil and Yetkiner (2009) find that improving the health condition of parent or children in a family significantly increases the school participation rate. Health and education investment reinforce each other. In conclusion, education spending and income exhibit significant positive correlation: this is visible also in the OECD countries (Figure 3).

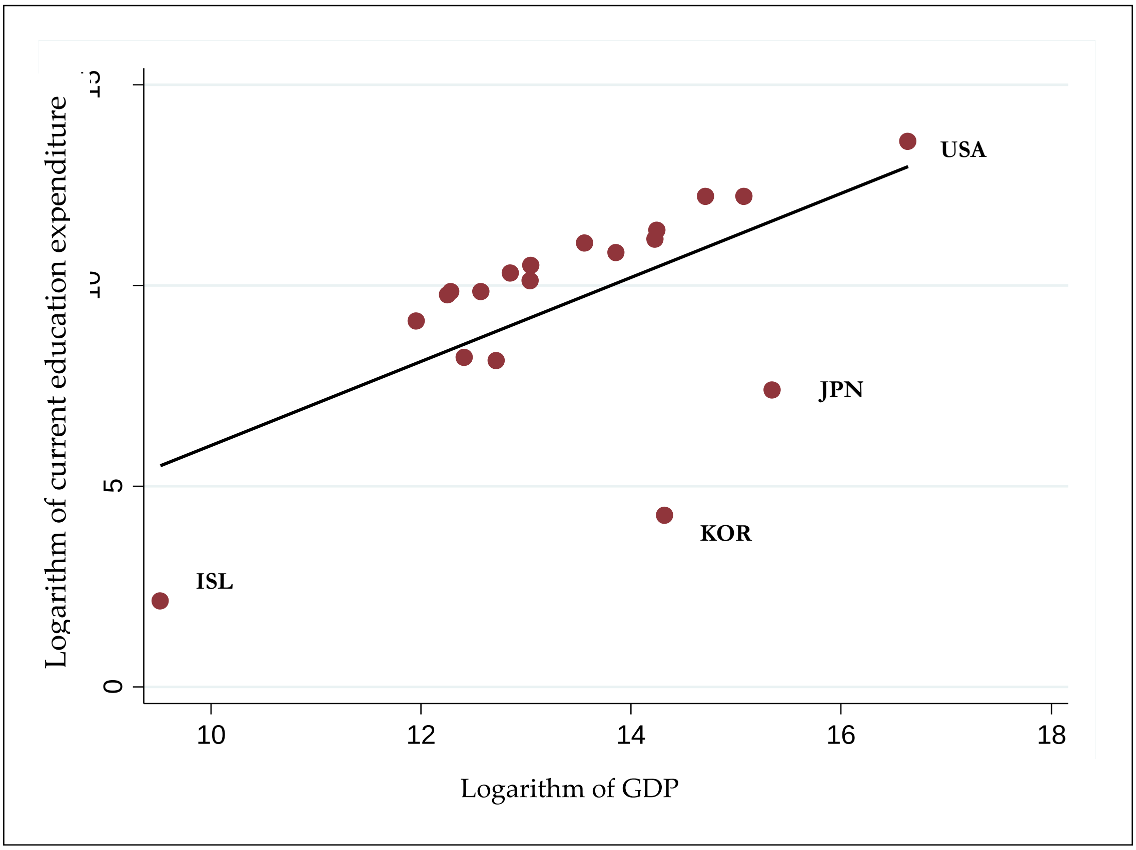


FIGURE 3 – Education expenditure and income for 20 OECD countries

Notes: Data from World Development Indicators, World Bank. GDP per capita and education expenditure refer to 2013. GDP and education expenditure are expressed in PPP US dollars.

Health and education are two of the most prominent components of human capital, and their impact on income has been solidly established by the literature (e.g. Barro 1991, Nordhaus 2002, Acemoglu and Johnson 2007, Weil 2007, Aghion et al. 2007). However, for a change in government expenditure on health or education to influence income it is not only necessary for human capital to relate with growth but also that the expenditure on health and education respectively determine the health and education status of the population. Empirical literature broadly supports the existence of a link between health and education expenditure with their respective human capital variable (Baldacci et al. 2004, Alam et al. 2010), yet, this relationship could be questioned or at least weakened under certain circumstances. As stated by Atella and Marini (2006), countries with a good national health service experience a strong substitution effect among private and public health expenditure. Consequently an increase in health or education expenditure crowds-out private investment so that the effect of spending on the underling health or education status could be mitigated or even eliminated (Basu and Bhattaria 2010). Rajkumar and Swaroop (2008) find that governance quality is crucial in ensuring the effectiveness of government spending. In fact, corruption and bureaucracy diminish the impact on human capital. The link is also sensible to how the money is employed, for instance according to Ashraf et al. (2009) the most effective health policies are those that affect children, therefore the distribution of the funds among different possible health or education interventions modifies the outcome on human capital. Finally, the link between expenditure and social effect differs in intensity across countries (Baldacci et al. 2004). Despite these limits, the relationship with human capital strongly persists and remains the major channel through which income is affected.

The impact of government action on growth is often debated and despite the fact that public social expenditure has occasionally been labelled as a "non-productive" type of expenditure; the impact of health and education expenditure on growth and income is estimated to be positive in the large majority of the papers but a consensus is still missing on whether these variables have a level or a growth effect in the long run (Sianesi and Reneen 2003). For instance, Musilla and Belassi (2004) using a cointegration approach and data for Uganda covering 1965-1999 estimates that income growth increases by 0.04% on the short-run and 0.6% on the long run when a 1% increase in education spending per worker occurs. Ding (2014) estimates for all 24 OECD countries that the effect of a one time 1% increase in health expenditure on the growth rate of GDP per capita is positive and add up to 0.19% increase in the growth rate on the long run. Public programmes are vital in forging human capital (Barro 1998), determining the distribution of resources, and shaping economic institutions and a favourable environment for investment (Beraldo et al. 2009).

1.4. The issue of reverse causality

A constant feature of health economics is the controversy surrounding the delicate issue of the causality between income and health expenditure (e.g. Atella and Marini 2006, Dogan et al. 2014, Erdil and Yetkiner 2009). If on the one hand social spending is a mean to accumulate human capital and stimulate growth on the other hand the level of expenditure might also be the consequence of the growth process. In fact, the expenditure on education and health is not random; wealthy nations with advanced institutions and infrastructures can increment their social spending more easily (Aghion et al. 2009), hence this is a possible source of reverse causality (Gurgul et al. 2012). Empirical findings support this possibility, for example Atella and Marini (2006) studying 20 OECD countries from 1960 to 2000 find that the level of income is the main determinant of health expenditure. Also, Baltagi and Moscone (2010) working on 20 OECD countries but from 1971 to 2004 and applying a cointegration analysis, reach the same conclusion. According to Ehrlich and Yin (2013) the expanding health expenditure in the Unites states is chiefly ascribable to consumer's demand. These evidences are consistent with the neoclassical theory, they show that utility-maximising agents increase the consumption of health services when income is raised. Furthermore, Chang and Yin (2005) testing for 15 OECD countries establish that health is a luxury good, having elasticity greater than one with respect to income, for most of the countries of the sample. Consequently economic growth should engender a more than proportional growth in health expenditure. Moreover, the correlation between health expenditure and growth might also be attributable to the influence of a third variable that is strongly correlated with both health spending and income (Grossman 1972). The variables that are most likely to assume this position are either education or technological progress. As stated by Newhouse

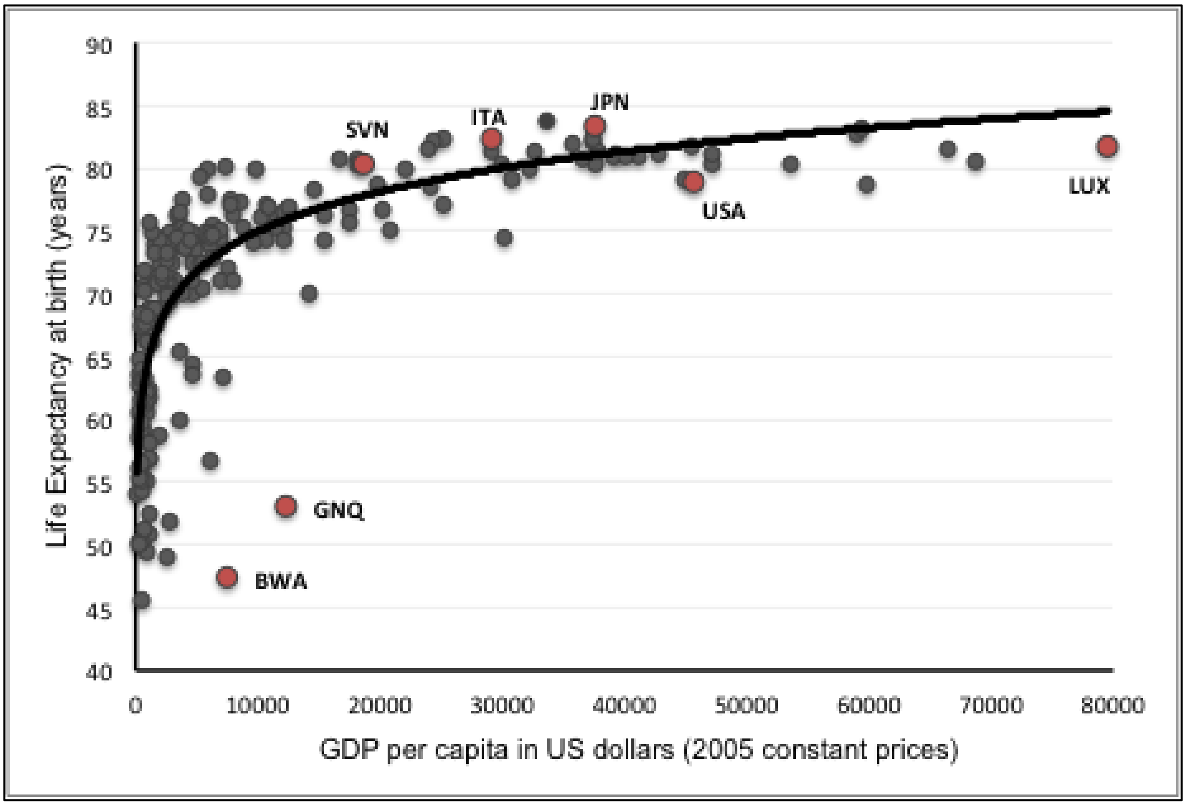


FIGURE 4 – Preston curve

Notes: 216 countries are plotted; data is from World Development Indicators, World Bank. The GDP per capita and life expectancy at birth refer to 2013.

technological change, and in particular innovation, allow to treat diseases that previously were beyond any cure; in consequence, expenditure on health increases because of the demand for the new treatments. In addition to that, the correlation among health and income might be the consequence of the effect of a third variable. For instance, education is a strong determinant of income and is constantly associated to better health conditions, so that the correlation between health and income might be a result of education instead of the consequence of a direct causal link (Deaton 2003).

In conclusion, apart from the fact that higher income allows to consume more health goods; health economists are sceptical about the existence of a causal link running from health status to income chiefly because population enjoying better health conditions command higher productivity and earnings, and because of the possible influence of a third variable (Deaton 2003).

The problem of the causality is normally addressed with granger causality test. So far no clear-cut answer has been furnished. Amiri and Ventelou (2012) evaluating the direction for health expenditure and income in 20 OECD countries find out that half of the countries exhibit bilateral granger causality, while 9 countries have a unidirectional granger causality running from health spending to income. Elmi and Sadeghi (2012) testing on developing countries, and Erdil and Yetkiner (2009) with a larger panel state that the relationship is characterised by bi-directional granger causality. The problem with this type of tests is that the outcome heavily relies on the countries included in the sample. Empirical studies on more advanced economies tend to display a higher number of uni-directional causality as compared to developing countries; for example, Gurgul et al. (2011), Rahman (2011) and Dogan et al. (2011) find that the direction from spending to income is a dominant feature in their study. This could be a consequence of the fact that the human capital in developing countries is more sensible to variations in income. This characteristic can clearly be spotted in figure 4 where we plotted GDP per capita against life expectancy for 216 countries. This graph is also known as Preston curve from Preston (1975) who first found that health and income exhibit a non-linear relationship and argues that the curve shifted upward over time as a consequence of improvements in public health care. An increase in income is correlated with a drastic improvement in health condition for developing countries whereas rich countries experience an almost negligible variation. For example, the GDP per capita in Slovenia is 4 times smaller than in Luxembourg but life expectancy in the latter is only 1 year longer, and still shorter than some countries with lower income per capita as Italy, Cyprus or Iceland.

In conclusion to the review of the empirical literature we have reported in table 1 the main findings concerning i) the presence of any short-run or long-run dynamics, ii) the direction of the link between income and health/education expenditure, iii) whether the influence of social spending is positive or negative and the channel through which this relation works

TABLE 1 – Findings of the principal empirical papers

	Main Variables	Methodology	Time period and Countries	Results
Baldacci et al. (2004)	- 5 years average of current education spending as a percentage of GDP - 5 years average of health spending as a percentage of GDP - Real per capita GDP growth rate	Regression Fixed-effect, 2SLS	120 Developing countries, 1975-2000	Both health and Education have a positive and significant effect on growth through human capital
Musilla and Belassi (2004)	- Log of real GDP - Log of government education expenditure per worker	Cointegration ECM	Uganda 1965-1999	Education expenditure per worker has a positive effect on growth. Raising expenditure by 1% increases output by 0.04% on the short-run and 0.6% on the long-run
Atella and Marini (2006)	- Health care expenditure per capita in PPP dollars - Income per capita in PPP $	Cointegration VECM with structural breaks	20 OECD countries 1960-2000 annually	Income is the main determinant of health expenditure. Health is not a luxury good since income elasticity is smaller than one.
Blankenau et al. (2007)	- 5 years average of annual GDP growth rate (dependent) - 5 years average of share of public education expenditure on GDP	Regression OLS	23 developed countries 1960-2000 annually	Education has a positive effect on growth despite the negative impact of taxes.

TABLE 1 – Findings of the principal empirical papers (continues)

	Main Variables	Methodology	Time period and Countries	Results
Rajkumar and Swaroop (2008)	- Log of GDP per capita in PPP dollars - Log of share of public health expenditure - Log of share on GDP of primary education spending	OLS Regressions	Cross-sectional data covering 91 countries for health expenditure and 57 for education expenditure, in 1990, 1997 and 2003.	Both education and health expenditure have a positive effect on income per capita but the efficiency of government spending could be hindered by the quality of governance. Countries with good institutions react more to variations in social spending.
Beraldo et al. (2009)	- GDP growth rate - Total, private and public health spending growth rate - Total, private and public education spending growth rate	OLS Regression	1971-1998 annually, 19 OECD countries	Education and health spending have a positive effect on growth. The effect of health expenditure is stronger than the effect of education expenditure.
Erdil and Yetkiner (2009)	- Growth rate of real per capita GDP - growth rate of real per capita health expenditure	VAR, granger causality	Data for 75 countries, covering the period 1990-2000 annually	Bi-directional Granger causality for most of the countries
Alam et al. (2010)	- GDP per capita growth rate - public spending on education as a percentage of GDP - public spending on health as a percentage of GDP	Cointegration VECM	10 Asian Countries 1970-2005 annually	A long-run relationship exists for all of the countries in the sample. Education and Health spending affect growth by increasing productivity.

TABLE 1 – Findings of the principal empirical papers (continues)

	Main Variables	Methodology	Time period and Countries	Results
Baltagi and Moscone (2010)	- Log of per capita health care expenditure - Log of per capita GDP in PPP US dollars	Cointegration: heterogeneous panel model with cross sectionally correlated errors	20 OECD countries 1971-2004 annually	Health care expenditure and output are non-stationary and cointegrated in the long-run. Income is the main determinant of Health expenditure. Health care expenditure is not a luxury good.
Ashgar et el. (2011)	- Log of per capita GDP - Log of Education and Health Expenditure	Cointegration VECM	Pakistan, annual data 1974-2008	Education and Health (jointly) have a positive effect on growth.
Chandra (2011)	- GDP current prices - Government expenditure on education in current prices	Cointegration: VECM, Granger causality	Data covers 1951-2009 annually for India	Bi-directional Granger causality between education and GDP.
Magazzino (2011)	- GDP at constant factor cost - Real public expenditure in real on education - Real public expenditure on health.	Cointegration, VECM, Granger causality	Italy, 1990-2010 annually.	Health and Education are cointegrated with GDP. The short-run granger causality is bi-directional, but in the long run no granger causality exists.

TABLE 1 – Findings of the principal empirical papers (continues)

	Main Variables	Methodology	Time period and Countries	Results
Magazzino and Mele (2011)	- Log of Real Health care expenditure - Log of Real GDP	Cointegration: VECM, Granger causality	8 South-Italian regions from 1980 to 2009 annually	Structural Break in 1993 due to Italian effort to meet Maastricht parameters. Existing cointegration relationship for all of the regions with bidirectional granger causality.
Tang (2011)	- Log of Real GDP per capita - Log of Real per capita Health Care Spending - Relative Price of Health Care Spending	Cointegration: VECM, Granger Causality	Data for Malaysia 1970-2009 annually	Bi-directional granger causality between income per capita and health expenditure per capita. Neutrality in the short-run.
Rahman (2011)	- Real GDP - Health expenditure - Education expenditure	Cointegration VECM, Granger causality	Bangladesh, annually 1990-2009	Education and Health spending positively affect GDP. Bi-directional causality between education expenditure and GDP. Unidirectional causality from health expenditure to GDP.
Wang (2011)	- GDP in current US dollars - Total expenditure on health in current US dollars - Total expenditure on health care in current US dollars - Per capita expenditure on health in current US dollars	Panel quantile regression and VECM	31 OECD countries 1986-2007 annually	Health care expenditure and GDP are cointegrated; an increase in education expenditure generates economic growth. However the effect is less pronounced for very rich and very poor countries.

Table 1 – Findings of the principal empirical papers (continues)

	Main Variables	Methodology	Time period and Countries	Results
Amiri and Ventelou (2012)	- Log of per capita GDP in 2000 constant US dollars - Log of per capita Health care expenditure	Cointegration: VECM and Granger Causality	20 OECD countries, 1970-2009 annually. *OECD Health* database.	10 countries out of 20 exhibit bi-directional granger causality. 9 countries display granger causality from income to Health care expenditure per capita.
Elmi and Sadeghi (2012)	- Health care expenditure in constant 2000 US dollars - GDP in constant 2000 US dollars	Cointegration: VECM and Granger causality test	20 developing countries, 1990-2009 annually	The paper finds a cointegration relationship with no short-run effect and bi-directional Granger causality
Gurgul et al. (2012)	- growth rate of GDP - growth rate of science and education expenditure - growth rate of health care and social security expenditure	VAR, Granger causality	Poland, 2000-2008 quarterly data	Health and education have a positive effect on growth and granger cause movements in income.
Dogan et al. (2014)	- Log of health expenditure per capita - Log of GDP per capita	Cointegration ARDL, granger causality	15 OECD countries with the highest rate of heath spending on GDP. Annual data covering 1995-2011	Bi-directional relationship in the long-run between health expenditure per capita and income per capita.

2) Methodology and data description

2.1. Methodology

The purpose of this paper is to identify the relationship between health and education spending with income and to determine the intensity and the direction of these relationships both in the long-run and the short-run. To address this issue we employ cointegration methodologies. Two variables are cointegrated if the linear combination of the two series yields a stationary process. The presence of a cointegration relationship necessarily implies the existence of a causality running in one direction or in the other (Engle and Granger 1987). It is interesting to assess the existence of a cointegration relationship is because it can provide us information on the presence of a long-run equilibrium. Among the possible methodologies we opted for the autoregressive distributed lags (ARDL) approach to cointegration developed by Pesaran et al. (2001) and Pesaran and Shin (1999). This methodology offers a series of advantages compared to other cointegration techniques such as Engle and Granger (1987) or Johansen (1988). Firstly, the method is more flexible because the variables do not need necessarily to be pure *I(0), I(1)* or mutually cointegrated as in other cointegration procedures. This methodology permits an error correction representation of the relationship; hence, it is adequate for studying long term and short term relationships. Unlike the Engle Granger (1987) Johansen (1988) procedures that have low power when applied to a low number of observations; the ARDL approach to cointegration produces consistent estimates and it is regarded as the most efficient in small samples (Romilly et al. 2001). Since we only have up to 45 observations per country we deem it more appropriate than alternative methodologies. Furthermore this cointegration technique uses only a single reduced equation instead of a system of equations as in the Vector Error Correction Model employed in the Johansen (1988) cointegration methodology. The only limitation of the ARDL approach is that the variables must not be integrated of order 2 (Pesaran et al. 2001). Therefore the first step in our analysis is to verify the order of integration of the series by implementing the Augmented Dickey-Fuller (Dickey and Fuller 1979) and the Phillips-Perron (Phillips and Perron 1988) unit-root tests.

The procedure for the empirical analysis is structured in two stages. In the first phase we estimate an ARDL model with the OLS method for the two pairs of variables: education expenditure (*E*) and GDP (*Y*), and Health (*H*) expenditure and GDP. We estimate the bivariate relationship in both directions because we cannot exclude *a priori* that expenditure is influenced by income or that income is affected by expenditure; the economic theory sustains both direction of causality. Later this model will be used to test for cointegration. A general form of an *ARDL(p,q)* model for a bivariate relationship between *y* and *x* is:

$$y_t = a_0 + \sum_{i=1}^{p} a_{1i}\, y_{t-i} + \sum_{i=1}^{q} a_{2i}\, x_{t-i} + u_t \qquad (1)$$

The selection of the optimal lag structure (*p* and *q*) is based on the Akaike information criterion (AIC). Before proceeding with the cointegration test we make sure that the coefficients are stable and perform a number of diagnostic checks.

