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Education Spending and Economic Growth: A Panel Data Analysis

Bachelor Thesis

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September 2015

The purpose of this paper is to investigate the short and long run relationship of education spending and economic growth through the medium of fixed effects panel data analysis. A review of the relevant economic theory and literature provides the basis for the theoretical foundations and assumptions made throughout the examination. The dataset comprises data of 11 OECD countries during a period of 41 years for 10 different indicators of economic growth.

Contents

1. Introduction

The positive relationship between education and economic growth is a common assumption in economics. With education representing one of the key drivers of human capital, it increases the productivity of labor, raises efficiency and increases the output of the economy. According to this train of thought, education is a clear driving force behind economic growth.

The idea that education results in economic prosperity and growth has been a common consensus among many countries. A result has been a strong focus on education policy, with large investments and a lot of public debates concerning the subject. As Article 26 of the Universal Declaration of Human Rights declares 'Everyone has the right to education' (United Nations, 1948), with basic education being free and compulsory for every individual. This basic right has been granted to most individuals living in more economically developed countries, with primary and secondary education almost having become a prerequisite. In 2012, the upper secondary level had been reached by 80.3% of the EU-28's population aged 20 to 24 (Eurostat, 2014).

As countries numbers of secondary level education graduates increases, more focus is put on tertiary education by governments and institutions. Education is one of the EU's 5 headline targets for 2020, where the goal of attainment levels of tertiary education is at least 40% of 30-34-year-olds. Quality assurance and employability are at the forefront of the policy developments the European Commission aims to encourage through this initiative (European Commission/EACEA/Eurydice, 2013).

With this continuing focus on education by both the public and politics also comes the continuous spending on education by governments, with both increasing numbers of individuals reaching higher levels of education and the increasing pressure to also increase quality of education across all levels, both driving up spending. One would assume that increasing spending on education would result in higher quality and a larger output. While this may be the case for some situations, the World Bank provides evidence that this is not the case (Hanushek & Wößmann, 2007), saying: "Simply increasing educational spending does not ensure improved student outcomes". The World Bank points to the lack of educational quality as one of the major factors why increasing spending on education would not result in higher human capital captured in economic growth values and finds little differences in the performance level by students of countries with higher or lower education spending. The incentives students and teachers receive in combination with the institutional structure are named as the most important factors for the improvement of educational quality, with educational quality being the important factor affecting economic growth through an increase in human capital (Hanushek & Wößmann, 2007).

While this evidence is contradicting to the commonly adapted notion that more spending on education is a good thing, this account focuses specifically on the indicator of student performance as a measure of successful investments in education through a rise in educational quality. With the World Bank giving the example that there is no strong positive relationship between spending on education and mathematical performance on the standardized test PISA in 2003 (Hanushek & Wößmann, 2007). It could be argued, that the measurement of educational performance through standardized testing, as for example the PISA test, do not provide a solid evaluation of educational quality and that there could hereby be some flaw in the argument that spending does not increase educational quality and human capital. A reason for this is that these standardized tests are an inaccurate reflection of what a student may have learned in class and is influenced by other factors, such as a student’s out-of-school learning activities and the already present native capabilities (Popham, 1999).

Furthermore, educational spending could affect economic growth though other channels than only the improvement of educational quality and infrastructure and its increase in performance on grade obtained in standardized test. Education has long been linked to improve other facets of society, with health representing one of the most important ones. Education affects health through numerous complicated mechanisms including social relations and other work, household and community contexts (Feinstein et al., 2006). Another interesting aspect of education is the awareness individuals have of education as an institution, where the learning content is pushed to the background and the aspect of status and socialization this signifies plays a dominant role (Meyer, 1977). Additional factors are, among others, voting, political activity (Milligan et al., 2003) and criminal activity (Lochner & Moretti, 2001), which are all affected by education.

It is this large influence of education on such varying facets of society that make it such an important contributor to the development of nations as recently demonstrated in the newly adopted Sustainable Development Goals (SDGs) by the United Nations (UNDP, 2015). The multi-facetted influences of education are meant to affect economic growth through the increase of human capital through numerous channels. With arguments both supporting spending on education and others calling for a reevaluation of these investments, it is interesting to look beyond indicators of the effect on individual's performance on standardized tests, but rather focus on the effect such spending may have on the entire economy.

In this context, the purpose of this research is to investigate the relationship between government expenditure on education and economic growth. As previously noted, both a European and worldwide effort has been taking place to increase the number of individuals obtaining education, as well as establishing a high standard of education all countries are to conform to (specific to Europe). Following this, determining whether higher expenditures and resulting higher enrollment and hopefully also increases the quality in education have actually benefited these countries' economies through economic growth is important for the countries future policy plans. Furthermore, spending on education, as analyzed here, falls under the category of public spending, paid for by the citizens of a country. The acceptance of education as a public good only holds so long as everyone can benefit from it. Such benefits may manifest themselves through the form of economic prosperity, providing benefits to more than just the students.