The bounds test is performed on the following unrestricted error correction models to establish if a cointegration relationship exists.

$$\Delta Y_{t,c} = \propto_0 + \sum_{i=1}^{n} \propto_{1i} \Delta Y_{t-i,c} + \sum_{i=0}^{n} \propto_{2i} \Delta E_{t-i,c} + \propto_3 Y_{t-1,c} + \propto_4 E_{t-1,c} + \varepsilon_t \qquad (2)$$

$$\Delta Y_{t,c} = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta Y_{t-i,c} + \sum_{i=0}^{n} \beta_{2i} \Delta H_{t-i,c} + \beta_3 Y_{t-1,c} + \beta_4 H_{t-1,c} + \varepsilon_t \qquad (3)$$

$$\Delta E_{t,c} = \gamma_0 + \sum_{i=1}^{n} \gamma_{1i} \Delta E_{t-i,c} + \sum_{i=0}^{n} \gamma_{2i} \Delta Y_{t-i,c} + \gamma_3 E_{t-1,c} + \gamma_4 Y_{t-1,c} + \varepsilon_t \qquad (4)$$

$$\Delta H_{t,c} = \delta_0 + \sum_{i=1}^{n} \delta_{1i} \Delta H_{t-i,c} + \sum_{i=0}^{n} \delta_{2i} \Delta Y_{t-i,c} + \delta_3 H_{t-1,c} + \delta_4 Y_{t-1,c} + \varepsilon_t \qquad (5)$$

Where Δ indicates the first difference of the variable, *c* is the country, *ε* are the residuals and *a, β, γ* and *δ* are parameters. The bounds test involves testing the joint significance of the coefficients of the lagged level of the two variables (i.e. $\alpha_3 = \alpha_4 = 0$ for the first equation). The null hypothesis of the test is the absence of cointegration. Pesaran et al. (2001) demonstrated that the hypothesis can be tested using an F-test or a Wald test if some specific classical assumption is violated. Therefore we estimate the two versions of the test statistics: a F-statistic and a W-statistic. The 2 asymptotic critical values of each test have a non-standard distribution. The hypothesis is rejected whenever the statistic is above the upper bound, thus signalling the presence of a cointegration relationship. On the contrary the test fails to reject the null (i.e. there is no cointegration) when the statistic is below the lower bound and it is inconclusive if the statistic falls between the two bounds. The critical values for each country in the sample are generated by stochastic simulation with 20000 reiterations. If the bounds test positively shows the presence of cointegration then the long-run form of the relationship is estimated.

Once cointegration has been assessed we proceed with the second stage of the analysis. If no cointegration is detected the direction of the short-run causality is evaluated with a VAR; if on the contrary a cointegration relation exists then we estimate the respective ECM. The following equations are estimated for every country *c:*

$$\Delta Y_{t,c} = a_0 + \sum_{i=1}^{p} a_{1i}\,\Delta Y_{t-i,c} + \sum_{i=1}^{q} a_{2i}\,\Delta E_{t-i,c} + a_3 EC_{t-1,c} + e_t \tag{6}$$

$$\Delta Y_{t,c} = b_0 + \sum_{i=1}^{p} b_{1i}\,\Delta Y_{t-i,c} + \sum_{i=1}^{q} b_{2i}\,\Delta H_{t-i,c} + b_3 EC_{t-1,c} + e_t \tag{7}$$

$$\Delta E_{t,c} = d_0 + \sum_{i=1}^{p} d_{1i}\,\Delta E_{t-i,c} + \sum_{i=1}^{q} d_{2i}\,\Delta Y_{t-i,c} + d_3 EC_{t-1,c} + e_t \tag{8}$$

$$\Delta H_{t,c} = f_0 + \sum_{i=1}^{p} f_{1i}\,\Delta H_{t-i,c} + \sum_{i=1}^{q} f_{2i}\,\Delta Y_{t-i,c} + f_3 EC_{t-1,c} + e_t \tag{9}$$

Where *a, b, d* and *f* are parameters, *EC* indicates the error correction term and *e* is the error term. The residuals are an *iid* stochastic process. The coefficients of the error correction term (a_3, b_3, d_3 and f_3) should be statistically significant and with a negative sign in order to ensure convergence to the long-run equilibrium. These coefficients also express the speed of adjustment in case of a shock to the value of the variable. If a long-run relationship exists between the variable *x* and *y,* then the short-run adjustment to the long-run equilibrium at any point in time is equal to:

$$EC_t = y_t - (\theta_0 + \theta_1 x_t) \tag{10}$$

The short-run dynamics among the variables are determined by the Wald test on the joint significance of the relevant coefficients. In the next section of the chapter we describe the data we will be used to estimate our model.

2.2. Data description and selection

The data we will employ has been collected from different sources. Health expenditure and GDP are from OECD Health database while education expenditure is from the World Development Indicators (WDI) of World Bank. For the purpose of our analysis we use the total current expenditure on education and health, which encompasses both private and public spending. The choice of incorporating private expenditure is due to the fact that in some countries health and education expenditure are funded mostly privately. Therefore, the total spending is a more reliable measure of the inputs of human capital. The data we have collected is for 9 high-income countries of the OECD for which data is sufficiently complete and social expenditure represents a large fraction of GDP. The sample includes the following countries: Canada, Denmark, Finland, Ireland, Netherlands, New Zealand, Switzerland and United Kingdom. All the variables are in current prices and local currency unit. According to Chandra (2011) the use of current prices is preferable to constant prices because imposing a base year may distort the data, and manipulations should be avoided in non-stationary analyses. Also, the use of prices in local currency unit is not a problem since we do not need to compare the countries between them in absolute values. Even though the time range of the sample has been constrained by the availability of the data, the observations we will employ in our estimations extend annually from 1970 to 2014. Some observations are missing: education for all countries goes up to 2013; health expenditure in 2014 is missing for New Zealand, United Kingdom, Denmark and Ireland. Ireland also has a missing value in 2013. Health expenditure in 1970 is missing for Denmark and Netherlands has 1970 and 1971 missing. As a consequence the number of observation for each country ranges from 43 (Netherlands, Ireland and Denmark) to 45. Nonetheless it can be concluded that the dimension of the database is suitable for this type of analysis (Asteriou and Hall 2011) and that the data is consistent with what has been used in the literature. To the best of our knowledge this dataset represents the longest ever to be applied to the issue of health and education expenditure so far.

In the sample of countries we have selected, the GDP and social expenditure steadily increased from 1970, even though most of the series exhibit a slowdown from 2010. In all of the countries health expenditure is higher than education expenditure (except in the United Kingdom) and each amount circa to 10% of GDP. Also, it is possible to spot that the series exhibit exponential growth; as an illustration in figure 5 we plotted the current education and health expenditure for Netherlands. Hence, for the remaining part of the analysis we use the logarithms of each variable in order to obtain a linear process. Further details can be found in in table 2 where we provide a descriptive summary for each of the variable we are using in the next chapter. We now proceed with the estimation of the model and the interpretation of the main empirical results.

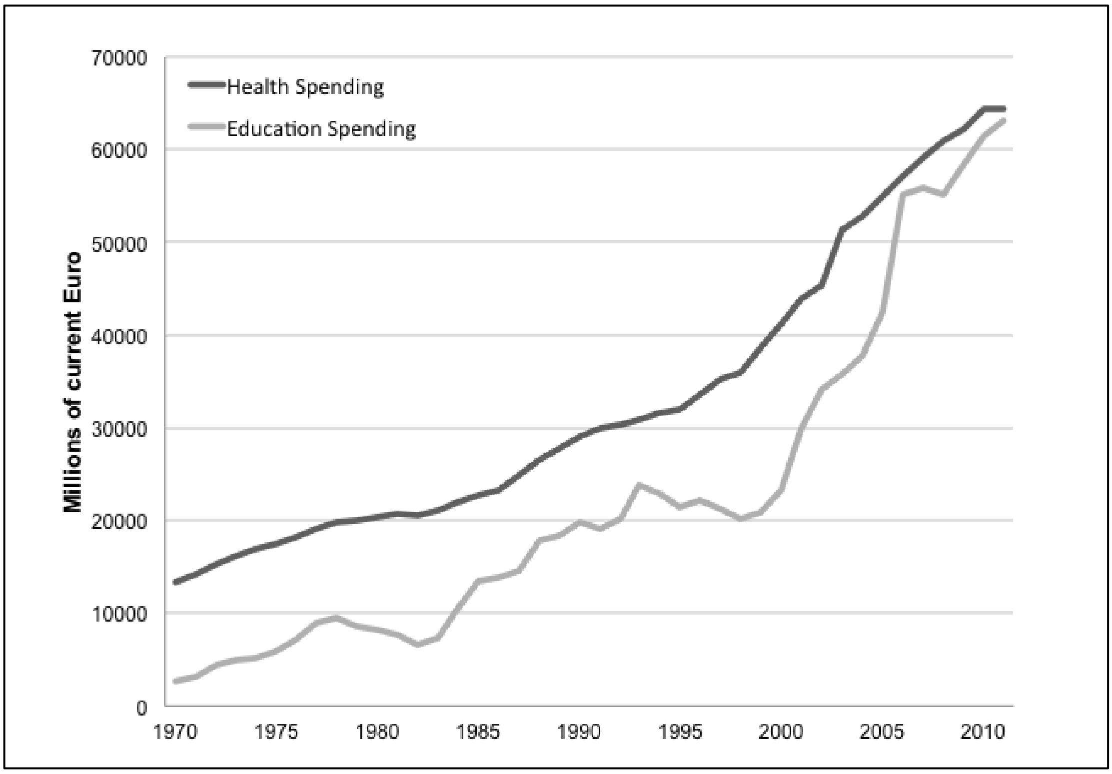


FIGURE 5 – Health and education expenditure in Netherlands (1970-2012)

Notes: *The data for total current health and education expenditure is respectively from OECD Health database and World development Indicators.*

TABLE 2 – Description of the variables

Variable	Decription	Unit	Observations	Mean	Standard deviation
lhecan	Logarithm of total current health expenditure for Canada	Canadian Dollars	45	11.267	0.503
ledcan	Logarithm of total current education expenditure for Canada	Canadian Dollars	44	10.109	0.655
lgdpcan	Logarithm of current GDP for Canada	Canadian Dollars	45	13.777	0.350
lhednk	Logarithm of total current health expenditure for Denmark	Danish Krone	43	11.526	0.305
leddnk	Logarithm of total current education expenditure for Denmark	Danish Krone	44	6.816	0.943
lgdpdnk	Logarithm of current GDP for Denmark	Danish Krone	45	13.984	0.254
lhefin	Logarithm of total current health expenditure for Finland	Euro	45	8.943	0.471
ledfin	Logarithm of total current education expenditure for Finland	Euro	44	8.602	0.839
lgdpfin	Logarithm of current GDP for Finland	Euro	45	11.624	0.337
lheirl	Logarithm of total current health expenditure for Ireland	Euro	43	8.515	0.658
ledirl	Logarithm of total current education expenditure for Ireland	Euro	44	8.006	1.018
lgdpirl	Logarithm of current GDP for Ireland	Euro	45	11.280	0.608
lhenld	Logarithm of total current health expenditure for Netherlands	Euro	43	10.315	0.470
lednld	Logarithm of total current education expenditure for Netherlands	Euro	44	9.602	0.931
lgdpnld	Logarithm of current GDP for Netherlands	Euro	45	12.869	0.313
lhenzl	Logarithm of total current health expenditure for New Zealand	New Zealand Dollar	44	8.937	0.486
lednzl	Logarithm of total current education expenditure for New Zealand	New Zealand Dollar	44	7.489	0.818
lgdpnzl	Logarithm of current GDP for New Zealand	New Zealand Dollar	45	11.631	0.307
lhenor	Logarithm of total current health expenditure for Norway	Norwegian Krone	45	11.363	0.396
lednor	Logarithm of total current education expenditure for Norway	Norwegian Krone	44	6.569	1.034
lgdpnor	Logarithm of current GDP for Norway	Norwegian Krone	45	14.057	0.396
lhechf	Logarithm of total current health expenditure for Switzerland	Swiss Franc	45	10.405	0.441
ledchf	Logarithm of total current education expenditure for Switzerland	Swiss Franc	44	8.348	1.167
lgdpchf	Logarithm of current GDP for Switzerland	Swiss Franc	45	12.931	0.216
lhegbr	Logarithm of total current health expenditure for United Kingdom	Pound Sterling	44	10.887	0.513
ledgbr	Logarithm of total current education expenditure for United Kingdom	Pound Sterling	44	11.275	0.691
lgdpgbr	Logarithm of current GDP for United Kingdom	Pound Sterling	45	13.739	0.304

3) Empirical results

The empirical results are organised in 6 sections. In the first part we determine the order of integration of the series to make sure that the methodology is applied correctly. In section 2 we apply Granger causality test. Next, we estimate the ARDL models that will be used for the bounds test and conduct some diagnostic checks to ensure the validity of the results. In the fourth section we test for cointegration. Finally, we build an error correction model and explore the short-run and long-run relationships between the variables. As a conclusion the last section provide a country-by-country analysis of the results.

3.1. Order of integration

A problem that could arise when dealing with macroeconomic data is the problem of spurious regression (Granger and Newbold 1974). It is widely recognised that macroeconomic variables are typically non-stationary in level and that could generate misleading results if applied in regression models. Also, the ARDL cointegration approach does not support *I(2)* variables, i.e. the presence of *I(2)* variables turns the computed F statistic invalid (Pesaran et al 2001). Therefore, it is a good practice to first evaluate the order of integration of the series. A series is said to be integrated of order *d,* or *I(d)*, if it is necessary to differentiate it *d* times to obtain a stationary process. In formal terms a covariance-stationarity process implies that its mean, variance and autocovariance are time invariant. However, these conditions are often hard to meet so that often the weak stationarity is preferred because it entails less stringent requirements for autocovariance. So, instead of demanding for time-invariance it is sufficient for the auto-covariance to depend on the time gap between two observations. Given the following simple process:

$$Z_t = \phi Z_{t-1} + u_t \qquad (11)$$

The impact of a shock at time *t-T* on Z_t is equal to $\phi^T u_{t-T}$. It is easy to demonstrate that if $\phi < 1$ then any shock gradually fades away because ϕ^T tends to *0* when *T* goes to infinite. On the contrary when there is a unit root (i.e. $\phi = 1$) the impact of the shock persists throughout time and therefore the process is not stationary. This feature is exploited in the tests we use to evaluate the stationarity of GDP and health and education expenditure.

In order to establish the order of integration we start testing for stationarity on the level series; at first we allow only for intercept, then, we include both intercept and trend. We apply the following unit-root tests: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP). In the ADF test (Dickey and Fuller 1979) and the PP test (Phillips and Perron 1988) the null hypothesis is the presence of a unit-root. The results are presented in table 3.

According to the results we can reject the null hypothesis at the 95% level of confidence for almost all of the variables. The ADF test suggests that education expenditure for Netherlands and Switzerland are stationary but the result is questionable since in both cases PP does not support the conclusion of the ADF test. We decide to base our decision on additional elements. We start analysing the correlograms of the two variables and observe that the autocorrelation function is significant and slowly decays as lags increase; this is an indication of the non-stationarity of the series (Gujarati and Porter, 2009). Moreover, the visual inspection of the plot for the 2 variables further corroborates the idea that the education expenditure is non-stationary in Netherlands and Switzerland. Therefore the conclusion is that none of the variables is *I(0)*, and it is necessary to proceed with the stationarity test on the differenced series.

In table 4 we report the result for the first difference of each variable. All the variables are stationary at the 5% level of confidence, except the first difference of the GDP of Ireland when a trend is included. However, for every tested variable the coefficient associated to the trend is not significant, so we can exclude the possibility of trend stationarity; and as a consequence we conclude that for all of the countries included in the sample the variables are I(1). Now that we know the order of integration of each variable we can move to the estimation of the model. We opted for ARDL because it permits to analyse both short and long run relationships with more flexibility than a traditional Vector Error Correction Model (VECM) in case of the absence of cointegration relationship. Furthermore, the results of the ARDL for small samples are superior and consistent compared to the VECM. The only requirement for the ARDL approach to cointegration is that variables must not be *I(2)*. Since our data satisfies this prerequisite we can prosecute with the analysis of the dynamic relationship in an ARDL framework.

TABLE 3 – ADF and PP unit root test on the variables in levels

		ADF		PP	
Country	Variable	C	C/T	C	C / T
Canada	*lhecan*	-1.27(0)	-1.52(1)	-2.03(2)	-1.44(1)
	ledcan	-1.48(0)	-2.46(0)	-1.50(2)	-2.45(0)
	lgdpcan	-2.24(0)	-3.23(1)*	-2.04(2)	-2.65(1)
Denmark	*lhednk*	-0.69(0)	-1.84(0)	-0.70(3)	-1.95(4)
	leddnk	-1.81(0)	-3.17(1)	-1.70(2)	-2.93(1)
	lgdpdnk	-2.12(0)	-0.43(0)	-2.01(2)	-0.67(1)
Finland	*lhefin*	-1.89(2)	-2.40(1)	-2,54(5)	-2.17(3)
	ledfin	-1.67(2)	-2.88(1)	-1.28(7)	-2.34(4)
	lgdpfin	-1.77(1)	-2.74(1)	-2.13(0)	-1.61(1)
Ireland	*lheirl*	-0.25(1)	-1.87(1)	-1.08(3)	-1.87(3)
	ledirl	-0.11(1)	-2.58(1)	-0.15(5)	-2.47(1)
	lgdpirl	-1.32(1)	-1.82(1)	-0.62(4)	-1.29(4)
Netherlands	*lhenld*	-0.74(0)	-0.74(0)	-0.65(4)	-2.03(4)
	lednld	-1.57(2)	-3.79(1)**	-1.96(1)	-2.98(2)
	lgdpnld	-1.48(1)	-1.18(1)	-1.99(2)	-0.70(2)
New Zealand	*lhenzl*	-0.47(1)	-0.47(1)	-0.06(0)	-1.63(1)
	lednzl	-0.01(0)	-1.98(0)	-0.05(3)	-1.98(0)
	lgdpnzl	-0.19(1)	-2.49(1)	0.31(2)	-2.05(3)
Norway	*lhenor*	-2.76(0)*	-2.76(0)	-2.77(1)*	-2.79(1)
	lednor	-1.42(1)	-3.06(1)	-1.66(3)	-2.62(2)
	lgdpnor	-1.13(0)	-2.51(0)	-1.66(6)	-2.54(6)
Switzerland	*lhechf*	-1.70(0)	-3.14(0)	-1.68(1)	-3.20(1)*
	ledchf	-2.97(0)**	-3.08(0)	-2.71(1)*	-3.07(3)
	lgdpchf	0.70(2)	-3.47(1)*	0.42(5)	-2.23(6)
United Kingdom	*lhegbr*	-0.95(0)	-1.51(0)	-0.87(2)	-1.84(2)
	ledgbr	-1.96(0)	-3.41(1)*	-1.64(2)	-2.67(0)
	lgdpgbr	-0.67(1)	-2.84(1)	-1.91(4)	-1.96(1)

Notes: The lag length for the Augmented Dickey Fuller (ADF) tests is indicated in parenthesis, the selection is based on the Schwarz information criterion. The choice of the lag structure for the Philips-Perron (PP) test is based on Newey-West bandwidth with Bartlett estimation method and it is expressed in parenthesis.
*The 1%, 5% and 10% significance level are represented respectively by ***, ** and *.*

TABLE 4 – ADF and PP unit root test on the variables in first difference

		ADF		PP	
Country	Variable	C	C /T	C	C / T
Canada	*dlhecan*	-4.32(0)***	-4.48(0)***	-4.35***	-4.46***
	dledcan	-6.61(0)***	-6.64(0)***	-6.62***	-6.70***
	dlgdpcan	-4.67(0)***	-4.89(0)***	-4.54***	-4.71***
Denmark	*dlhednk*	-7.80(0)***	-7.71(0)***	-4.35***	-4.46***
	dleddnk	-5.21(0)***	-5.25(0)***	-5.12***	-5.14***
	dlgdpdnk	-5.08(0)***	-5.40(0)***	-5.04***	-5.31***
Finland	*dlhefin*	-4.97(1)***	-5.33(1)***	-3.68***	-4.31***
	dledfin	-4.95(1)***	-5.06(1)***	-5.37***	-5.60***
	dlgdpfin	-3.90(0)***	-4.15(0)***	-3.70***	-3.95***
Ireland	*dlheirl*	-4.46(0)***	-4.35(0)***	-4.45***	-4.33***
	dledirl	-6.17(0)***	-6.10(0)***	-6.18***	-6.17***
	dlgdpirl	-3.27(0)**	-3.31(0)	-3.22**	-3.27*
Netherlands	*dlhenld*	-4.58(0)***	-4.53(0)***	-4.63***	-4.59***
	dlednld	-4.72(1)***	-4.81(1)***	-3.57**	-3.63***
	dlgdpnld	-4.23(0)***	-4.50(0)***	-4.25***	-4.50***
New Zealand	*dlhenzl*	-4.47(0)***	-4.40(0)***	-4.38***	-4.31***
	dlednzl	-5.85(0)***	-5.80(0)***	-5.84***	-5.79***
	dlgdpnzl	-4.05(0)***	-4.00(0)***	-4.05***	-4.00***
Norway	*dlhenor*	-6.02(0)***	-4.47(0)***	-6.02***	-6.47***
	dlednor	-4.18(0)***	-4.29(0)***	-4.17***	-4.28***
	dlgdpnor	-5.84(1)***	-5.87(1)***	-7.51***	-8.84***
Switzerland	*dlhechf*	-6.56(0)***	-6.57(0)***	-6.69***	-6.86***
	dledchf	-4.74(0)***	-5.02(0)***	-4.65***	-4.97***
	dlgdpchf	-5.13(1)***	-5.26(1)***	-4.69***	-4.93***
United Kingdom	*dlhegbr*	-5.14(0)***	-5.14(0)***	-5.14***	-5.13***
	dledgbr	-5.25(0)***	-5.29(0)***	-5.16***	-5.20***
	dlgdpgbr	-4.48(0)***	-4.48(0)***	-4.23***	-4.16***

Notes: The lag length for the Augmented Dickey Fuller (ADF) tests is indicated in parenthesis, the selection is based on the Schwarz information criterion. The choice of the lag structure for the Philips-Perron (PP) test is based on Newey-West bandwidth with Bartlett estimation method and it is expressed in parenthesis.
*The 1%, 5% and 10% significance level are represented respectively by ***, ** and *.*

3.2. Granger causality test

The cointegration analysis ascertains the existence of a relationship between health or education expenditure and Income in the long run. Furthermore, it is also interesting to understand how the variables are linked and to identify which one among these is the dependent variable. In this section we apply the Granger causality test to gather some information on the direction of the causality before implementing the ARDL cointegration approach.