The research question essential to examine therefore is:

Does government expenditure on education influence economic growth?

In order to answer the above stated question, it will be broken down into more specific partial statements that will help reach an overall answer. In this case, a distinction is made between the effect and the relationship between education spending and economic growth. One way of approaching the research question is by looking at the imminent relationship between education spending and economic growth. Education spending, may, as further discussed in the literature, also be a reflection of different aspects of society and may hereby also reflect short term relationship of these two variables. This idea is formulated in the following hypothesis:

H1: Education spending is positively related to economic growth.

On the other hand, when considering the effect of education spending on economic growth, the channel through which this effect takes place is through the increase in human capital, which in turn causes higher labor productivity. Following this line of thought, it would be assumed that effects of expenditure are not direct but present themselves in the longer run, as individuals having benefited from the resources connected to education spending only enter the labor market after a while. As such, one hypothesis echoing this line of thought is:

H2: Education spending has a positive long-run effect on economic growth.

The assumption of both hypothesis of a positive, instead of a negative, relationship between the two variables under question is due to the fact that this notion is most established in research and theory. Confirmation of these notions would provide further reinforcement of these notions but also provide further incentive to delve deeper into different aspects of this relationship outside the scope of this research. Finding no evidence that there is indeed a positive relationship of some form between these two variables on the other hand may force reevaluation of theory and closer investigation of differences with previous research.

In order to provide a thorough contextual answer to the research question through empirical investigation of the two hypotheses, first, a framework of the theoretical ideas relevant to this paper shall be presented in the Theoretical Framework. Following this will be a demonstration of previous literature on the subject of education but also on the investigation of economic growth and its theoretical development. An elaboration on the relevant data and the methodology applied to this research shall ensue. Further components will include a presentation of the results with a discussion to the findings and concluding remarks.

2. Theoretical Framework

2.1 Economic Growth Theory

The theories forming the basis of the framework for most research into the topic of economic growth can be divided into two categories. While exogenous growth models are older and by some perceived as the frontrunners of the now more popular endogenous growth models in economic growth theory, both have contributed considerably to the topic of economic growth and shall therefore both be reviewed.

Exogenous Growth Models

One of the earliest economic growth models is the Harrod-Domar Model. Harrod established his theory in his work 'An essay in Dynamic theory' in 1939, as did Domar in his work 'Capital Expansion, Rate of Growth and Employment' in 1946 (Harrod, 1939; Domar, 1946). Although both developed their theory separately from each other, both employed the same basic principles and cornerstones in their theory, with the level of saving and the productivity of capital being the main variables present in these models.

Harrod summarizes his dynamic theory in two propositions. His first includes the assumption that the 'propensity to save', i.e., the saving rate and the 'quantity of capital required by technological and other considerations per unit increment of output' i.e. the productivity of capital jointly determine the rate of growth. The second proposition is that the rate of growth sets a 'unique warranted line', departing from this rate in the form of over-or under-production creates a greater chance of deviating further from the equilibrium growth rate set forward by this 'line' (Harrod, 1939). The saving rate plays a major role as it reflects the economies likelihood to invest resulting from policies and technological improvements; as the determination falls outside the scope of this model this variable is an exogenous variable. While Domar approaches the role of capital productivity with a stronger focus on its aspect of labor productivity, the general assumptions and approach are very similar to those of Domar; hereby both set the basis for the Harrod-Domar Model (Domar, 1946).

The major criticism to the Harrod-Domar Model was its use of fixed factors of production. The alternative Solow-Swan Model, also known as the Neoclassical Model, which was also developed independently by Solow and Swan and succeeded the Harrod-Domar Model in 1956, rectified its major criticism by including flexible factors of production. Its mathematical formulation through the help of the Cobb-Douglas production function is one of its attractive properties. Solow formulates the basis of his model in a simple manner 'output is produced with the help of two factors of production; capital and labor… technological possibilities are represented by a production function' (Solow, 1956). Solow hereby assumes that the long-run rate of growth is determined exogenously by technology, more specifically, its rate of growth. The Harrod-Domar model, in contrast, appoints the saving rate as the exogenous factor driving the long-run economic growth rate.

While the role of education does not seem very apparent in these models at first glance, it is indeed present in a more indirect manner. One could say that this role could be reflected through the productivity of capital, specifying human capital in this context, in the Harrod-Domar Model and the labor productivity in the Solow-Swan Model. With human capital and labor both being factors determined in part by education, one can see how even these relatively basic models resonate with the idea that education and hereby its spending on it effects economic growth. Even though this concept can be deducted, there remains an absence of specification to what the most significant sources of economic growth are, with technological change representing the only specification. Resolving this issue was central in the expansion of growth theory to 'modern growth theories'.