A variable y is Granger caused by x when the variable y can be better predicted using information on the past values of x and y than just by just using its own past values. Therefore, Granger causality does not exactly establish the presence of a causal relationship but it can exclude the absence of a relation. In fact, we test for Granger non-causality because if two variables are correlated only by chance, it is unlikely that all the past values of the first series help predicting the values of the second variable unless they have causal connection between them. Given the following equations:

$$y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{j=1}^{p} \alpha_{p+j} x_{t-j} + \varepsilon_t \tag{12}$$

$$x_t = \beta_0 + \sum_{i=1}^{p} \beta_i x_{t-i} + \sum_{j=1}^{p} \beta_{p+j} y_{t-j} + \varepsilon_t \tag{13}$$

where p is the number of lags and α and β are parameters, it is possible to test for Granger causality by testing the joint significance of the α_{p+j} and β_{p+j} coefficients. For instance, the null hypothesis that x does not cause y is rejected whenever all the α_{p+j} together are significantly different from zero.

In the table 5 we report the results for the Granger causality test. The direction of the Granger causality in Norway runs from social spending to income. As opposed to the majority of the countries for which the causality between income and social expenditure goes from the former to education and health expenditure. This result does not seem to fully support the idea that social expenditure contributes to growth. On the contrary, the test gives the impression that health and education are commodities for which the consumption depends on the level of income. Especially for health expenditure, these findings could be a consequence of the fact that the analysis only concerns high-income countries where the improvements in health condition are less likely to affect productivity. Due to the complexity of the link in some cases it is hard to empirically determine a uni-directional Granger causality. In fact in Switzerland and Ireland the relation between health expenditure and income is found to run in both directions. Granger causality test has been frequently applied to this issue but the question remains unsettled because the results vary in accordance with the countries included in the sample (some examples include Atella and Marini 2006, Chandra 2011, Amiri and Ventelou 2012 and Elmi and Sadeghi 2012).

TABLE 5 – Granger causality test

Country	Null Hypothesis:	Education Expenditure	Health Expenditure	Direction of Causality
Canada	*Income does not Granger cause*	7.69***	11.59***	Y→E, Y→H
	Income is not Granger caused	0.47	2.07	
Denmark	*Income does not Granger cause*	3.98***	3.89***	Y→E, Y→H
	Income is not Granger caused	1.20	0.41	
Finland	*Income does not Granger cause*	4.81***	10.43***	Y→E, Y→H
	Income is not Granger caused	1.99	1.37	
Ireland	*Income does not Granger cause*	4.50***	13.44***	Y→E, Y↔H
	Income is not Granger caused	0.45	4.71***	
Netherlands	*Income does not Granger cause*	4.36***	4.46***	Y→E, Y→H
	Income is not Granger caused	0.87	0.33	
New Zealand	*Income does not Granger cause*	2.06	5.23***	Y→H
	Income is not Granger caused	0.16	0.45	
Norway	*Income does not Granger cause*	2.28	0.29	Y←E, Y←H
	Income is not Granger caused	3.21***	8.51***	
Switzerland	*Income does not Granger cause*	3.95***	4.93***	Y→E, Y↔H
	Income is not Granger caused	1.83	4.88***	
United Kingdom	*Income does not Granger cause*	7.01***	8.32***	Y→E, Y→H
	Income is not Granger caused	0.27	1.56	

<u>Notes:</u> *The Granger causality tests are carried on 42 observations. The values reported in the table correspond to the F-statistic of the test.*
**** designates a 0.05 significance level for the rejection of the null hypothesis.*
→ and ← indicate the direction of the Granger causality while ↔ represents a bilateral relationship.

3.3. Estimation of the models

The ARDL approach to cointegration requires the estimation of an ARDL model for the level series. For each country we separately analyse the relationship of income (Y) with health expenditure (H) and education expenditure (E). A model is estimated in both directions of the relationships because they can provide information on the short-run dynamics. Thus, we are building 4 models for every country: income as a determinant of education expenditure (Y→E), income as a determinant of Health expenditure (Y→H), income as a function of education expenditure (E→Y) and income as a function of health expenditure (H→Y). In total 36 models are estimated. The results are presented in table 6, where we report only the order of the ARDL model due to limited availability of space. For simplicity, we assign a number to every model so that we can easily refer to them later. Also, the complete models can be found in Appendix A and follow the same numeration. Since the data is annual, we limit the number of lags of the ARDL model to a maximum of 4 and base the selection on Akaike information criterion.

Before implementing the cointegration analysis it is a good habit to first verify the stability and appropriate behaviour of model's residuals. Therefore, we conduct some diagnostic tests to check for Homoscedasticity, normality of residual's distribution, the presence of any serial correlation among residuals and the correctness of the applied functional form. The results of the tests are displayed in table 7. The inspection of the outcome confirms that the distribution of the residuals is homoscedastic in all of the countries. Nevertheless the results also indicate the presence of some weaknesses. As a matter of fact, the test for the functional form reveals that the second Danish model (model 6) might be affected by problems of specification. In addition to that, the most common issue is the non-normality of residuals' distribution that affects 10 out of 36 models (e.g. models 18, 19 and 20). Some of the models affected by this problem are also vitiated by serial correlation in the residuals. This is the case of United Kingdom and Netherlands in the models where education and health expenditure are explanatory variables. Serial correlation also appears in one of New Zeland's models (model 22). Consequently the implications, inferences and outcome of these models must be treated with caution. As a further matter, additional issues could arise in autoregressive models if the estimated coefficients do not create a stable process. In order to verify the stability of the coefficients for each model we apply the cumulative sum of recursive residuals (CUSUM), developed by Brown et al. (1975). If the CUSUM statistic remains within the 2 lines indicating the 5% significance then the models is deemed to be stable. Stability problems arise only in New Zealand for the two models involving health and income (model 22 and 24). In figure 6 we have drawn the CUSUM for the two unstable models. The CUSUM graphs for every model can be found in appendix B.

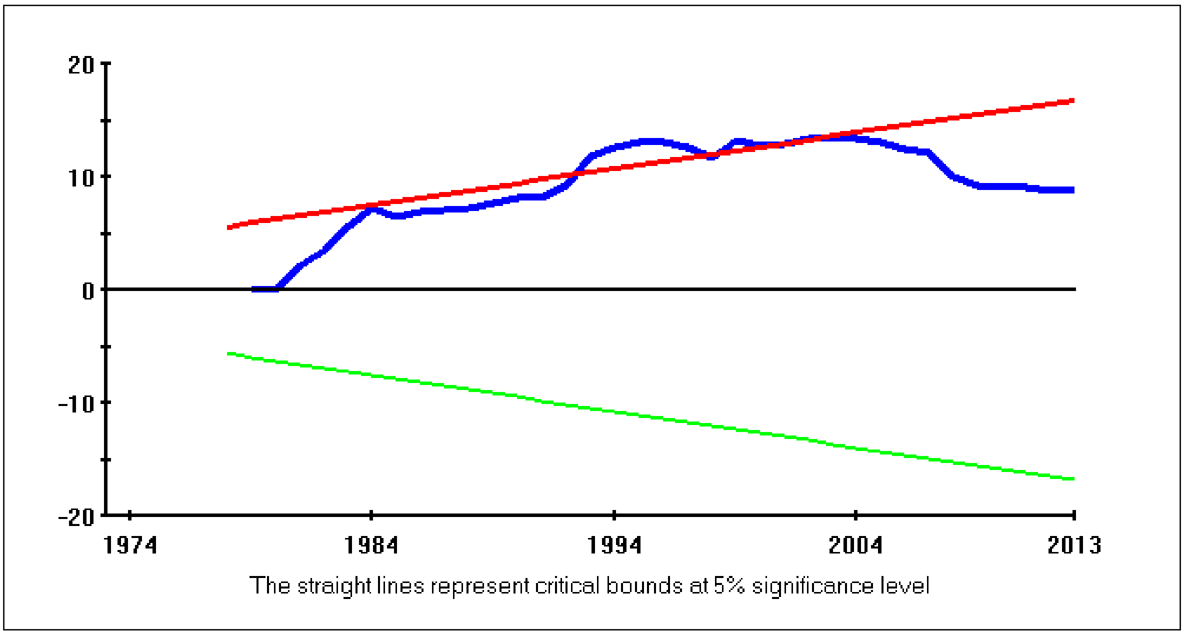


FIGURE 6 – CUSUM for model 22

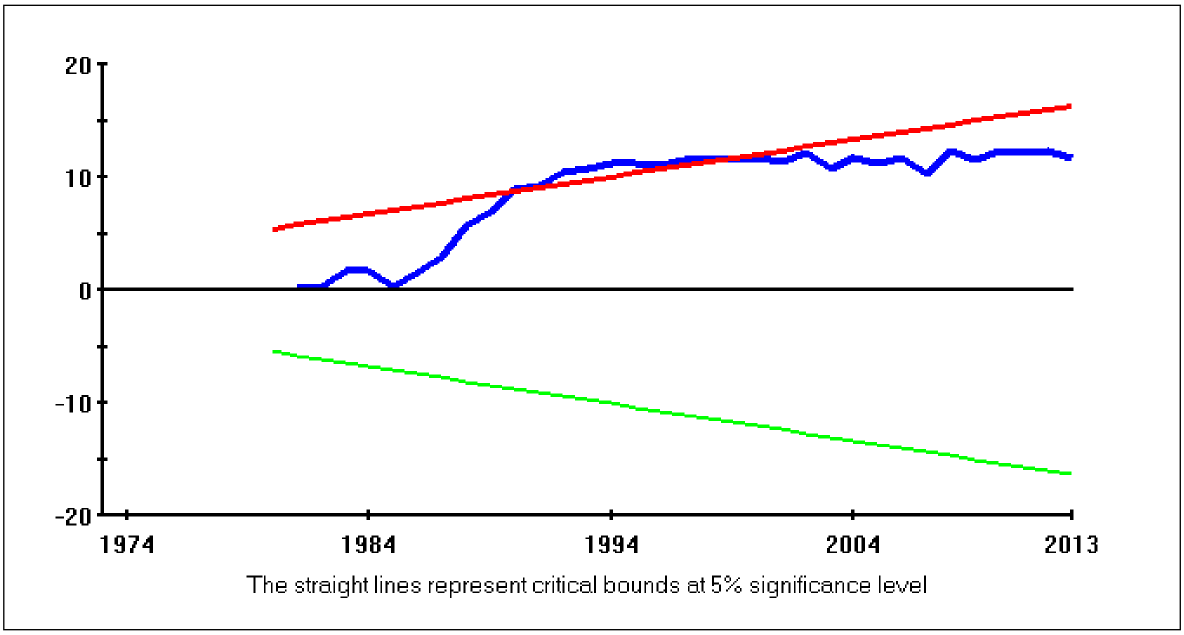


FIGURE 7 – CUSUM for model 24

TABLE 6 – ARDL models

Country	Model number	Dependent variable	Regressor		ARDL specification
Canada	1	*Education expenditure*	*GDP*	Y → E	ARDL(3,2)
	2	*Health expenditure*	*GDP*	Y → H	ARDL(3,1)
	3	*GDP*	*Education expenditure*	E → *Y*	ARDL(2,4)
	4	*GDP*	*Health expenditure*	H → *Y*	ARDL(1,1)
Denmark	5	*Education expenditure*	*GDP*	Y → E	ARDL(2,0)
	6	*Health expenditure*	*GDP*	Y → H	ARDL(1,0)
	7	*GDP*	*Education expenditure*	E → *Y*	ARDL(1,0)
	8	*GDP*	*Health expenditure*	H → *Y*	ARDL(1,0)
Finland	*9*	*Education expenditure*	*GDP*	Y → E	ARDL(2,0)
	10	*Health expenditure*	*GDP*	Y → H	ARDL(3,1)
	11	*GDP*	*Education expenditure*	E → *Y*	ARDL(3,0)
	12	*GDP*	*Health expenditure*	H → *Y*	ARDL(3,0)
Ireland	*13*	*Education expenditure*	*GDP*	Y → E	ARDL(1,0)
	14	*Health expenditure*	*GDP*	Y → H	ARDL(2,1)
	15	*GDP*	*Education expenditure*	E → *Y*	ARDL(2,0)
	16	*GDP*	*Health expenditure*	H → *Y*	ARDL(2,0)
Netherlands	*17*	*Education expenditure*	*GDP*	Y → E	ARDL(4,0)
	18	*Health expenditure*	*GDP*	Y → H	ARDL(1,0)
	19	*GDP*	*Education expenditure*	E → *Y*	ARDL(2,0)
	20	*GDP*	*Health expenditure*	H → *Y*	ARDL(2,0)
New Zealand	*21*	*Health expenditure*	*GDP*	Y → E	ARDL(4,0)
	22	*Education expenditure*	*GDP*	Y → H	ARDL(3,2)
	23	*GDP*	*Education expenditure*	E → *Y*	ARDL(2,3)
	24	*GDP*	*Health expenditure*	H → *Y*	ARDL(2,0)
Norway	*25*	*GDP*	*Education expenditure*	Y → E	ARDL(3,0)
	26	*GDP*	*Health expenditure*	Y → H	ARDL(2,2)
	27	*Education expenditure*	*GDP*	E → *Y*	ARDL(2,0)
	28	*Health expenditure*	*GDP*	H → *Y*	ARDL(1,0)
Switzerland	*29*	*Education expenditure*	*GDP*	Y → E	ARDL(1,0)
	30	*Health expenditure*	*GDP*	Y → H	ARDL(1,1)
	31	*GDP*	*Education expenditure*	E → *Y*	ARDL(3,1)
	32	*GDP*	*Health expenditure*	H → *Y*	ARDL(2,2)
United Kingdom	*33*	*Education expenditure*	*GDP*	Y → E	ARDL(2,2)
	34	*Health expenditure*	*GDP*	Y → H	ARDL(1,1)
	35	*GDP*	*Education expenditure*	E → *Y*	ARDL(3,1)
	36	*GDP*	*Health expenditure*	H → *Y*	ARDL(2,0)

Notes: The selection of the optimal ARDL specification e is based on the Akaike information criterion with the maximum number of lags allowed equal to 4. Estimations are based on 43 observation for all of the countries except Netherlands (41) and Denmark (42). The full estimated models are in appendix A.

TABLE 7 – Diagnostic checking

Country		Serial correlation		Functional Form		Normality		Heteroscedasticity	
		LM	F	LM	F	LM	F	LM	F
Canada	Y →E	1.14	0.94	1.02	0.84	0.64	-	0.14	0.13
		(0.284)	(0.338)	(0.311)	(0,366)	(0.726)		(0.709)	(0.718)
	Y→H	0.55	0.46	1.64	1.41	0.23	-	2.03	2.03
		(0.460)	(0.504)	(0.200)	(0.243)	(0.891)		(0.154)	(0.162)
	E→Y	0.20	0.15	0.96	0.76	10.93	-	0.68	0.67
		(0.656)	(0.697)	(0.328)	(0.390)	(0.004)***		(0.407)	(0.420)
	H→Y	2.60	2.43	0.11	0.97	4.33	-	0.47	0.45
		(0.107)	(0.128)	(0.740)	(0.758)	(0.115)		(0.492)	(0.505)
Denmark	Y→E	1.91	1.75	0.343	0.31	0.96	-	3.27	3.88
		(0.167)	(0.194)	(0.556)	(0.584)	(0.618)		(0.071)*	(0.074)*
	Y→H	2.49	2.39	6.08	6.46	13.58	-	0.00	0.00
		(0.114)	(0.131)	(0.014)**	(0.016)**	(0.001)***		(0.995)	(0.995)
	E→Y	0.38	0.34	2.13	2.03	2.74	-	0.49	0.05
		(0.540)	(0.563)	(0.144)	(0.163)	(0.254)		(0.825)	(0.831)
	H→Y	0.03	0.03	0.70	0.65	1.40	-	0.48	0.47
		(0.855)	(0.864)	(0.400)	(0.426)	(0.497)		(0.485)	(0.498)
Finland	Y→E	3.08	2.92	0.015	0.013	0.64	-	3.42	3.55
		(0.079)*	(0.096)*	(0.901)	(0.908)	(0.726)		(0.064)*	(0.067)*
	Y→H	2.83	2.512	1.56	1.34	1.40	-	2.29	2.30
		(0.093)*	(0.123)	(0.212)	(0.256)	(0.498)		(0.131)	(0.137)
	E→Y	0.03	0.26	2.70	2.46	9.48	-	3.66	3.83
		(0.861)	(0.872)	(0.100)	(0.126)	(0.009)***		(0.056)*	(0.058)*
	H→Y	0.28	0.25	3.26	3.01	11.15	-	3.68	3.85
		(0.592)	(0.623)	(0.071)	(0.091)	(0.004)***		(0.055)*	(0.057)*

TABLE 7 – Diagnostic checking (Continues)

Country		Serial correlation		Functional Form		Normality		Heteroscedasticity	
		LM	F	LM	F	LM		LM	F
Ireland	Y→E	0.37	0.34	0.96	0.89	1.46	-	3.23	3.33
		(0.543)	(0.565)	(0.327)	(0.351)	(0.482)		(0.072)*	(0.075)*
	Y→H	0.57	0.49	2.14	2.05	2.01	-	2.06	2.06
		(0.452)	(0.491)	(0.142)	(0.159)	(0.366)		(0.151)	(0.159)
	E→Y	0.00	0.00	3.49	3.39	2.15	-	0.79	0.76
		(0.955)	(0.958)	(0.062)	(0.076)	(0.341)		(0.374)	(0.387)
	H→Y	0.06	0.05	0.01	0.01	2.41	-	0.03	0.03
		(0.809)	(0.823)	(0.932)	(0.937)	(0.300)		(0.871)	(0.875)
Netherlands	Y→E	0.29	0.24	0.29	0.24	1.24	-	0.49	0.47
		(0.589)	(0.627)	(0.592)	(0.630)	(0.537)		(0.481)	(0.494)
	Y→H	0.30	0-27	1.50	1.40	36.29	-	0.52	0.50
		(0.587)	(0.609)	(0.220)	(0.245)	(0.000)***		(0.470)	(0.84)
	E→Y	3.15	2.98	3.14	2.97	7.27	-	0.62	0.61
		(0.076)*	(0.094)*	(0.076)*	(0.094)*	(0.026)**		(0.430)	(0.443)
	H→Y	4.82	4.79	2.39	2.219	6.53	-	0.65	0.63
		(0.028)**	(0.036)**	(0.122)	(0.146)	(0.038)**		(0.419)	(0.433)
New Zealand	Y→E	1.04	0.85	0.05	0.04	0.35	-	0.50	0.48
		(0.308)	(0.362)	(0.824)	(0.843)	(0.839)		(0.481)	(0.493)
	Y→H	7.84	8.05	0.04	0.03	10.51	-	0.98	0.96
		(0.005)***	(0.008)***	(0.847)	(0.862)	(0.005)***		(0.321)	(0.334)
	E→Y	2.88	2.49	1.47	1.22	2.83	-	3.78	3.96
		(0.089)	(0.124)	(0.225)	(0.277)	(0.243)		(0.052)*	(0.054)*
	H→Y	0.58	0.51	1.82	1.67	4.77	-	2.29	2.29
		(0.447)	(0.476)	(0.177)	(0.204)	(0.092)*		(0.131)	(0.138)
Norway	Y→E	0.19	0.17	0.11	0.09	0.27	-	1.73	1.72
		(0.660)	(0.682)	(0.751)	(0.768)	(0.874)		(0.188)	(0.198)
	Y→H	0.01	0.01	0.01	0.00	3.68	-	2.41	2.44
		(0.917)	(0.922)	(0.949)	(0.952)	(0.143)		(0.120)	(0.127)

TABLE 7 – Diagnostic checking (Continues)

Country		Serial correlation		Functional Form		Normality		Heteroscedasticity	
		LM	F	LM	F	LM		LM	F
Norway	*E*→Y	0.59	0.51	0.07	0.06	5.21	-	2.74	2.79
		(0.441)	(0.479)	(0.786)	(0.804)	(0.074)*		(0.098)*	(0.103)
	H→Y	0.04	0.04	1.79	1.55	0.03	-	3.70	3.96
		(0.827)	(0.844)	(0.181)	(0.223)	(0.987)		(0.062)*	(0.054)*
Switzerland	Y→E	1.09	1.01	0.00	0.00	1.21	-	1.42	1.40
		(0.296)	(0.321)	(0.977)	(0.978)	(0.545)		(0.233)	(0.244)
	Y→H	0.01	0.01	1.69	1.54	1.60	-	0.92	0.89
		(0.943)	(0.947)	(0.194)	(0.223)	(0.449)		(0.339)	(0.351)
	E→Y	3.94	3.61	0.13	0.10	7.06	-	0.66	0.63
		(0.047)**	(0.066)**	(0.727)	(0.752)	(0.029)**		(0.418)	(0.431)
	H→Y	1.26	1.07	0.28	0.23	0.84	-	2.84	2.90
		(0.262)	(0.305)	(0.598)	(0.633)	(0.657)		(0.092)*	(0.097)*
United Kingdom	Y→E	0.11	0.08	0.01	0.01	2.11	-	0.69	0.66
		(0.746)	(0.770)	(0.902)	(0.912)	(0.349)		(0.406)	(0.419)
	Y→H	0.74	0.66	2.21	2.05	0.29	-	2.67	2.72
		(0.390)	(0.422)	(0.137)	(0.161)	(0.863)		(0.102)	(0.107)
	E→Y	4.70	4.39	4.21	3.88	9.91	-	1.944	1.94
		(0.030)**	(0.044)**	(0.40)	(0.057)	(0.007)***		(0.163)	(0.172)
	H→Y	7.83	8.52	11.55	14.22	20.88	-	0.32	0.30
		(0.005)***	(0.006)***	(0.001)***	(0.001)***	(0.000)***		(0.574)	(0.585)

Notes: We test for serial correlation by applying a Lagranger multiplier test of residual serial correlation. The functional form is evaluated with a Ramsey's RESET test based on the square of the fitted values. The normality of the residuals is established on a test for the skewness and kurtosis. The test for heteroscedasticity is based on the regression of the squared residuals on the squared fitted values.
For each test we run 2 versions and report both the chi-square statistic (for LM tests) and F-statistic (for F version); the number in parenthesis is the p-value of the test.
→ is used to indicate the direction of the relationship assumed in the underlying ARDL model: the arrow runs from the independent to the dependent variable.
The complete ARDL models to which the diagnostic tests refer can be found in Appendix A.