Endogenous Growth Models

While exogenous Growth Models are most criticized due to their lack of specification of exogenous variables, which leave their nature and connection within the model often unexplained, endogenous Growth Models aim at eradicating this ambiguity. While exogenous growth model's steady state long-run growth rate is attributed to technical change, the endogenous growth model points to more specific factors influencing economic growth, making them interesting for policy (Ickes, 1996).

The endogenous growth models are said to be a product of the 1980's, their development where often influenced by earlier work on the topic. Kaldor's 'stylized facts', which were aimed at explaining statistical tendencies of economic growth, were an early opposition to the earlier discussed more classical views (Kaldor, 1957). Other significant earlier influences include, amongst others, Kenneth J. Arrow (1962), Eytan Sheshinski (Sheshinski, 1967) and Hirofumi Uzawa (Uzawa, 1965).

A major contributor to the foundation of endogenous growth theory, also sometimes named the founder of this branch of growth theory, is Paul Romer. A central aspect, differencing his findings from previous research, is the consideration of increasing returns of production inputs and their role in the model of long-run growth (Romer, 1986;Greiner et al., 2005). Another aspect was the reference to externalities, an idea previously developed by Arrow, who argued for the positive spillover effects of knowledge production (Arrow, 1962). Romer departs from the previously assumed principle of diminishing returns and offers an alternative approach in which rates of investment and return on capital increase with capital stock. While exogenous growth theory focuses on the convergence of growth rates to a so called 'steady state' rate, this concepts rejects the idea of convergence by distancing economic growth paths from "any kind of exogenously specified technical chance of differences between countries" (Romer, 1986) (Romer,1994). Romer assumes the accumulation of knowledge as capital form explaining changes, with its three components, externalities (as external effects of newly created knowledge by one individual), increasing returns in production (as there a no bonds to the accumulation of knowledge) and decreasing returns in production of new knowledge (as investments will not produce the same quantity of new knowledge) playing a central role. These components are the basis for Romer's 'competitive equilibrium model of growth'. The idea of including marginal productivity of physical capital as well as the factor knowledge, used exclusively in this model, is not excluded by Romer. However, no such extension is included although encouraged (Romer, 1986).

While Romer main focus is on the growth of knowledge, the economist Robert Lucas put his focus on the aspect of human capital. He uses the standard neoclassical model developed by Solow and extends it focusing on human capital accumulation, reasoning that this affects both labour and physical capital productivity. The types of capital (physical and human) are hereby reduced to only one in this model, which is based on the constant marginal returns to human capital (Lucas, 1988).

Sergio Rebelo is another significant contributor to endogenous growth theory, his approach aims at investigating the disparity of economic growth rates across countries. Looking at the different government policies across countries, Rebelo tries to link these differences to the equally heterogeneous growth patterns in countries. An interesting aspect in this regard is the focus on taxation and its effect on growth rates, the reason given for this focus is the difference in tax policies between countries, which may provide further evidence on the effect of other policies. The author uses a simple linear model to investigate growth as this is considered as "a natural benchmark in terms of thinking about the growth process" (Rebelo, 1990). This simple linear model, also known as the AK-Model, form the theoretical foundation for many investigations of economic growth or the effect of different variables on economic growth. The model will be discussed more explicitly in the upcoming section.

All the contributions discussed up till now are all relevant for the understanding of the development of growth theory, although many incorporate aspects of human capital, less delve into the more specific roles. As education and particularly education spending is the point of focus of this paper, relation of this aspect to relevant economic growth theory is particularly applicable. Robert Barro investigates this relationship with the help of a model combining aspects of the above mentioned literature. With his view of the different endogenous and exogenous models being “more complementary than they are competing”, he develops a model incorporating the useful characteristics of both (Barro, 2001, 2013).

The convergence principle of the neoclassical model states that higher levels of growth will be achieved by economies with lower starting levels of real gross domestic product per capita. A country further below the steady state would in this case experience higher growth levels than a country closer to this level. Barro points out that this notion is only applicable if the economics are equivalent, any difference means that this notion of convergence can only apply conditionally. The empirical consistencies of this property make it an important aspect in Barro’s framework. With the main criticism of the neoclassical model being that one of its main elements is the exogenous variable technological progress, this shortcoming is rectified by also addressing the newer endogenous theories focusing on a mixture of physical and human capital. These theories particularly introduce the government’s role through its actions and their consecutive effect of long-term growth, as R&D theories (Grossmann & Helpman, 1991) and the idea of imperfect competition via spillovers play a major role in determining economic growth (Barro, 1996).