3.4. Identification of the relationships and cointegration test

In order to detect the cointegration relationships in the couple of variables we perform the bounds test developed by Pesaran et al. (2001). The critical values are computed by using stochastic simulation with 20000 reiterations. We estimate the F-statistic and the W-statistic and observe that the conclusions of the 2 tests are identical. We first expound the outcome of the bounds test in table 8, and then in the next section we examine any long run form that we evinced from our cointegration analysis.

The bounds test points to the presence of 9 cointegration relationships at the 5% significance level. Health expenditure and income are cointegrated in 5 out of 9 countries (Canada, Finland, Norway, Switzerland and United Kingdom) and at the 10% of significance also in New Zealand. On the other hand, education and output are cointegrated Canada, Switzerland and United Kingdom and at the 90% of confidence also in Denmark and Finland. From an economic perspective a cointegration relationship suggests the presence of a long-run equilibrium between social expenditure and income so that they should not inordinately diverge from each other. In the case of a shock to one of the variables the divergence between the series tends to be corrected over time as if an underlying force of the economy caused them to move together. Furthermore, our results firmly validate the nexus outlined by the Granger test: a dominant characteristic of the long-run relationship is the preponderant influence that income exerts on education and health expenditure. In fact, all the cointegration relationships run from output to the category of social spending; the only exception is Norway for which the direction is inverted.

To a great extent this result is surprising; according to the economic growth theory in the long-run the causality should run from social spending to income. In the short-run, income should be a fundamental determinant of health and education spending because the maximum expenditure is constrained by the available income. However, if health and education expenditure are a correct measure for the means invested on human capital, then in the long run social expenditure should promote the accumulation of human capital and ultimately growth. A possible interpretation of the results is that in advanced economies the accumulation of human capital occurs through different mechanisms and that monetary inputs represent an important determinant of human capital and growth only in developing countries. In conclusion the outcome gives force to the thesis developed in health economics

TABLE 8 – Bounds test

Country	Dependent variable	F-statistic	Lower bound	Upper bound	W-statistic	Lower bound	Upper bound	Outcome
Canada	$Y \rightarrow E$	7.08	5.22	6.12	14.17	10.45	12.23	Cointegration
	$Y \rightarrow H$	9.25	5.22	6.12	18.50	10.45	12.23	Cointegration
	$E \rightarrow Y$	1.21	5.22	6.12	2.43	10.45	12.23	No cointegration
	$H \rightarrow Y$	2.02	5.22	6.12	4.04	10.45	12.23	No cointegration
Denmark	$Y \rightarrow E$	4.05	5.41	6.21	8.11	10.83	12.42	No cointegration
	$Y \rightarrow H$	3.28	5.41	6.21	6.55	10.83	12.42	No cointegration
	$E \rightarrow Y$	1.89	5.41	6.21	3.79	10.83	12.42	No cointegration
	$H \rightarrow Y$	2.67	5.41	6.21	5.34	10.83	12.42	No cointegration
Finland	$Y \rightarrow E$	4.66	5.23	6.12	9.33	10.45	12.23	No cointegration
	$Y \rightarrow H$	11.80	5.23	6.12	23.61	10.45	12.23	Cointegration
	$E \rightarrow Y$	0.97	5.23	6.12	1.95	10.45	12.23	No cointegration
	$H \rightarrow Y$	0.71	5.23	6.12	1.42	10.45	12.23	No cointegration
Ireland	$Y \rightarrow E$	2.66	5.41	6.21	5.32	10.83	12.42	No cointegration
	$Y \rightarrow H$	8.48	5.41	6.21	16.96	10.83	12.42	Cointegration
	$E \rightarrow Y$	0.43	5.41	6.21	0.86	10.83	12.42	No cointegration
	$H \rightarrow Y$	3.40	5.41	6.21	6.81	10.83	12.42	No cointegration
Netherlands	$Y \rightarrow E$	3.04	5.45	6.20	6.09	10.90	12.39	No cointegration
	$Y \rightarrow H$	5.33	5.45	6.20	10.66	10.90	12.39	No cointegration
	$E \rightarrow Y$	1.10	5.45	6.20	2.20	10.90	12.39	No cointegration
	$H \rightarrow Y$	1.37	5.45	6.20	2.75	10.90	12.39	No cointegration
New Zealand	$Y \rightarrow E$	4.47	5.23	6.12	8.94	10.45	12.23	No cointegration
	$Y \rightarrow H$	5.50	5.23	6.12	11.01	10.45	12.23	No cointegration
	$E \rightarrow Y$	2.35	5.23	6.12	4.70	10.45	12.23	No cointegration
	$H \rightarrow Y$	0.49	5.23	6.12	0.98	10.45	12.23	No cointegration
Norway	$Y \rightarrow E$	1.67	5.23	6.12	3.33	10.45	12.23	No cointegration
	$Y \rightarrow H$	1.35	5.23	6.12	2.70	10.45	12.23	No cointegration
	$E \rightarrow Y$	2.20	5.23	6.12	4.39	10.45	12.23	No cointegration
	$H \rightarrow Y$	9.07	5.23	6.12	18.15	10.45	12.23	Cointegration
Switzerland	$Y \rightarrow E$	6.29	5.23	6.12	12.57	10.45	12.23	Cointegration
	$Y \rightarrow H$	6.40	5.23	6.12	12.79	10.45	12.23	Cointegration
	$E \rightarrow Y$	2.15	5.23	6.12	4.31	10.45	12.23	No cointegration
	$H \rightarrow Y$	3.26	5.23	6.12	6.53	10.45	12.23	No cointegration
United Kingdom	$Y \rightarrow E$	7.48	5.23	6.12	14.96	10.45	12.23	Cointegration
	$Y \rightarrow H$	8.14	5.23	6.12	16.28	10.45	12.23	Cointegration
	$E \rightarrow Y$	0.02	5.23	6.12	0.05	10.45	12.23	No cointegration
	$H \rightarrow Y$	2.10	5.23	6.12	4.20	10.45	12.23	No cointegration

Notes: We obtain the critical values by stochastic simulation applying 20000 repetitions using Microfit 5.0. The null hypothesis of the tests is the absence of cointegration relationship. The null hypothesis is rejected when the statistic is higher than the upper bound. The test is inconclusive if the result falls between the two critical values. The complete ARDL models used to test for cointegration are presented in appendix A.

that health is a luxury good. In fact, when GDP and education expenditure are cointegrated the relationship runs from the former to the latter health. The bounds test revealed the existence of a link in some of the countries in the long-run, but we still ignore the precise influence of the variables on each other both in their sign and intensity. In the next section we first estimate the long-run relationship for the cointegrated variables. Subsequently we build an Error Correction Model (ECM) both for the cointegrated and non-cointegrated variables to investigate the short run dynamics existing among them.

3.5. Long-run form and Error correction model

For every pair of variable that is cointegrated, the long-run relationship shows that GDP and social expenditure are positively linked: if income increases social expenditure follows suit, this fact holds for all of the models. In every country exhibiting a cointegration relationship the effect of an increase in income is higher on education expenditure than it is on health expenditure. For example if GDP grows by 1% in the United Kingdom, health expenditure increases by 1.65% while education spending increases by 2.12% (see model 33 and 34). Similarly in Canada health and education spending would increase respectively by 1.33 % and 1.65% (see model 1 and 2). Also, the ultimate impact on growth is notable: expanding health expenditure by 1% raises economic growth by 0.62% (see model 28). The results for all of the pair of variables are reported in the next section in the panel B of each model.

In addition to the long run effects that we mentioned, health and education spending are responsible for important dynamics in the short run. The specification of the ECM that we estimate for every country are the one in equations (6), (7), (8) and (9). Where *EC* indicates the error correction term while *p* and *q* designate the lag structure of each variable. For the purpose of the estimation the selection of the number of lags is based on the Akaike information criterion. The coefficients of the differenced *variables* and their lagged terms describe the short run effects of the regressors while the error correction term represents the short-run adjustments to the equilibrium (if any). The significance of the regressors' parameters is tested with a Wald test whenever at least one lagged term is included. The models that we estimated for each country, together with the Wald test are fully reported in appendix A. The growth of income is found to be a significative determinant of the education spending in 8 out of 9 countries (the only exception is Norway). Moreover an increase of 1% of GDP in Canada or New Zealand is associated with a growth of 0.35% in health expenditure. As a consequence we can conclude that income is a key factor in explaining social spending. However, in the short run income is also heavily influenced by the health and education spending and, in accordance with the literature on government expenditure, social spending does not exert a favourable influence on output. The impact of education expenditure on output is negative. The main reason is that the economic benefits of education are not immediate thus exacerbating the costs in the short-run. Also the effect of health expenditure on GDP is substantially negative in the short run. The estimates for Canada and Ireland show that an increase of 1% in health expenditure reduces output growth over the next year by circa 0.30%. This sizeable impact might be due to the crowding-out of productive investments. In fact, in situations where the available income is constrained, an increase in social spending displaces resources that could be invested in more productively. In the diagram of figure 8 we summarised the short-run causality for each country. Furthermore, the estimates for the error correction term show that education expenditure adapts to changes in income more quickly than health expenditure. The pace of adjustment to the increase in income is of 15.3% every year for health expenditure and 26.8% for education expenditure. However the effect of health expenditure on income is absorbed even more rapidly: in the extreme case of Norway, the speed of adjustment is 48.9% per year.

3.6. Results country by country

Canada. The bounds test reveals that 2 cointegration relationships exist for Canada. In the long-run income is found to be a determinant of health and education expenditure. According to the estimates of the long-run form an increase in GDP generates a more than proportional increase in social spending. In fact, if the logarithm of GDP augments by 1 unit than the logarithm of health and education spending grows respectively by 1.335 and 1.665. However, in the short-run the two pairs of variables exhibit a bi-directional causality. The error correction models (ECM) shows that the speed of adjustment to the long-run equilibrium is extremely high for both education and health spending (model 1 and 2), with respectively 26.8% and 15.3% of the disequilibrium corrected every year.

Denmark. Unlike Canada, Denmark exhibits no long run relationship. The ECM gives an unambiguous uni-directional causality in the short-run for both the categories of spending. We also find that health expenditure and education expenditure are a function of income: a 1% increase in GDP causes education spending to expand by 0.73% and health by 0.15%. However the results on health expenditure are not fully reliable because the residuals of the underlying ARDL model are not distributed normally, and the specification of the model might not be the most appropriate to represent the relationship (see Table 8).

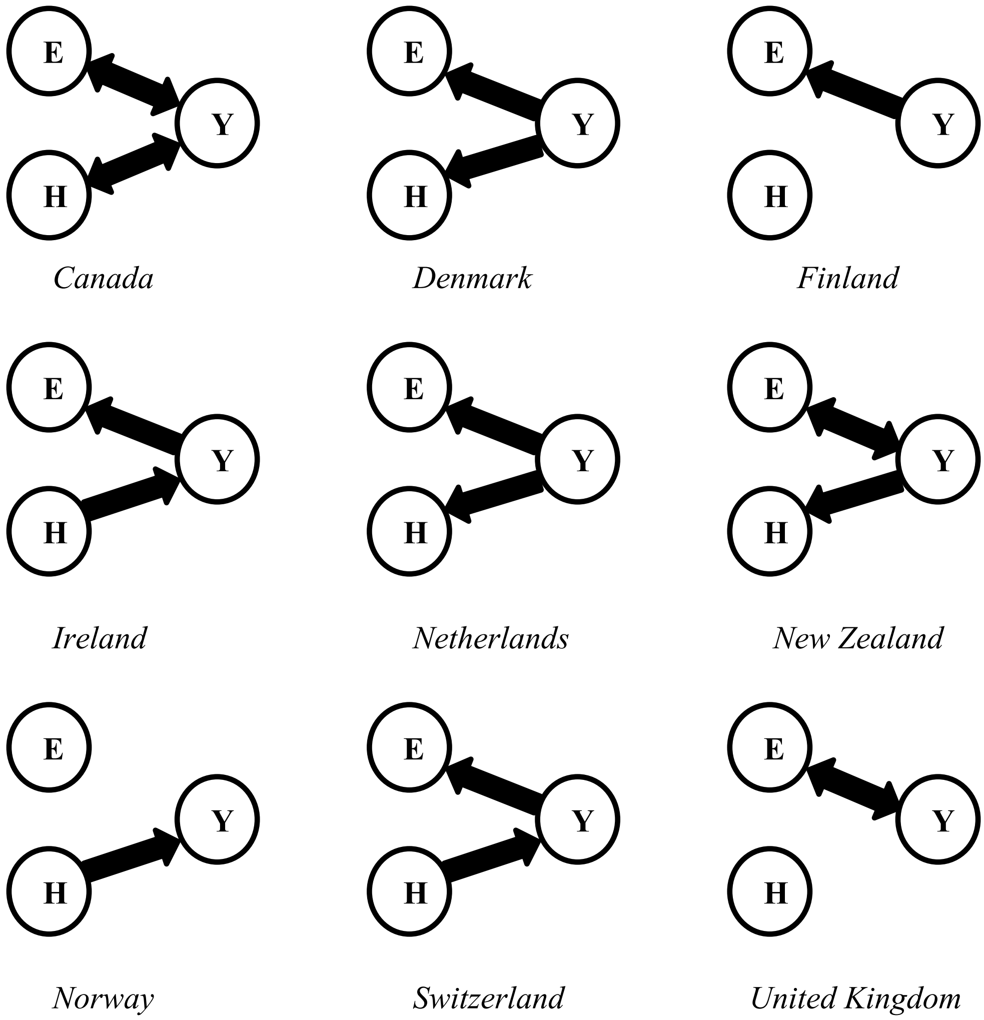


FIGURE 7 – The short-run dynamics

<u>Notes:</u> H, E and Y are respectively the health expenditure, Education expenditure and GDP. The black arrows indicate the existence of a significant short-run relationship among the variables. The significance is based on a Wald test with the hypothesis that all the relevant coefficients of the explanatory variable in the ECM are equal to zero. The rejection implies causality. If no lagged value of the explanatory variable is present then the significance is assessed with the t statistic of the coefficient. The t-statistic and Wald test for every model can be found in Appendix A.

Finland. The only existing cointegration relationship runs from income to health expenditure. The GDP positively affects the level of education spending in the long-run but no short-run influence can be observed. In fact, the only short-run causality goes from income to education spending but again the validity is questionable since the residuals of the model are not normally distributed. The ECM shows that in case of shock to the variables, health converges to the equilibrium in *circa* 4 years (the coefficient of the *EC* is equal to -0.240 for model 10).

Irland. In the case of Ireland Income and Health are cointegrated. The long-run form reveals that the impact of income on health spending is positive, yet, very light. As a matter of fact, an increase of 1 unit in *lgdpirl* only causes *ledirl* to grow by 1.066 in the long-run. This coefficient is smaller than in Switzerland, United Kingdom or Canada. The speed of adjustment to the equilibrium is of 30.7% per year. In the short-run a rise in income augments education spending while the effect of health expenditure is decisively negative on GDP: a 1% increase in health spending reduces the rate of growth of the GDP by 0.20% over the next year.

Netherland. Similarly to Denmark there is no cointegration relationship in Netherland and in the short-run the social expenditure is a function of output. The elasticity of education spending to an increase in income is positive and higher for education than it is for health (the coefficients are respectively 0.498 and 0.163).

New Zealand. The bounds test points to the absence of cointegration in New Zealand, therefore we estimated no long-run equilibrium. In the short-run health spending positively influences income and income affects education spending. Nevertheless the first causal relation might not accurately hold since the CUSUM of model 24 reveals some issues with the stability of the coefficients (see Figure 7).

Norway. Norway is the only country for which a cointegration relationship has been found between health spending and GDP with the causality running from the former to the latter. The long-run relationship is positive: a unitary increase in *lhenor* raises the logarithm of GDP by 0.635. From the ECM we can observe that health expenditure has a negative impact in the short-run: income decreases by 0.05% over the next year if health spending is raised by 1%. We can infer that the immediate negative effect of higher spending is outbalanced by the benefits of human capital as time elapses. The ECM also shows that in case of shock the adjustment to the equilibrium is performed extremely rapidly in around two years (48.9% *per annum*).

Switzerland. In Switzerland income is cointegrated with health expenditure and education expenditure. The long-run relationship is positive in both cases, so that a variation in output causes a movement in the same direction of the two categories of social expenditure. Similarly to other countries the sensibility of education spending to changes in GDP is higher than for health in the long-run (the coefficient is 3.980 against 1.203). In the short-run, education is strongly affected by the income whereas health expenditure influences the output level. The estimates of the ECM show that the correction of the disequilibrium is faster for education than for health: 19.4% against 13.4% every year.

United Kingdom. Finally, the United Kingdom exhibits two long-run cointegration relationships. In the long-run a rise in GDP produces a substantial increase in social spending, suggesting that it is considered a luxury good (with elasticity to income higher than the unity). For instance a one-time increase of *lgdpgbr* engenders a growth of 1.651 in the logarithm of health spending and 2.123 in the logarithm of education spending. Between education spending and Income there is bi-directional causality in the short-run but the causality runs predominantly from output to education spending. In point of fact, not only the effect of education expenditure on GDP is estimated to be moderate (the parameter is 0.007) but also the solidity of the estimate is arguable since the residuals of the underlying ARDL model are serially correlated and not distributed normally (table 7). The ECM further indicates that education expenditure converges to the long-run equilibrium at the rate of 45.8% every year while health expenditure at 21.7% every year.

Discussion and Conclusion

Using data for 9 OECD countries covering the period 1970-2014, we analysed the relationship between income and two large spending categories: health and education. The data we collected for total health expenditure and education expenditure includes private and public spending in order to capture all the monetary inputs of Human capital. In this paper we applied the ARDL approach to cointegration (Pesaran et al. 2001) because it is a flexible methodology that yields consistent estimated with small samples. The preliminary analysis reveals that Health expenditure, education expenditure and GDP are *I(1)* so that the methodology can be safely applied. Then, we estimated the 2 bivariate relationships (between health expenditure and income and education expenditure and income) in both directions to exclude any possible problems arising from reverse causality. The dominant direction of the causality in each pair of variables is determined within the ARDL framework. Subsequently, the bounds test was employed to check for cointegration. Our results point to the existence of 9 cointegration relationships in the sample. Finally, we build the error correction model to study the long run and short run dynamics.

The prevailing conclusion of the analysis is that on average GDP is a strong determinant of social spending for the countries we have selected, both in the short and the long run. Health and education have a strong consumption component in advanced economies. This hypothesis posits that health and education expenditure are commodities for which the consumption augments whenever the income increases: the expenditure is pushed by the demand. That is to say that social expenditure tends to be higher in countries that are richer because rich countries can afford higher costs. This result is in line with the conclusions of the previous empirical literature, especially the studies regarding health expenditure in the OECD. For example, Baltagi and Moscone (2010) and Atella and Marini (2006) with a sample of 20 OECD countries also find that income accounts for the largest part of health expenditure level. Not only we find that health and education spending are a function of income but also that social expenditure reacts very quickly to any change in the level of income. As a consequence in some of the countries we have studied an increase in GDP often causes a more than proportional increment in health and education spending. This argument could explain the trend of social spending in the last 50 years. The correlation with GDP is non-random because the rich nations that have good institutions are more likely to expand social spending because they can afford it. Therefore, the expansion of social expenditure over time is the consequence of the process of economic growth.

Nevertheless, also social expenditure is capable of influencing income. In fact, our analysis shows that in the short run health and education expenditures have a negative impact on GDP. The effect is negative because the available resources at any given point in time are limited, so that an increase in social expenditure inevitably crowds-out other possible productive investments. Furthermore, the theoretical literature postulates that the taxes levied to fund the public social expenditure create distortions in the markets. We expect the immediate costs to be offset in the long run because a healthy and well-educated population is supposed to generate a higher income. But in spite of that argumentation, for the majority of the countries we found no significative effect of health and education spending on the long run growth; the effect is positive solely in Norway where a 1% increase in health expenditure raises growth by 0.62% in the long run. This results must not be interpreted as unsupportive of endogenous growth theory, rather, the link between social expenditure as a monetary inputs of human capital and human capital itself, ought to be questioned in developed countries where the impact of added resources is likely to be modest. In his paper on health spending Nordhaus (1977) stated that when health expenditure is augmented in developed countries, the investments are more likely used in "health care" instead of "health cures". The intuitive argument of Nordhaus let us presume that human capital could obey to diminishing marginal return to investments in health and education.

During the recent crisis social expenditure was the first category of spending to be affected by austerity measures. Even though the results show that health and education expenditure did not fundamentally contributed to economic growth in the majority of the countries of our sample; it must not be forgotten that the effect of changes in income, health or education expenditure varies considerably across countries. Yet, even if it is not possible to confute the hypothesis that some nations are currently overspending, an excessive reduction in health and education expenditure might have social and economic impacts. The current analysis could take advantage from a number of improvements. Firstly, the accuracy and the generality of the results would greatly benefit from the inclusion of a larger number of countries in the sample, especially developing countries. Then, the model could be further expanded to capture macroeconomic interactions. For instance, it would be interesting to model health and education spending together to take into considerations the externalities that health and education exert over each other. Also, the models could be expanded to account the fiscal impact of social expenditure. Or, the health and education expenditure could be further broken down in private and public spending to isolate the impact of each source of financing. For example, in the United States health expenditure is mostly privately funded, and therefore we would expect it to be more sensible to changes in income than in France or Germany.

References

ACEMOGLU, D. , JOHNSON, S. AND ROBINSON, J. (2004) `Institutions as the fundamental cause of long-run growth', *NBER Working papers series,* 10481.

ACEMOGLU, D., JOHNSON, S. AND ROBINSON, J. (2005) `The Rise of Europe: Atlantic Trade, Institutional Change, and Economic Growth', *The American Economic Review,* 95(3), pp.546-579.

ACEMOGLU, D. AND JOHNSON, S. (2007) `Disease and Development: The Effect of Life Expectancy on Economic Growth', *Journal of Political Economy,* 115(6), pp.925-985.

ACEMOGLU, D., GALLEGO, F. AND ROBINSON, J. (2014) `Institutions, Human Capital and Development', *NBER Working papers series,* 19933.

AGENOR, P. R. AND NEANIDIS, K. C. (2006) `The Allocation of Public Expenditure and Economic Growth', *The University of Manchester Economics Discussion Paper,* 608.

AGHION, P., BOUSTAN, L. HOXBY, C. AND VANDENBUSSCHE, J. (2009) `The Causal Impact of Education on Economic Growth: Evidence from U.S.', *Brookings Papers on Economic Activity*, spring 2009 conference draft.

AISA, R. AND PUEYO, F. (2013) `Population aging, health care, and growth: a comment on the effects of capital accumulation', *Journal of Population Economics*, 26, pp.1285-1301.

ALAM, S., SULTANA, S. AND BUTT, M. S.(2010) `Does Social Expenditure Promote Economic Growth? A Multivariate Panel Cointegration Analysis for Asian Countries', *European Journal of Social Sciences*, 14(1), pp.44-54.

AMIRI, A. AND VENTELOU, B. (2012) `Granger causality between total expenditure on health and GDP in OECD: Evidence from Toda-Yamamoto approach', *Economic Letters,* 116, pp.541-544.

ASHGAR, N., AZIM, P. AND REHMAN, H. (2011) `Impact of Government Spending in Social Sectors on Economic Growth. A Case Study of Pakistan', *Journal of Business & Economics,* 3(2), pp. 214-234.

ASHRAF, Q. H., LESTER, A. AND WEIL, D. N. (2008) `When does Improving Health Raises GDP?', in ACEMOGLU, D., ROGOFF, K. AND WOODFORD, M. (2008) *NBER Macroeconomics Annual 2008*, *Volume 23*, University of Chicago Press.

ASTERIOU, D. AND HALL, S. G. (2011) *Applied Econometrics,* 2nd ed., Palgrave Macmillian.

ATELLA, V. AND MARINI, G. (2006) `Is Health care expenditure really a luxury good? Re-assessment and new evidence based on OECD data', *Working paper.*

BALDACCI, E., CLEMENTS, B., GUPTA, S. AND CUI, Q. (2004) `Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving the MDGs', *IMF Working Paper,* 217.

BALTAGI, B. H. AND MOSCONE, F. (2010) `Health care expenditure and income in the OECD reconsidered: Evidence from panel data', *Economic Modelling*, 27, pp.804-811.

BARRO, R. J. (1991) `Economic Growth in a Cross Section of Countries', *The Quarterly Journal of Economics,* 106(2), pp.407-443.

BARRO, R. J. (1998) `Human capital and growth in a cross-country regression', *Swedish Economic Policy Review*, 6, pp.237-277.

BARRO, R. J. (2013) `Health and Economic Growth', *Annals of Economics and Fianance,* 12(2), pp.305-342.

BARRO, R. J. AND SALA-I-MARTIN, X. (1991) `Convergence across States and Regions', *Brooking Paper on Economic Activity,* 1, pp.107-182.

BASU, P. AND BHATTARAI, K. (2010) `Does Government Spending on Education Promote Growth and Schooling Returns?', *Working Papers.*

BAUMOL, W. J. (1967) `Macroeconomics of unbalanced growth: the anatomy of urban crisis', *American Economic Review,* 57(3),, pp.415-426.

BERALDO, S., MONTOLIO, D. AND TURATI, G. (2009) `Healthy, educated and wealthy: A primer on the impact of public and private welfare expenditure on economic growth', *The Journal of Socio-Economics*, 38, pp.946-956.

BLANKENAU, W. F., SIMPSON, N. B. AND TOMLJANOVICH, M. (2007) `Public Education Expenditures, Taxation, and Growth: Linking Data to Theory', *The American Economics Review,* 97(2), pp.393-397.

BLOOM, D. E. AND CANNING, D. (2005) `Health and Economic Growth: Reconciling the Micro and Macro Evidence', *Harvard School of Public Health Working Papers.*

BOSE, N., EMRANUL, H. M., OSBORNE, D. R. (2003) `Public Expenditure and Economic Growth: A Disaggregated Analysis', *University of Wisconsin Working Papers.*

BROWN, R. L., DURBIN, J. AND EVANS, J. M. (1975) `Techniques for testing the constancy of regression relationships over time', *Journal of the Royal Statistical Society*, 37(2), pp.149-192.

CARRION-I-SILVESTRE, J. L. (2004) `Health care expenditure and GDP: Are they broken stationary?', Journal of *Health Economics,* 24, pp.839-854.

CHANDRA, A. (2011) `Nexus Between Government Expenditure on Education and Economic Growth: Empirical Evidences from India', *Revista Romanescu pentru Educatie Mutidimensionala,* 6, pp.73-85.

CHANG, K. AND YING, Y. (2006) `Economic growth, human capital investment, and health expenditure: a study of OECD countries', *Hitotsubashi Journal of Economics,* 47(1), pp.1-16.

DEATON, A. (2003) `Health, Inequality, and Economic Development', *Journal of Economic Literature,* 41, pp.113-158.

DICKEY, D. A. AND W. A. FULLER (1979) `Distribution of the Estimators for Autoregressive Time Series with a Unit Root', *Journal of the American Statistical Association*, 74, pp.427–431.

DING, H. (2014) `Economic Growth and Welfare State: A debate of Econometrics', *Journal of Social Science for Policy Implications,* 2(2), pp.165-196.

DOGAN, I., TULUCE, N. S. AND DOGAN, A. (2014) `Dynamics of Health Expenditures in OECD Countries: Panel ARDL Approach', *Theoretical Economics Letters,*4, pp.649-655.

EHRLICH, I. AND YIN, Y. (2013) `Equilibrium Health Spending and Population Aging in a Model of Endogenous Growth: Will the GDP Share of Health Spending Keep Rising?', *Journal of Human Capital,* 7(4), pp.411-447.

ENGLE, R. F., GRANGER, C. W. J. (1987) `Co-integration and error correction: representation, estimation, and testing', *Econometrica*, 55, pp.251–76.

ELMI, Z. M. AND SADEGHI, S. (2012) `Health Care Expenditure and Economic Growth in Developing Countries: Panel Co-Integration and Causality', *Middle-East Journal of Scientific Research,* 12(1), pp.89-91.

ERDIL, E. AND YETKINER, I. H. (2009) `The Granger causality between health care expenditure and output a panel data approach', *Applied Economics,* 41, pp.511-518.

GRANGER, C. W. J. AND NEWBOLD, P. (1974) `Spurious Regressions in Econometrics', *Journal of Econometrics,* 2, pp.111.120.

GROSSMAN, M. (1972) `On the Concept of Health Capital and the Demand for Health', *Journal of Political Economic,* 80, pp.223-255

GUJARATI, D. N. AND PORTER, D. C. (2009) *Basic Econometrics,* 5th ed., McGraw-Hill

GURGUL, H., LACH, L. AND MESTEL, R. (2012) `The relationship between budgetary expenditure and economic growth in Poland', *CEJOR,* 20, pp.161-182.

HALL, R. E. AND JONES, C. I. (1996) `The Productivity of Nations', *NBER Working Papers,* 5812.

HALL, R. E. AND JONES, C. I. (1999) `Why do some countries produce so much more output than others?', *The Quarterly Journal of Economics*, 114(1), pp.83-113.

HALL, R. E. AND JONES, C. I. (2007) `The Value of Life and the Rise in Health Spending', *The Quarterly Journal of Economics*, 122(1), pp.39-72.

HANSEN, C. W. (2013) `Health and Development: A neoclassical Perspective', *Journal of Human Capital,* 7(3), pp.274-295.

HARTWIG, J. (2008) `What drives health care expenditure? Baumol's model of 'unbalanced growth' revisited', *Journal of Health Economics*, 27, pp.63-623.

JEWELL, T., LEE, J., TIESLAU, M. AND STRAZICICH, M. C. (2003) `Stationarity of health expenditure and GDP: evidence from panel unit root tests with heterogeneous structural breaks', *Journal of Health Economics,* 22, pp.313-323.

JOHANSEN, S. (1988) `Statistical analysis of cointegration vectors', *Journal of Economic Dynamic and Control*, 12, pp.231-254.

JONES, C. I. (2001) *Introduction to Economic Growth,* second edition, W&W Norton Company.

KWIATKOWSKI, D., PHILLIPS, P. C. B., SCHMIDT, P. AND SHIN, Y. (1992) `Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root', *Journal of Econometrics*, 54, pp.159-178.

LUCAS, R. (1988) `On the Mechanics of Economic Development', *Journal of Monetary Economics*, 22, pp.3-42.

MAGAZZINO, C. (2011) `Disaggregated public spending, GDP and Money Supply: Evidence for Italy', *European Journal of Economics, Finance and Administrative Sciences*, 41, pp.118-131.

MAGAZZINO, C. AND MELE, M. (2011) `Health Care Expenditure and Economic Growth in Southern Italian Regions: an Empirical Analysis', *Rassegna Economica ,* 20, pp.51-66.

MONTEIRO, G. AND TURNOVSKY, S. J. (2008) `The composition of productive government expenditure', *Indian Growth and Development Review,* 1(1), pp.57-83.

MUSHKIN, S. J. (1962) `Health as an Investment', *Journal of Political Economy,* 70(5), pp.129-157.

MUSILLA AND BELASSI (2004) `The Impact of Education Expenditures on Economic Growth in Uganda: Evidence from Time Series Data', *The Journal of Developing Areas,* 30(1), pp.123-133.

NEWHOUSE, J.P. (1977) `Medicare expenditure: a cross-national survey', *Journal of Human Resources,* 12(1), pp.115-125.

NEWHOUSE, J. P. (1992) `Medical Care Costs: How Much Welfare Loss?', *Journal of Economic Perspectives,* 6(3), pp.3-21.

NORDHAUS, W. D. (2002) `The Health of Nations: The Contribution of Improved Health to Living Standards', *NBER Working Paper Series,* 8818.

OECD (2014) `Social expenditure update – social expenditure is falling in some countries but in many others it remains at historically high levels', OECD, available online at: www.oecd.org/social/expenditure.htm.

PESARAN, M. H. and Shin, Y. (1999) `An autoregressive distributed lag modelling approach to cointegration analysis', in STROM, S. (1999) *Econometrics and Economic Theory in the 20th century: The Ragnar Frisch Centennial Symposium*, Cambridge University Press, Cambridge.

PESARAN, M. H., SHIN, Y. AND SMITH, R.J. (2001) `Bounds Testing Approache to the Analysis of Level Relationships', *Journal of Applied Econometrics,* 16, pp.289-326.

PHILLIPS, P.C.B. AND PERRON, P. (1988) `Testing for a Unit Root in Time Series Regression', *Biometrika*, 75, pp.335–346.

PRESTON, S. H. (1975) `The Changing Relation between Mortality and Level of Economic Development', *Population Studies,* 29, pp.231-248.

RAHMAN, M. (2011) `Causal Relationship among Education Expenditure, Health Expenditure and GDP: A Case Study for Bangladesh', *International Journal of Economics and Finance*, 3(3), pp.149-159.

RAJKUMAR, A. S. AND SWAROOP, V. (2007) `Public spending and outcomes: Does Governance matter?', *Journal of Development Economics*, 86, pp.96-111.

ROMER, P.M. (1986) `Increasing Returns and Long-Run Growth', *The Journal of Political Economy*, 94(5), pp.1002-1037.

ROMILLY, P., SONG, H. AND LIU, X. (2001) `Car ownership and use in Britain: A comparison of the empirical results of alternative cointegration estimation methods and forecasts', *Applied Economics,* 33, pp.1803-1818.

SALA-I-MARTIN, X. (1997) `I Just ran two Million Regressions', American Economic Review, 87(2), pp.178-183.

SIANESI, B. AND RENEEN, J. V. (2003) `The Returns to Education: Macroeconomics', *Journal of Economic Surveys,* 17(2), pp.157-200.

SOLOW, R. M. (1956) `A Contribution to the Theory of Economic Growth', *The Quarterly Journal of Economics,* 70(1), pp.65-94.

SWAN, T. W. (1956) `Economic Growth and Capital Accumulation', *Economic Record,* 32(2), pp.334-361.

TANG, C. F. (2011) `Multivariate Granger Causality and the Dynamic Relationship between Health Care Spending, Income and Relative Price of Health Care in Malaysia', *Hitotsubashi Journal of Economics*, 52, pp.199-214.

WANG, K. M. (2011) `Health care expenditure and economic growth: Quantile panel-type analysis', *Economic Modelling,* 28, pp.1536-1549.

WEIL, D. N. (2007) `Accounting for the effect of health on economic growth', *The Quarterly Journal of Economics,* 122(3), pp.1265-1306.

Appendix A

In this section we report the complete estimated models and relationships for every country, for a discussion of the main results refer to section 3.5 and 3.6.

Canada (model 1)

Dependent variable:	Education expenditure		
PANEL A	**ARDL model**		R^2= 0.98
Variables	Coefficients	Standard error	t-ratio
ledcan (-1)	0.966	0.141	6.876 ***
ledcan (-2)	-0.325	0.175	-0.186
ledcan (-3)	-0.201	0.132	-1.518
lgdpcan	1.761	0.578	3.046***
lgdpcan (-1)	-3.658	0.892	-4.102***
lgdpcan (-2)	2.3409	0.577	4.054***
constant	-3.3596	1.150	-2.924***
PANEL B	**LONG-RUN RELATIONSHIP**		
Variables	Coefficients	Standard error	t-ratio
lgdpcan	1.660	0.132	12.56***
constant	-12.550	1.854	-6.78***
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dledcan (-1)	0.234	0.140	1.669
dledcan (-2)	0.201	0.132	1.518
dlgdpcan	1.761	0.578	3.046***
dlgdpcan (-1)	-2.341	0.577	-4.054***
ec (-1)	-0.268	0.732	-3.657***
Error correction term:	*ledcan -1.660 lgdpcan + 12.550 C*		
Wald test:	Null hypothesis:	*dlgdpcan (-1) =dlgdpcan = 0*	
	Wald statistic (p-value):	21.235 (0.000)	

Canada (model 2)

Dependent variable:	health expenditure		
PANEL A	**ARDL model**		R^2= 09.99
Variables	Coefficients	Standard error	t-ratio
lhecan (-1)	1.278	0.134	9.516***
lhecan (-2)	-0.617	0.210	-2.933***
lhecan (-3)	0.186	0.129	1.441
lgdpcan	0.351	0.125	-2.591***
lgdpcan (-1)	0.555	0.141	3.934***
constant	-1.053	0.394	-2.671***
PANEL B	**LONG-RUN REALTIONSHIP**		
Variables	Coefficients	Standard error	t-ratio
lgdpcan	1.335	0.067	20.02***
constant	-6.874	0.973	-7.07***
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlhecan (-1)	0.432	0.126	3.424***
dlhecan (-2)	-0.186	0.129	-1.441
dlgdpcan	0.351	0.135	-2.592***
ec (-1)	-0.153	0.042	-3.636***
Error correction term:	*lhecan -1.335 lgdpcan +6.874 C*		

Canada (model 3)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpcan (-1)	1.348	0.155	8.65***
lgdpcan (-2)	-0.405	0.168	-2.41**
ledcan	0.117	0.040	2.93***
ledcan (-1)	-0.146	0.050	-2.90***
ledcan (-2)	-0.019	0.046	-0.43
ledcan (-3)	0.018	0.045	0.39
ledcan (-4)	0.059	0.034	1.75*
constant	0.522	0.325	1.60
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpcan (-1)	0.406	0.168	2.41
dledcan	0.117	0.039	2.93
dledcan (-1)	-0.578	0.036	-1.59
dledcan (-2)	-0.769	0.033	-2.30
dledcan (-3)	-0.059	0.034	-1.75
ec (-1)	-0.057	0.039	-1.47
Error correction term:	*lgdpcan -0.499 ledcan -9.054 C*		
Wald test:	Null hypothesis:	*dledcan=dledcan(-1)=dledcan(-2)=dledcan(-3)=0*	
	Wald statistic (p-value):	17.08 (0.002)	

Canada (model 4)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpcan (-1)	1.029	0.077	13.23***
lhecan	-0.385	0.155	-2.47**
lhecan (-1)	0.351	0.137	2.56**
constant	0.013	0.472	0.03
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlhecan	-0.385	0.156	-2.47**
ec (-1)	0.029	0.078	0.38
Error correction term:	*lgdpcan -1.141 lhecan +0.466 C*		

Denmark (model 5)

Dependent variable:	Education expenditure		
PANEL A	**ARDL model**		R^2=0.98
Variables	Coefficients	Standard error	t-ratio
leddnk (-1)	1.037	0.158	6.54***
leddnk (-2)	-0.245	0.155	-1.57
lgdpdnk	0.726	0.287	2.52***
constant	-8.893	3.513	-2.47**
PANEL B	**LONG-RUN MORELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dleddnk (-1)	0.245	0.155	1.57
dlgdpdnk	0.726	0.288	2.52**
ec (-1)	-0.207	0.078	-2.67**
Error correction term:	*leddnk -3.494 lgdpdnk +41.823 C*		

Denmark (model 6)

Dependent variable:	Health expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lhednk (-1)	0.883	0.493	17.90***
lgdpdnk	0.152	0.619	2.46**
constant	-0.767	0.368	-2.08**
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpdnk	0.152	0.062	2.46**
ec (-1)	-0.116	0.049	-2.36**
Error correction term:	*lhednk -1.306 lgdpdnk -6.5800 C*		

Denmark (model 7)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpdnk (-1)	1.009	0.065	15.41***
leddnk	-0.011	0.018	-0.58
constant	-0.033	0.792	-0.04

PANEL B	LONG-RUN RELATIONSHIP

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dleddnk	-0.011	0.018	-0.58
ec (-1)	0.008	0.065	0.14
Error correction term:	*lgdpdnk -1.198 leddnk -3.704 C*		

Denmark (model 8)

Dependent variable:

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpdnk (-1)	1.038	0.059	17.62***
lhednk	-0.056	0.047	-1.17
constant	0.123	0.320	0.38

PANEL B	LONG-RUN RELATIONSHIP

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlhednk	-0.056	0.048	-1.17
ec (-1)	0.038	0.059	0.65
Error correction term:	*lgdpdnk -1.448 lhednk +3.186 C*		

Finland (model 9)

Dependent variable: education expenditure

PANEL A	ARDL model		R^2=0.98
Variables	Coefficients	Standard error	t-ratio
ledfin (-1)	1.064	0.149	7.11***
ledfin (-2)	-0.277	0.137	-2.02**
lgdpfin	0.501	0.167	3.00***
constant	-3.953	1.414	-2.79***

PANEL B	LONG-RUN RELATIONSHIP

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dledfin (-1)	0.278	0.137	2.03**
dlgdpfin	0.501	0.168	3.01***
ec (-1)	-0.214	0.066	-3.21***
Error correction term:	*ledfin -2.347 lgdpfin +18.497 C*		

Finland (model 10)

Dependent variable: Health expenditure

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lhefin (-1)	1.137	0.155	7.32***
lhefin (-2)	-0.679	0.205	-3.31***
lhefin (-3)	0.302	0.118	2.55**
lgdpfin	0.087	0.127	0.68
lgdpfin (-1)	0.214	0.154	1.39
constant	-1.332	0.350	-3.80***

PANEL B	LONG-RUN RELATIONSHIP		
Variables	Coefficients	Standard error	t-ratio
lgdpfin	1.258	0.054	23.28***
constant	5.553	0.643	8.64***

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlhefin (-1)	0.376	0.130	2.893***
dlhefin (-2)	-0.302	0.118	-2.555**
dlgdpfin	0.087	0.127	0.686
ec (-1)	-0.240	0.051	-4.748***
Error correction term:	*lhefin -1.258 lgdpfin -5.553 C*		

Finland (model 11)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpfin (-1)	1.524	0.163	9.32***
lgdpfin (-2)	-0.828	0.268	-3.09***
lgdpfin (-3)	0.326	0.167	1.94*
ledfin	-0.017	0.025	-0.67
constant	-0.085	0.489	-0.17

PANEL B	LONG-RUN RELATIONSHIP

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpfin (-1)	0.502	0.161	3.12***
dlgdpfin (-2)	-0.326	0.167	-1.94**
dledfin	-0.017	0.026	-0.67
ec (-1)	0.022	0.060	0.36

Error correction term:	*lgdpfin -0.789 ledfin -3.874 C*

Finland (model 12)

Dependent variable: Income

PANEL A	ARDL MODEL		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpfin (-1)	1.497	0.170	8.79***
lgdpfin (-2)	-0.806	0.267	-3.01***
lgdpfin (-3)	0.275	0.179	1.54
lhefin	0.011	0.103	0.11
constant	0.294	0.651	0.45

PANEL B	LONG-RUN RELATIONSHIP

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpfin (-1)	0.530	0.178	2.96***
dlgdpfin (-2)	-0.276	0.179	.1.53
dlhefin	0.012	0.103	0.11
ec (-1)	-0.032	0.135	-0.24

Error correction term:	*lgdpfin -0.354 lhefin -8.975 C*

Ireland (model 13)

Dependent variable: Education expenditure

PANEL A	ARDL model		R^2=0.98
Variables	Coefficients	Standard error	t-ratio
ledirl (-1)	0.849	0.071	11.88***
lgdpirl	0.251	0.118	2.12**
constant	-1.561	0.805	-1.94*

PANEL B	LONG-RUN RELATIONSHIP

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpirl	0.251	0.118	2.12**
ec (-1)	-0.150	0.071	-2.10**
Error correction term:	*ledirl -1.673 lgdpirl + 10.395 C*		

Ireland (model 14)

Dependent variable: Health expenditure

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lheirl (-1)	0.974	0.171	5.68***
lheirl (-2)	-0.281	0.126	-2.23**
lgdpirl	-0.178	0.228	-0.78
lgdpirl(-1)	0.506	0.287	1.75**
constant	-1.022	0.261	-3.91***

PANEL B	LONG-RUN RELATIONSHIP		
Variables	Coefficients	Standard error	t-ratio
lgdpirl	1.066	0.342	31.20***
constant	-3.330	0.389	-8.57***

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlheirl (-1)	0.281	0.126	2.23**
dlgdpirl	-0.179	0.227	-0.78
ec (-1)	-0.307	0.072	-4.06***
Error correction term:	*lgdpirl -1.066 lgdpirl +3.330 C*		

Ireland (model 15)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpirl (-1)	1.602	0.145	11.05***
lgdpirl (-2)	-0.622	0.158	-3.93***
ledirl	0.005	0.021	0.27
constant	0.159	0.225	0.71

PANEL B **LONG-RUN RELATIONSHIP**

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpirl (-1)	0.622	0.158	3.93***
dledirl	0.006	0.021	0.27
ec (-1)	-0.017	0.034	-0.49
Error correction term:	*lgdpirl -0.348 ledirl -9.340 C*		

Ireland (model 16)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpirl (-1)	1.453	0.132	10.93***
lgdpirl (-2)	-0.242	0.173	-1.39
lheirl	-0.206	0.070	-2.92***
constant	-0.570	0.246	-2.31**

PANEL B **LONG-RUN RELATIONSHIP**

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpirl (-1)	0.242	0.174	1.39
dlheirl	-0.206	0.071	-2.92***
ec (-1)	0.211	0.075	2.80***
Error correction term:	*lgdpirl -0.978 lheirl -2.703 C*		

Netherlands (model 17)

Dependent variable: education expenditure

PANEL A	ARDL model		R^2=0.98
Variables	Coefficients	Standard error	t-ratio
lednld (-1)	1.476	0.167	8.83***
llednld (-2)	-1.051	0.281	-3.74***
lednld(-3)	0.612	0.275	2.22**
lednld(-4)	-0.320	0.156	-1.49
lgdpnld	0.498	0.210	2.36**
constant	-4.525	2.018	-2.24**

PANEL B **LONG-RUN RELATIONSHIP**

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlednnld (-1)	0.668	0.162	4.13***
dlednld (-2)	-0.382	0.167	-2.29**
dlednld (-3)	0.230	0.154	1.49
dlgdpnld	0.498	0.210	2.36**
ec (-1)	-0.192	0.077	-2.50**

Error correction term: *lednld -2.584 lgdpnld + 23.467 C*

Netherlands (model 18)

Dependent variable: Health expenditure

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lhenld (-1)	0.891	0.38	22.99***
lgdpnld	0.163	0.60	3.01***
constant	-1.210	0.404	-2.99***

PANEL B **LONG-RUN RELATIONSHIP**

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpnld	0.183	0.607	3.01***
ec (-1)	-0.108	0.039	-2.80***

Error correction term: *lhenld -1.683 lgdpnld + 11.108 C*

Netherlands (model 19)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpnld (-1)	1.386	0.156	8.89***
lgdpnld (-2)	-0.389	0.157	-2.47**
lednld	-0.005	0.014	-0.33
constant	0.101	0.351	0.28
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpnld (-1)	0.389	0.157	2.47**
dlednld	-0.005	0.014	-0.33
ec (-1)	-0.003	0.037	-0.08
Error correction term:	*lgdpnld +1.464 lednld -31.329 C*		

Netherlands (model 20)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpnld (-1)	1.362	0.158	8.65***
lgdpnld (-2)	-0.327	0.184	-1.78
lhenld	-0.033	0.047	-0.70
constant	-0.098	0.455	-0.26
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpnld (-1)	0.327	0.183	1.78*
dlhenld	-0.033	0.047	-0.70
ec (-1)	0.035	0.076	0.49
Error correction term:	*lgdpnld -0.940 lhenld -2.764 C*		

New Zealand (model 21)

Dependent variable:	Education expenditure		
PANEL A	**ARDL model**		R^2=0.97
Variables	Coefficients	Standard error	t-ratio
lednzl (-1)	0.936	0.158	5.91***
lednzl (-2)	-0.002	0.211	-0.01
lednzl (-3)	-0.251	0.157	-1.59
lgdpnzl	2.684	1-067	2.51**
lgdpnzl (-1)	-4.087	1.744	-2.34**
lgdpnzl (-2)	2.283	1.039	2.20**
constant	-7.839	2.634	-2.98***
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlednzl (-1)	0.253	0.163	1.55
dlednzl (-2)	0.251	0.157	1.60
dlgdpnzl	2.684	1.067	2.51**
dlgdpnzl (-1)	-0.283	1.039	-2.19**
ec (-1)	-0.316	0.113	-2.79***
Error correction term:	*lednzl -2.780 lgdpnzl +24.765 C*		
Wald test:	Null hypothesis:	*dlgdpnzl=dlgdpnzl (-1)=0*	
	Wald statistic (p-value):	7.753 (0.021)	

New Zealand (model 22)

Dependent variable:	Health expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lhenzl (-1)	1.322	0.153	8.65***
lhenzl (-2)	-0.901	0.243	-3.71***
lhenzl (-3)	0.738	0.242	3.05***
lhenzl (-4)	-0.372	0.246	-2.55**
lgdpnzl	0.344	0.104	3.31***
constant	-2.099	0.650	-3.23***
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlhenzl (-1)	0.535	0.143	3.74***
dlhenzl (-2)	-0.366	0.147	-2.48**
dlhenzl (-3)	0.372	0.145	2.55**
dlgdpnzl	0.344	0.144	3.31***
ec (-1)	-0.212	0.067	-3.21***
Error correction term:	*lhenzl -1.621 lgdpnzl +9.874 C*		

New Zealand (model 23)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpnzl (-1)	1.410	0.137	10.24***
lgdpnzl (-2)	-0.503	0.141	-3.56***
lednzl	0.059	0.023	2.51**
lednzl (-1)	-0.057	0.032	-1.78*
lednzl (-2)	-0.014	0.031	-0.46***
lednzl (-3)	0.050	0.023	2.20**
constant	0.815	0.420	1.94*

PANEL B	LONG-RUN RELATIONSHIP
No cointegration relationship	

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpnzl (-1)	0.503	0.141	3.56***
dlednzl	0.059	0.024	2.51**
dlednzl (-1)	-0.035	0.025	-1.45
dlednzl (-2)	-0.050	0.023	-2.19**
ec (-1)	-0.934	0.047	-1.98*
Error correction term:	*lgdpnzl -0.404 lednzl -8.725 C*		
Wald test:	Null hypothesis:	*dlednzl = dlednzl (-1) = dlednzl (-2) =0*	
	Wald statistic (p-value):	10.434 (0.015)	

New Zealand (model 24)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpnzl (-1)	1.350	0.144	9.35***
lgdpnzl (-2)	-0.391	0.149	-2.62**
lhenzl	0.029	0.043	0.67
constant	0.224	0.445	0.50

PANEL B	LONG-RUN RELATIONSHIP
No cointegration relationship	

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpnzl (-1)	0.390	0.149	2.62**
dlhenzl	0.288	0.043	0.67
ec (-1)	-0.041	0.071	-0.57
Error correction term:	*lgdpnzl -0.712 lhenzl -5.531 C*		

<u>Norway</u> (model 25)

Dependent variable:	education expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lednor (-1)	1.351	0.146	9.27***
lednor (-2)	-0.455	0.149	-3.04***
lgdpnor	0.241	0.173	1.39
constant	-2.666	2.020	-1.32
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlednor (-1)	0.445	0.150	3.04***
dlgdpnor	0.241	0.173	1.39
ec (-1)	-0.103	0.065	-1.58
Error correction term:	*lednor -2.322 lgdpnor +25.699 C*		

<u>Norway</u> (model 26)

Dependent variable:	Health expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lhenor (-1)	0.949	0.074	12.88***
lgdpnor	0.051	0.114	0.45
constant	-0.100	0.789	-0.13
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpnor	0.052	0.114	0.45
ec (-1)	-0.051	0.074	-0.69
Error correction term:	*lhenor -1.011 lgdpnor +1.963 C*		

Norway (model 27)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpnor (-1)	1.034	0.158	6.53***
lgdpnor (-2)	-0.452	0.225	-2.01*
lgdpnor (-3)	0.263	0.156	1.68
lednor	0.056	0.031	1.79*
constant	1.822	0.904	2.01*

PANEL B **LONG-RUN RELATIONSHIP**

No cointegration relationship

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpnor (-1)	0.188	0.156	1.21
dlgdpnor (-2)	-0.263	0.157	-1.68
dlednor	0.056	0.031	1.79*
ec (-1)	-0.154	0.079	-1.95*

Error correction term: *lgdpnor -0.364 lednor -11.825 C*

Norway (model 28)

Dependent variable: Income

PANEL A	ARDL model		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpnor (-1)	0.804	0.155	5.19***
lgdpnor (-2)	-0.0293	0.147	-1.99*
lhenor	0.025	0.158	0.16
lhenor (-1)	-0.112	0.215	-0.52
lhenor (-2)	0.393	0.167	2.34**
constant	3.436	0.800	4.29***

PANEL B	LONG-RUN RELATIONSHIP		
Variables	Coefficients	Standard error	t-ratio
lhenor	0.625	0.023	27.22***
constant	7.026	0.272	25.84***

PANEL C	ERROR CORRECTION MODEL		
Variables	Coefficients	Standard error	t-ratio
dlgdpnor (-1)	0.293	0.147	1.99*
dlhenor	0.025	0.158	0.16
dlhenor (-1)	-0.392	0.167	-2.35**
ec (-1)	-0.489	0.116	-4.23***

Error correction term: *lgdpnor -0.625 lhenor -7.0256 C*

Wald test: Null hypothesis: *dlhenor = dlhenor (-1) = 0*

Wald statistic (p-value): 5.601 (0.006)

Switzerland (model 29)

Dependent variable:	education expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
ledchf (-1)	0.806	0.634	12.64***
lgdpchf	0.772	0.303	2.55**
constant	-8.256	3.406	-2.42**
PANEL B	**LONG-RUN RELATIONSHIP**		
Variables	Coefficients	Standard error	t-ratio
lgdpchf	3.980	0.485	8.21***
constant	-42.561	6.333	-6.72***
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpchf	0.772	0.303	2.55**
ec (-1)	-0.194	0.064	-3.04***
Error correction term:	*ledchf -3.980 lgdpchf +42.561 C*		

Switzerland (model 30)

Dependent variable:	health expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lhechf (-1)	0.866	0.038	23.05***
lgdpchf	0.014	0.126	0.11
lgdpchf (-1)	0.242	0.120	2.02*
constant	-1.871	0.564	-3.32***
PANEL B	**LONG-RUN RELATIONSHIP**		
Variables	Coefficients	Standard error	t-ratio
lgdpchf	1.203	0.060	20.00***
constant	-13.934	1.234	-11.29***
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpchf	0.014	0.126	0.11
ec (-1)	-0.134	0.037	-3.57***
Error correction term:	*lhechf -1.203 lgdpchf +13.934 C*		

Switzerland (model 31)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpchf (-1)	1.251	0.159	7.87***
lgdpchf (-2)	-0.613	0.237	-2.59**
lgdpchf (-3)	0.264	0.152	1.73*
ledchf	-0.019	0.030	-0.64
ledchf (-1)	0.043	0.026	1.63
constant	1.087	0.649	1.67
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpchf (-1)	0.349	0.149	2.33**
dlgdpchf (-2)	-0.264	0.152	-1.73*
dledchf	-0.019	0.030	-0.63
ec (-1)	-0.098	0.058	-1.70*
Error correction term:	*lgdpchf -0.243 ledchf -11.024 C*		

Switzerland (model 32)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpchf (-1)	1.071	0.149	7.19***
lgdpchf (-2)	-0.316	0.148	-2.13**
lhechf	0.015	0.195	0.08
lhechf (-1)	-0.243	0.253	-0.96
lhechf (-2)	0.357	0.174	2.05**
constant	1.847	0.776	2.38**
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpchf (-1)	0.316	0.148	2.13**
dlhechf	0.015	0.195	0.08
dlhechf (-1)	-0.357	0.174	-2.05**
ec (-1)	-0.246	0.101	-2.43**
Error correction term:	*lgdpchf -0.528 lhechf -7.517 C*		
Wald test:	Null hypothesis:	*dlhechf (-1) = dlhechf = 0*	
	Wald statistic (p-value):	4.204 (0.122)	

United Kingdom (model 33)

Dependent variable:	Education expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
ledgbr (-1)	0.896	0.156	5.73***
ledgbr (-2)	-0.355	0.149	-2.38**
lgdpgbr	1.739	0.709	2.45**
lgdpgbr (-1)	-2.352	1.158	-2.03**
lgdpgbr (-2)	1.587	0.769	2.06**
constant	-8.157	2.289	-3.56***
PANEL B	**LONG-RUN RELATIONSHIP**		
Variables	Coefficients	Standard error	t-ratio
lgdpgbr	2.123	0.134	18.65***
constant	-17.802	1.570	-11.34***
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dledgbr (-1)	0.355	0.149	2.38**
dlgdpgbr	1.739	0.709	2.45**
dlgdpgbr (-1)	-1.587	0.769	-2.06**
ec (-1)	-0.458	0.119	-3.85***
Error correction term:	*ledgbr -2.123 lgdpgbr +17.802 C*		
Wald test:	Null hypothesis:	*dlgdpgbr = dlgdpgbr (-1) = 0*	
	Wald statistic (p-value):	8.083 (0.018)	

United Kingdom (model 34)

Dependent variable:	Health expenditure		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lhegbr (-1)	0.783	0.054	14.53***
lgdpgbr	-0.114	0.176	-0.64
lgdpgbr (-1)	0.473	0.190	2.49**
constant	-2.516	0.671	-3,75***
PANEL B	**LONG-RUN RELATIONSHIP**		
Variables	Coefficients	Standard error	t-ratio
lgdpgbr	1.651	0.062	26.55***
constant	-11.593	0.860	-13.48***
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpgbr	-0.114	0.175	-0.65
ec (-1)	-0.217	0.054	-4.03***
Error correction term:	*lhegbr -1.651 lgdpgbr +11.593 C*		

United Kingdom (model 35)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpgbr (-1)	1.391	0.147	9.45***
lgdpgbr (-2)	-0.759	0.234	-3.25***
lgdpgbr (-3)	0.355	0.148	2.40**
ledgbr	0.976	0.031	2.46**
ledgbr (-1)	-0.071	0.031	-2.25**
constant	0.123	0.507	0.244
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpgbr (-1)	0.404	0.144	2.79***
dlgbpgbr (-2)	-0.356	0.148	-2.40**
dledgbr	0.077	0.031	2.46**
ec (-1)	-0.013	0.058	-0.21
Error correction term:	*lgdpgbr -0.460 ledgbr -9.766 C*		

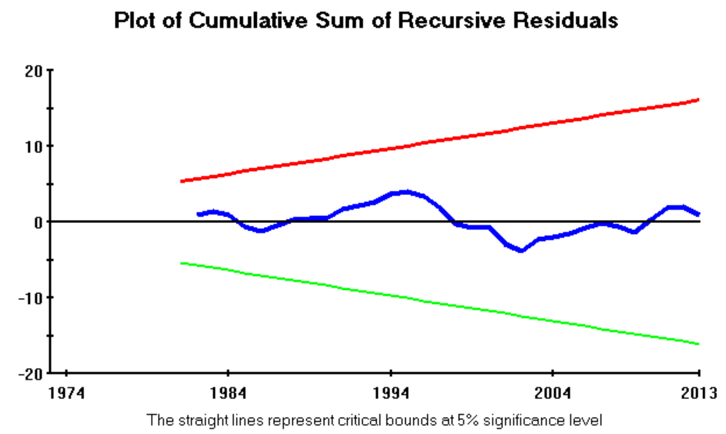
United Kingdom (model 36)

Dependent variable:	Income		
PANEL A	**ARDL model**		R^2=0.99
Variables	Coefficients	Standard error	t-ratio
lgdpgbr (-1)	-1.266	0.147	8.58***
lgdpgbr (-2)	-0.447	0.173	-2.58**
lhegbr	0.108	0.066	1.63
constant	1.315	0.797	1.65
PANEL B	**LONG-RUN RELATIONSHIP**		
No cointegration relationship			
PANEL C	**ERROR CORRECTION MODEL**		
Variables	Coefficients	Standard error	t-ratio
dlgdpgbr (-1)	0.447	0.173	2.57**
dlhegbr	0.108	0.066	1.63
ec (-1)	-0.181	0.110	-1.64
Error correction term:	*lgdpgbr -0.596 lhegbr -7.276 C*		

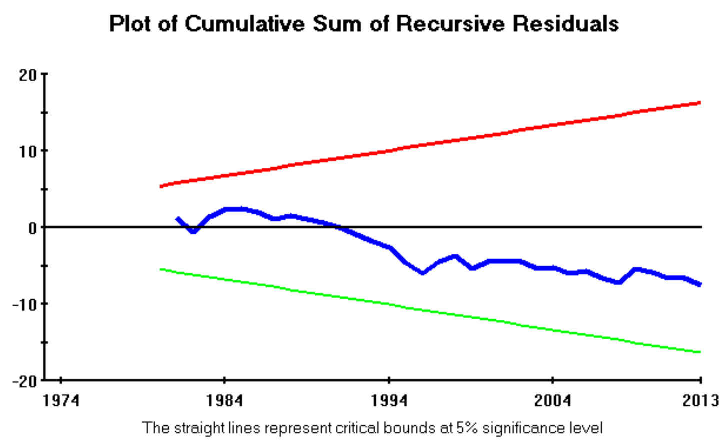
Appendix B

In this appendix it is possible to find the plot for the cumulative sum of recursive residuals (CUSUM) for the 36 models we estimated. The CUSUM has been developed by Brown et al. (1975) and is used to evaluate the stability of the coefficient. If the CUSUM statistic remains within the 2 lines indicating the 5% significance then the models is deemed to be stable. According to this criterion the only models possibly affected by instability are model 22 and 24.

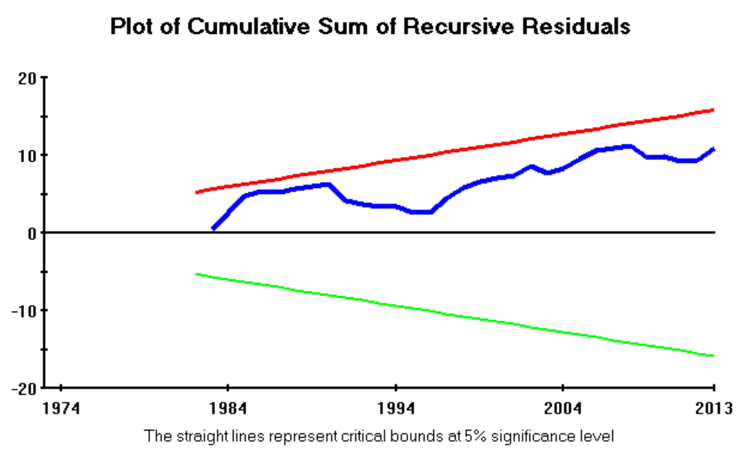
Canada (model 1)



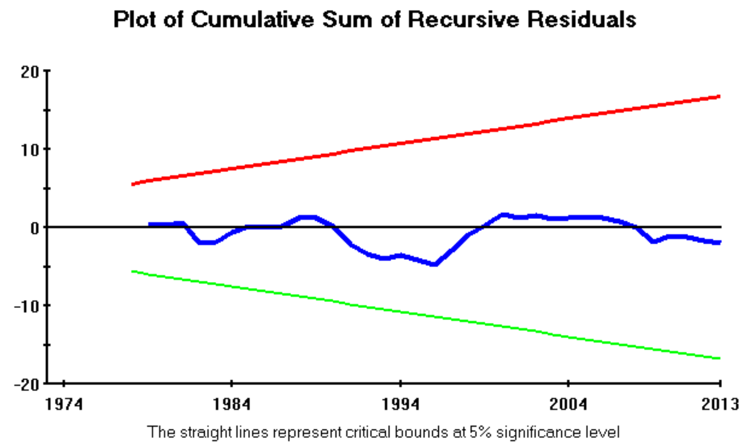
Canada (model 2)



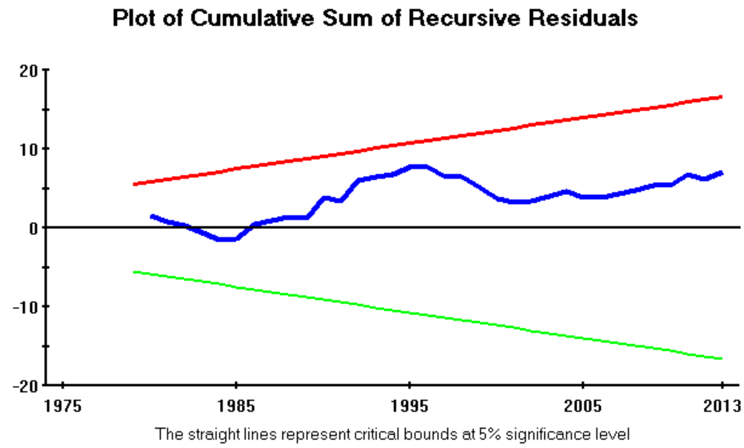
Canada (model 3)



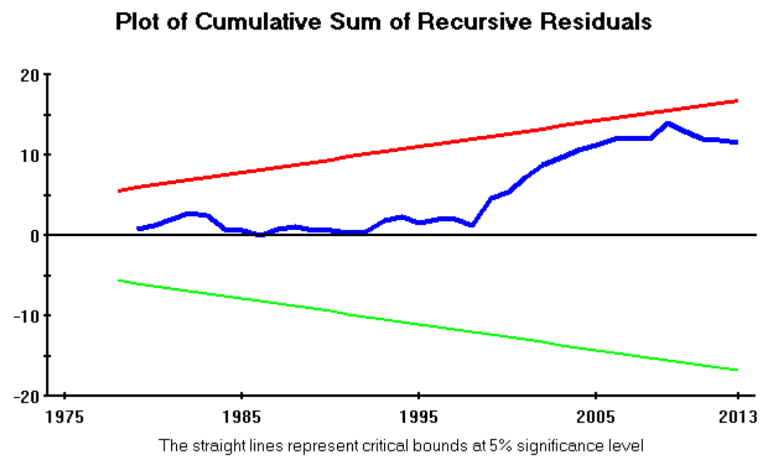
<u>Canada</u> (model 4)



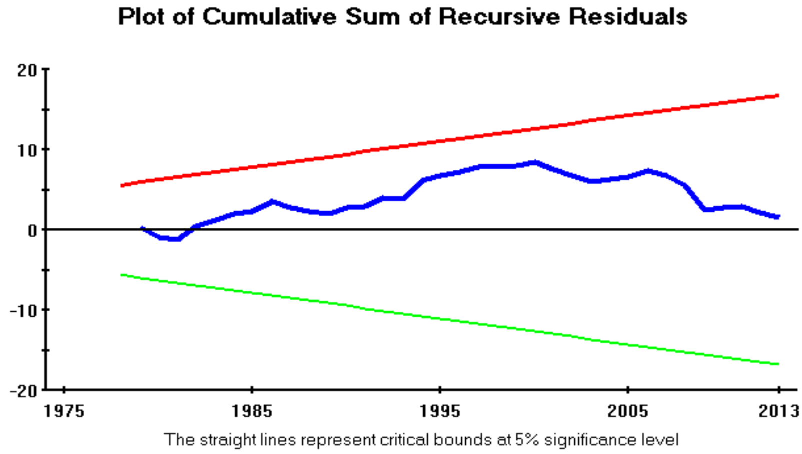
<u>Denmark</u> (model 5)



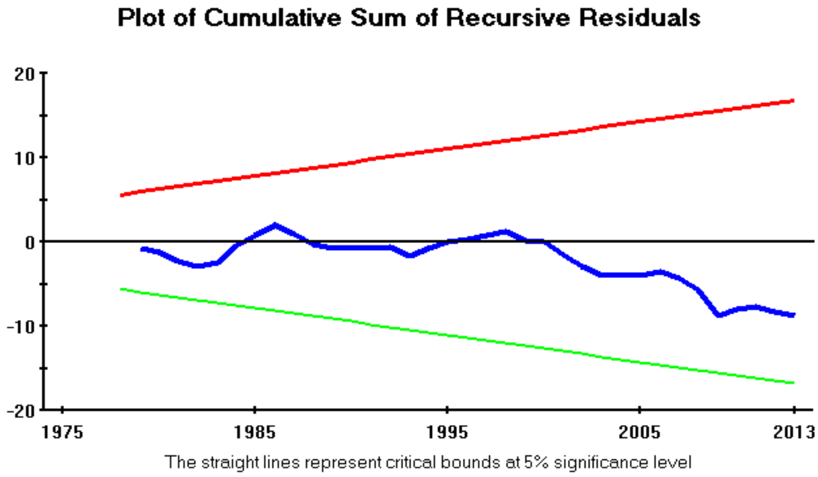
<u>Denmark</u> (model 6)



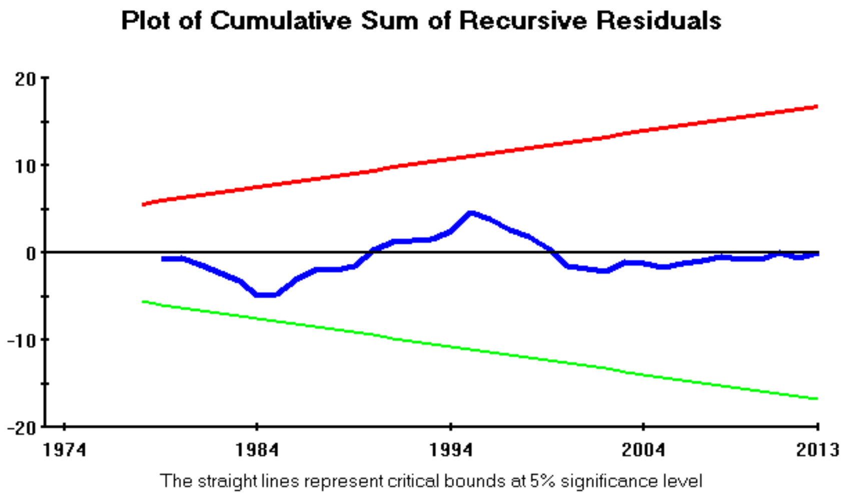
Denmark (model 7)



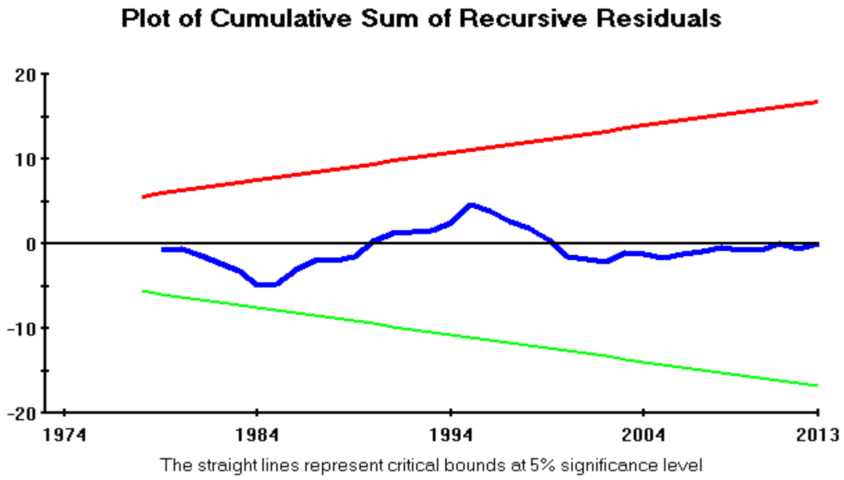
Denmark (model 8)



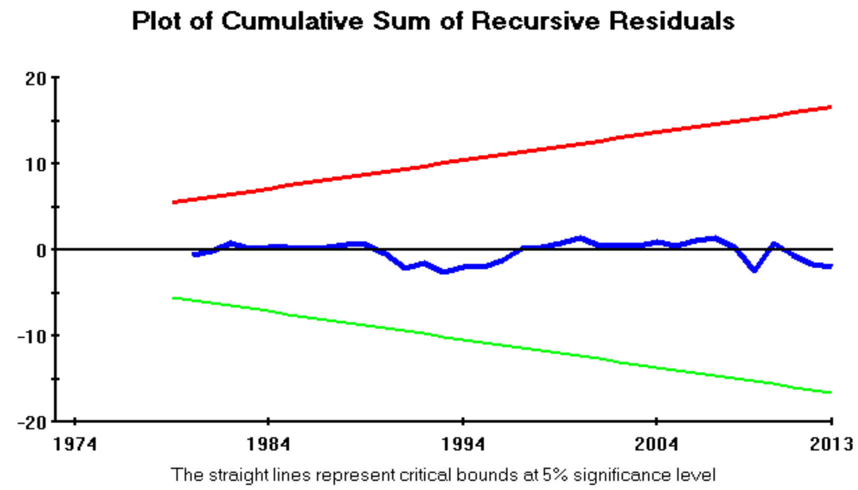
Finland (model 9)



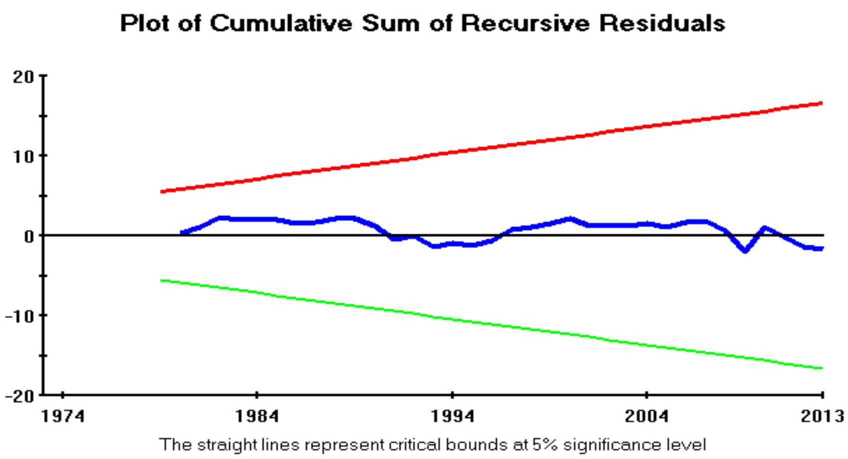
Finland (model 10)



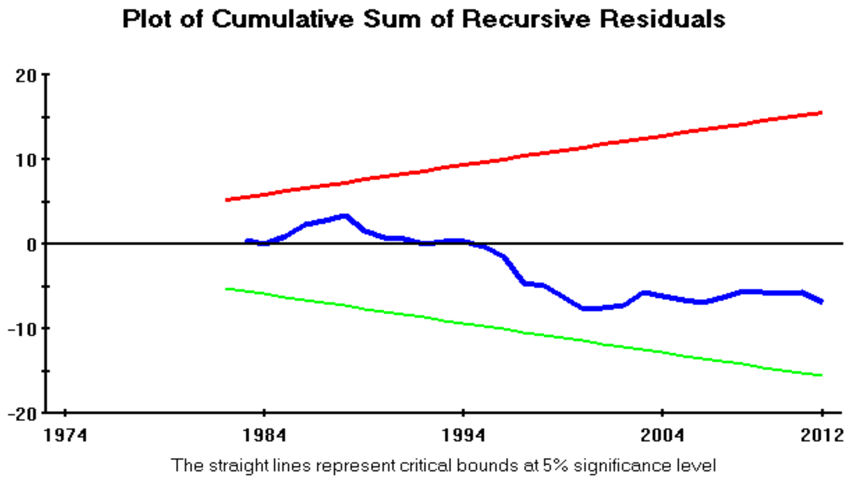
Finland (model 11)



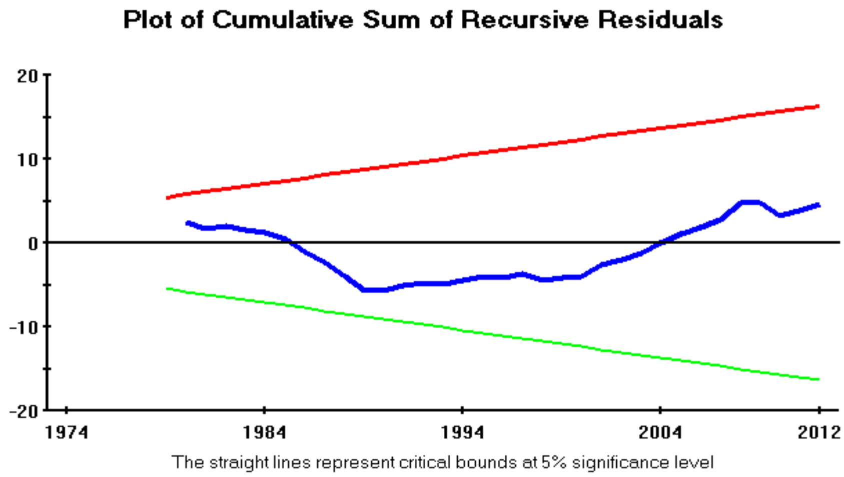
Finland (model 12)



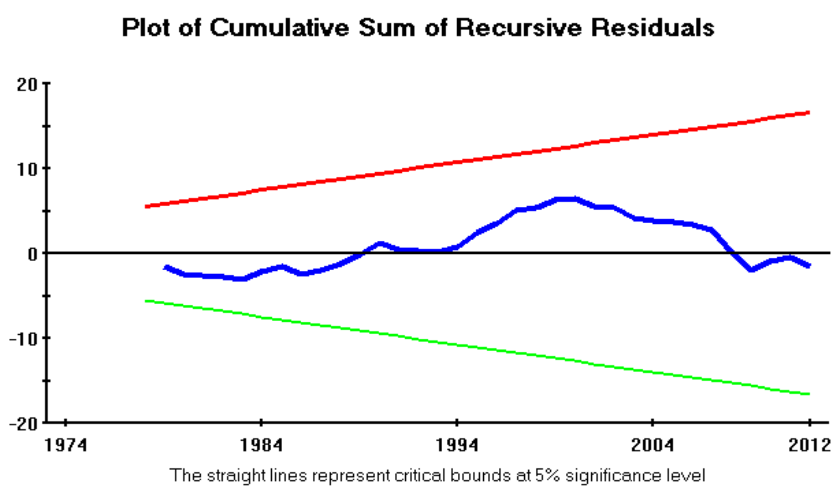
<u>Ireland</u> (model 13)



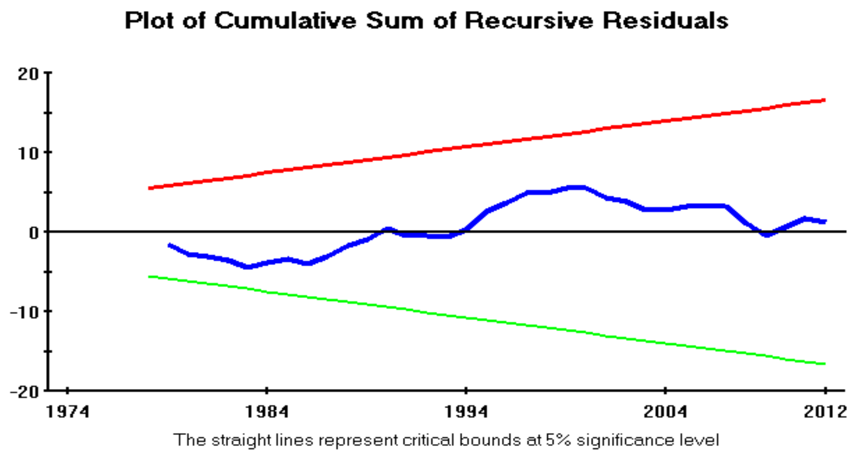
<u>Ireland</u> (model 14)



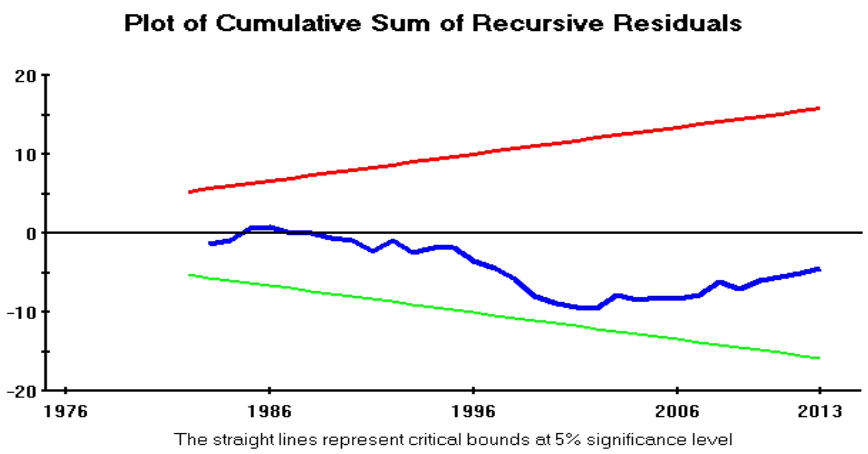
<u>Ireland</u> (model 15)



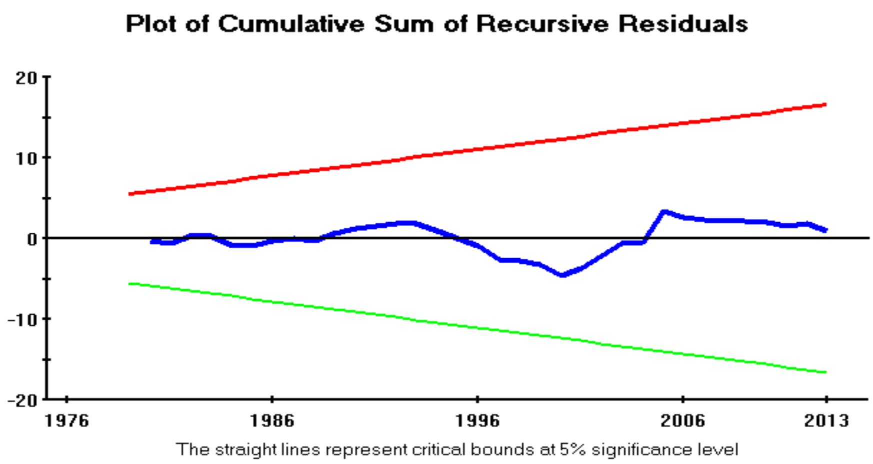
<u>Ireland</u> (model 16)



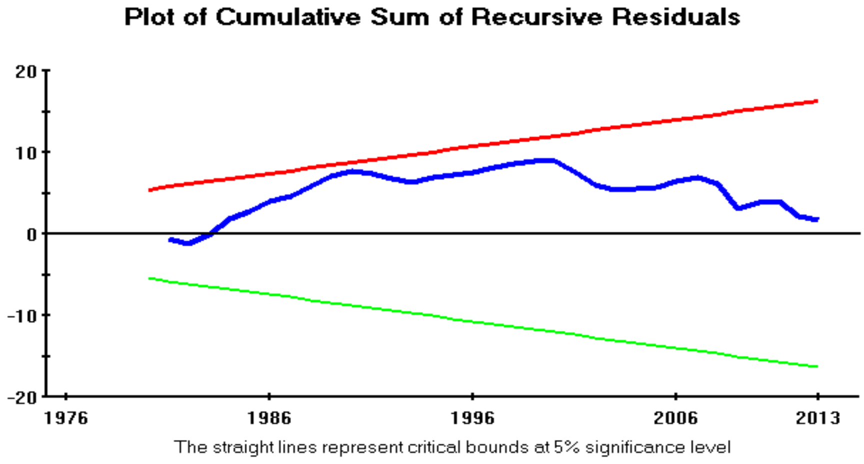
<u>Netherlands</u> (model 17)



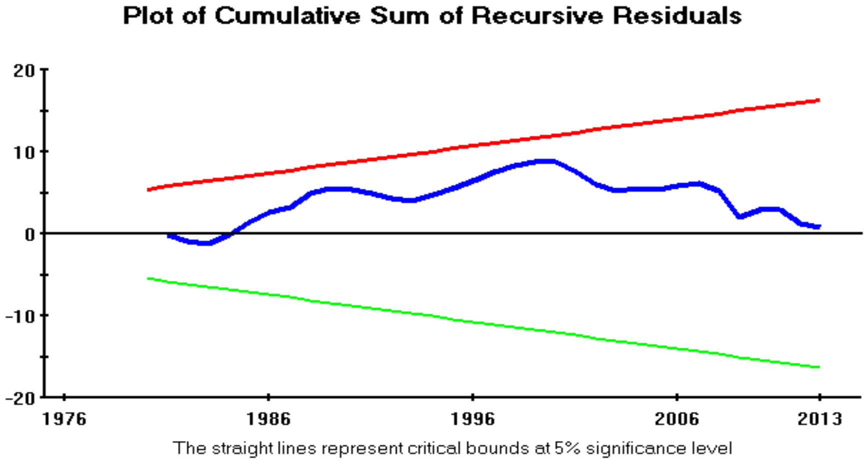
<u>Netherlands</u> (model 18)



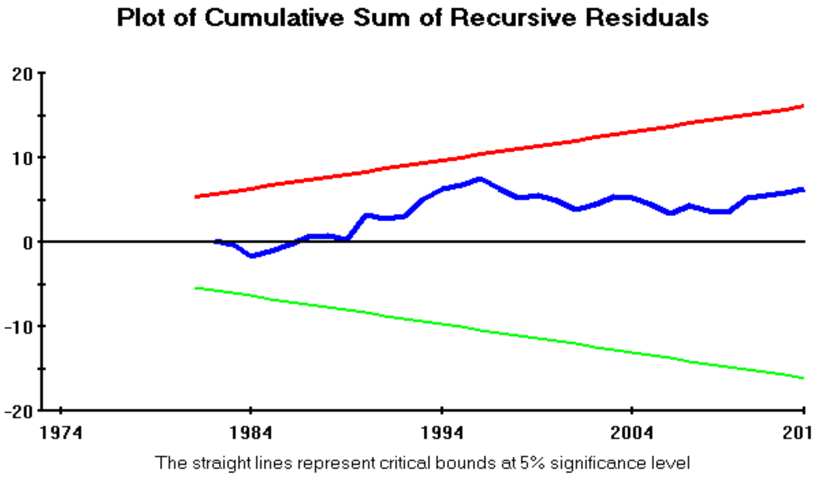
Netherlands (model 19)



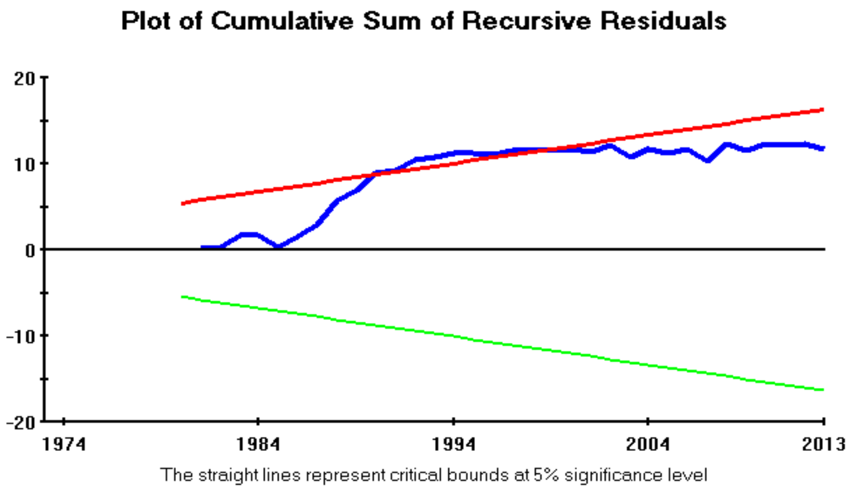
Netherlands (model 20)



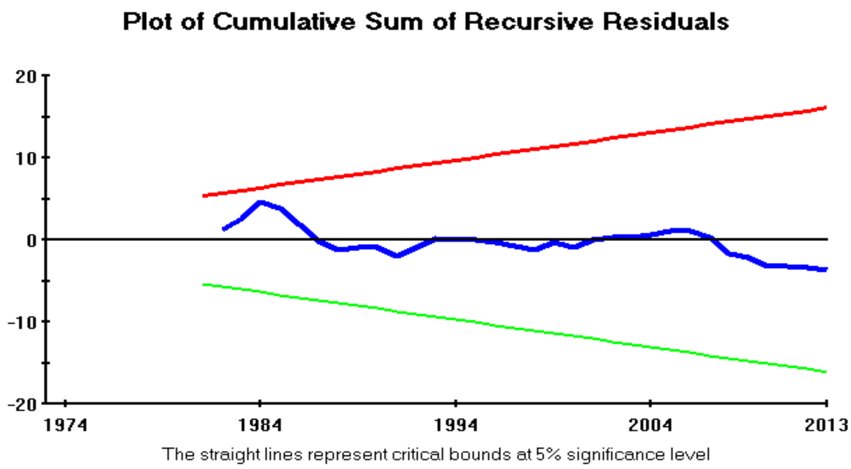
New Zealand (model 21)



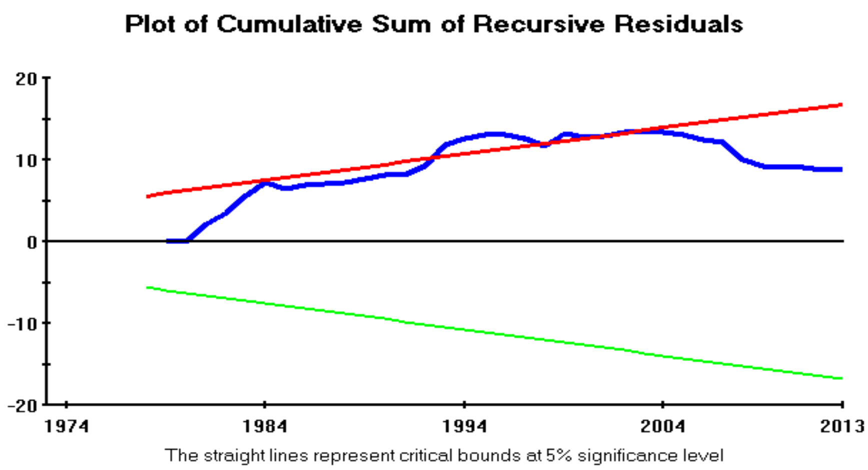
<u>New Zealand</u> (model 22)



<u>New Zealand</u> (model 23)

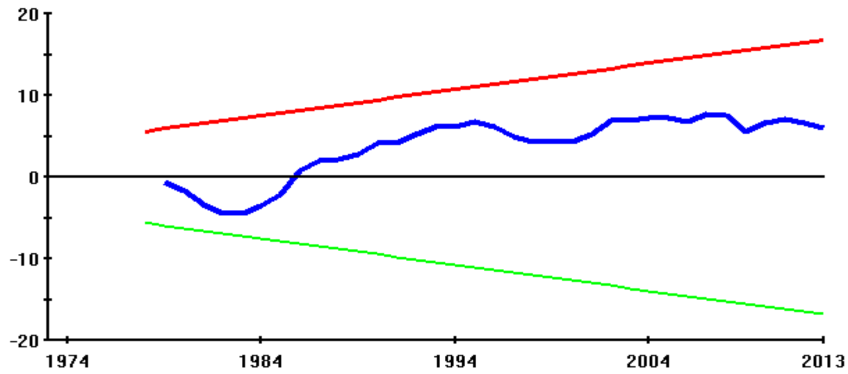


<u>New Zealand</u> (model 24)



Norway (model 25)

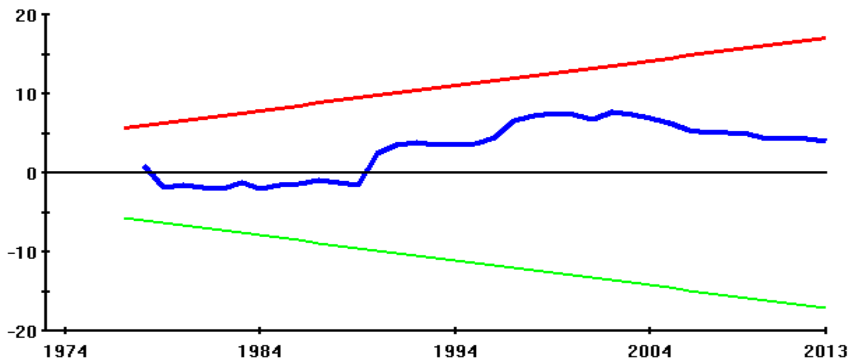
Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Norway (model 26)

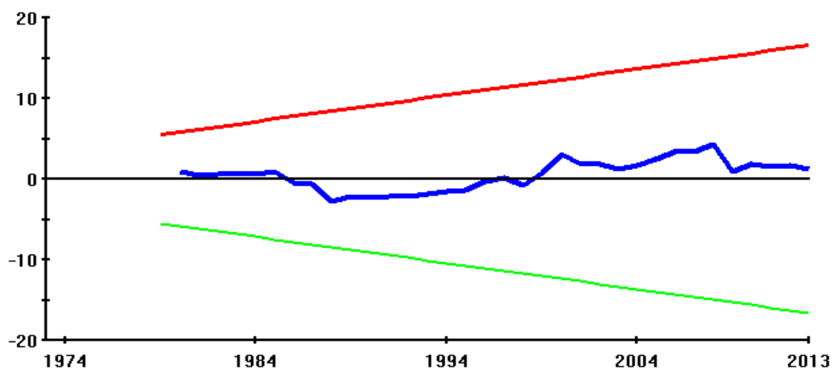
Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

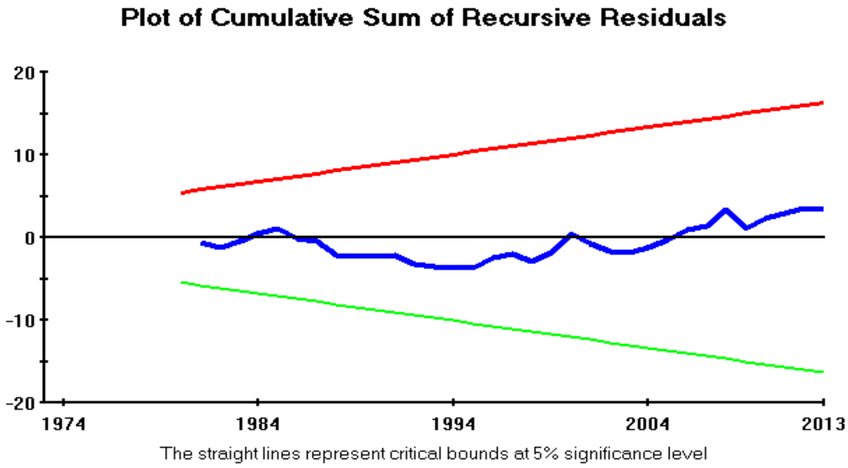
Norway (model 27)

Plot of Cumulative Sum of Recursive Residuals

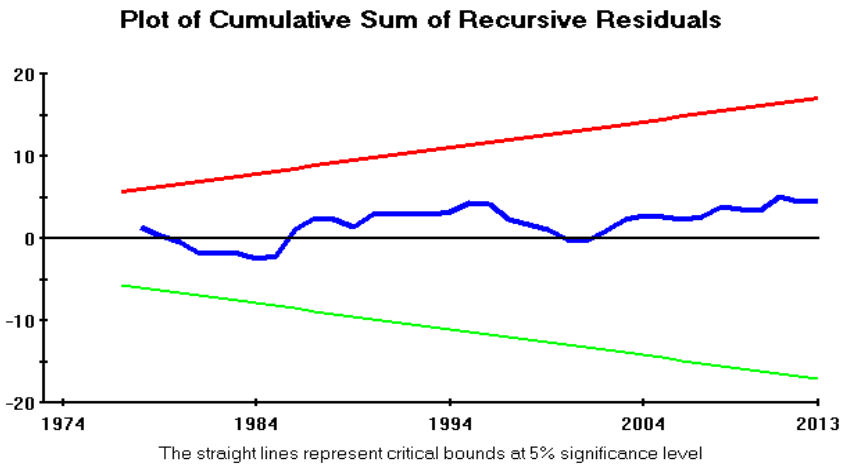


The straight lines represent critical bounds at 5% significance level

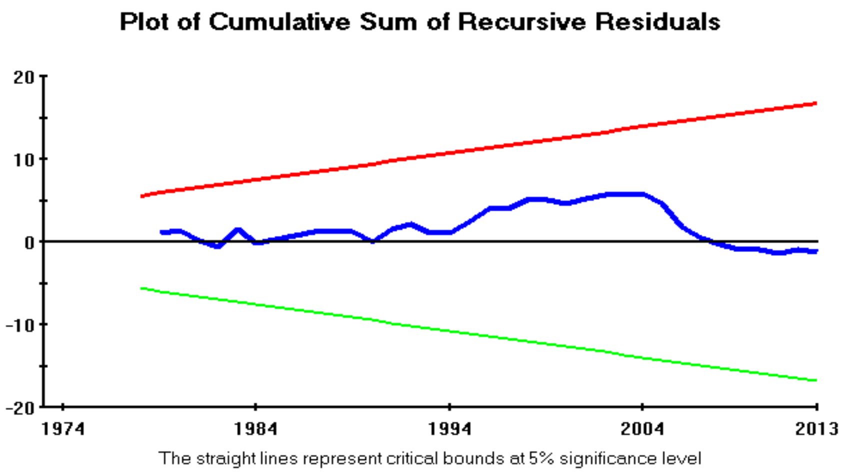
<u>Norway</u> (model 28)



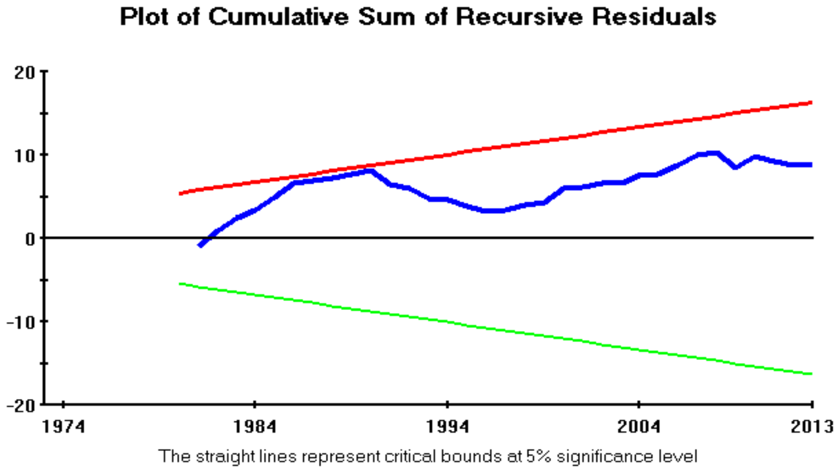
<u>Switzerland</u> (model 29)



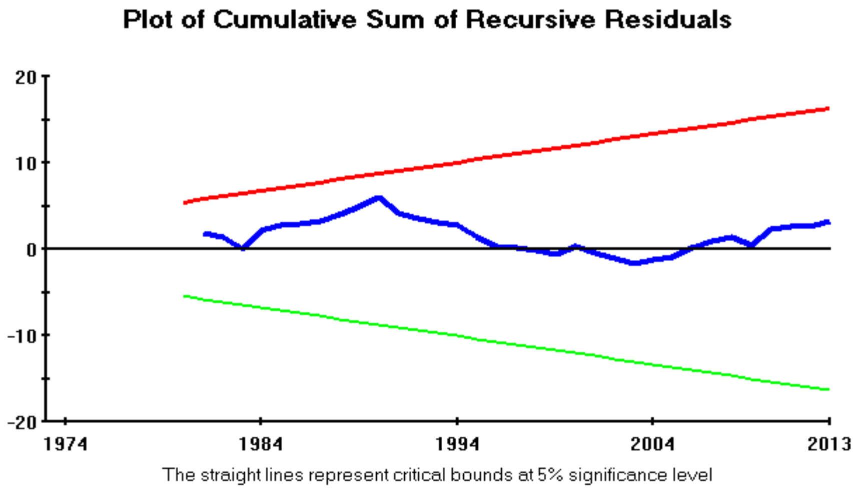
<u>Switzerland</u> (model 30)



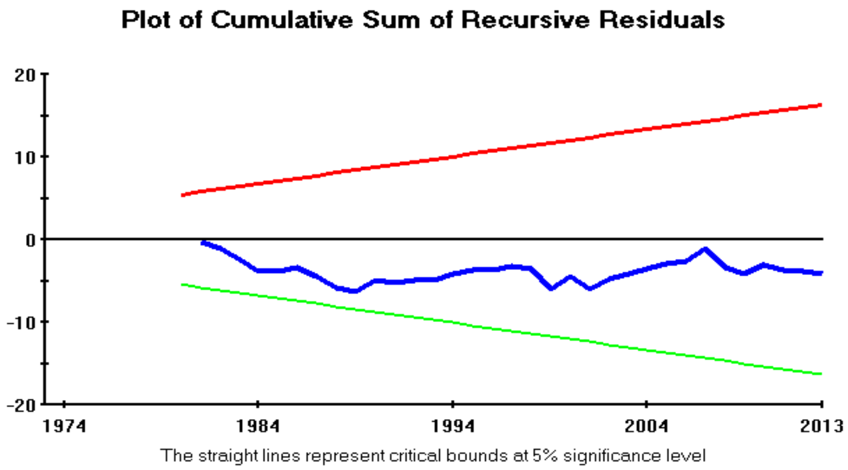
<u>Switzerland</u> (model 31)



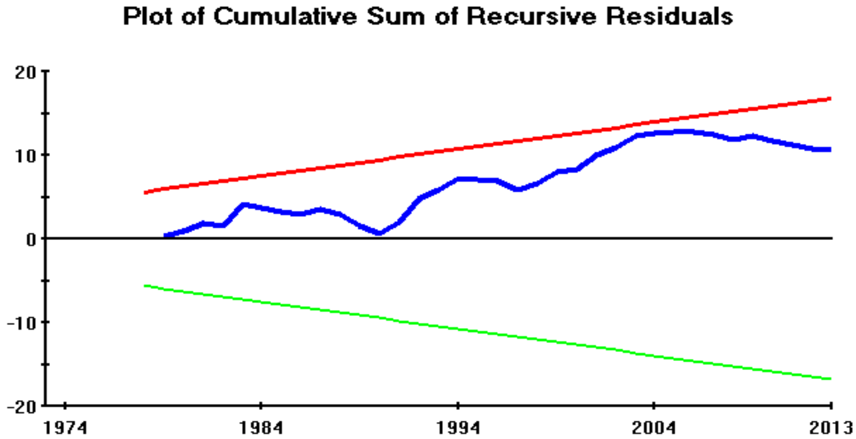
<u>Switzerland</u> (model 32)



<u>United Kingdom</u> (model 33)

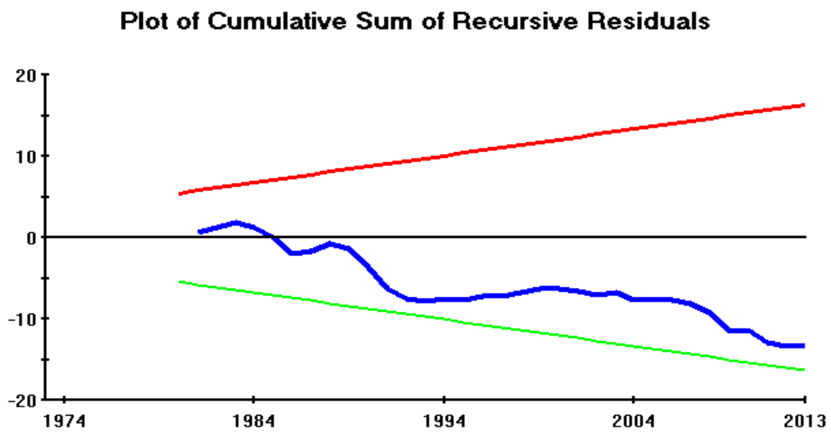


United Kingdom (model 34)



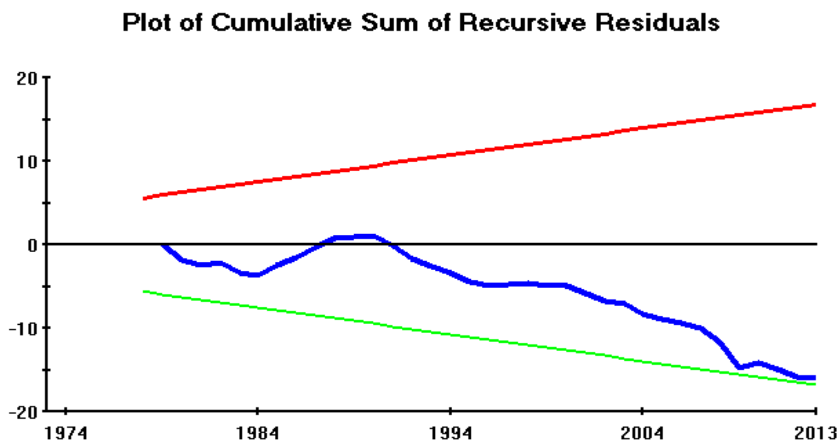
The straight lines represent critical bounds at 5% significance level

United Kingdom (model 35)



The straight lines represent critical bounds at 5% significance level

United Kingdom (model 36)



The straight lines represent critical bounds at 5% significance level