A contradiction in Barro’s framework is the combination of the neoclassical theory, which supports the idea of a diminishing growth rate, and the endogenous growth models that support growth at a constant or even increasing rate. This theoretical contradiction is not addressed in Barro’s work.

2.2 The Model

The framework used in this analysis follows Barro's framework (Barro, 1996), which is a derivation from an extension of the neoclassical growth model. This extension incorporates the previously described aspects of both the endogenous (neoclassical) growth model and the endogenous growth model.

The model is summarized by the following equation:

$$(1) \qquad Dy = f(y, y^*),$$

With the different variables being defined as the following:

Dy: growth rate of capital per output

y: current level of per capita output

*y**: long-run or steady-state level of per capita output.

The steady-state level of y^* represents the notion of convergence to this particular steady-state level of output (y^*). As a result, the growth rate (*Dy*) will rise if the steady-state level increases of fall if it decreases (assuming the current output level, y, is below the steady-state level, y^*). Increases in the steady-state level y^* are accredited to improvements in government activities related to business or changing demographic patterns allowing growth to rise. Such improvements could include the reduction of inefficiencies such as corruption or high corporate taxes of a lower birth rate inducing a larger saving rate in households. The steady state level y^* increase then results in an increasing growth rate, *Dy*, as a transitional form of adaption to the new steady-state level. Eventually, the characteristic of diminishing returns will return the growth rate, *Dy*, to the level driven by the long-run technological process (not as exogenously defined in the neoclassical model). In the neoclassical setting, the model would credit the long-run growth rate of *y* to the exogenously determined level of technological change. In this framework however, the endogenous model's view of output, *y*, encompassing per capita product of both physical and especially human capital is applicable. As such, the inputs to the production process include physical capital and human capital, as well as more permanent inputs to the production process. The long-run technological change is a rate determined by human capital (or 'knowledge) and its effect on physical capital as discussed by Romer (1986) and Lucas (1988).

Barro's (2013) economic growth's determinants can hereby be divided into two categories. On the one hand, there is the long-run 'natural' growth rate determined by the long-run technological change, which is, according to newer endogenous growth models, based on human capital (i.e. knowledge). The other component of the growth rate is a result of changing government policies and also, as conferred by empirical findings, often manifests itself through a long-term effect on economic growth. As such, isolating these two determinants is challenging as these appear in the same long-term form (Barro, 2013).

The aim of this paper is to investigate the relationship between education spending and economic growth, isolating the effect of government spending on education is therefore imperative. In order to do so, different determinants of economic growth will have to be included in the analysis to allow for a proper isolation of variable relevant for this research. These different determinants are included in this empirical investigation through a number of different independent variables introduced to the regression equation forming as part of the empirical model presented in the methodology section of this paper. Many variables are similar to those Barro (2013) uses in his investigation of the relationship between education and economic growth, they include variables reflecting health, education, wealth, government expenditure and trade policies and activities; the dependent variable being that of economic growth of per capita GDP and the independent variable of interest being education spending.

3. Literature

Before investigating the relationship between education spending and economic growth, it is important to both understand the theoretical background that has established the link between economic growth and education and review previous empirical findings relevant to this topic.

3.1 Education Spending

This paper examines the relationship between education spending and economic growth in order to investigate the effectiveness of spending in an economic sense. While determining the different factors affecting education spending is therefore not the central issue, it is important to provide some logical foundation and background on this topic.

Early research on education spending points to several factors representing its major determinants, including demography, the political climate, economic resources and religion (Castles, 1989). More recent discussion on the topic divides the factors influencing education spending into different categories and more specific variables; such as socio-economic variables (GDP per capita, share of young in population) institutional variables (overall public social spending, fiscal policy authority, tax revenues, privatization levels) and partisan factors (level of rightist parties, conservative government participation) (Busemeyer, 2007). These variables point to the strong influence of the political climate and its resulting policies. While this is the case, Busemeyer (2007) also notes that there is “a more or less constant demand on public funding”, specific to education. The reason given is that a large part of education spending of OECD countries is dedicated to primary and secondary education, whose wide acceptability and notice of importance make them a public expenditure not easily changed (Busemeyer, 2007).

3.2 Education and Economic Growth

There have been comprehensive studies investigating human capital’s and more specifically education’s role in economic growth. Several of these studies find a positive relationship between education and economic growth, particularly the early stages of education display a positive effect on economic growth (Barro, 2013; Keller, 2009). Case studies in Guatemala (Loening, 2005) and India (Self & Grabowski, 2004) show that primary education is the most important of the three categories, followed by secondary education.

In this regard higher education seems to be a less ground breaking in its contribution to economic growth than primary education or secondary education. It is therefore not surprising, that in less economically developed areas, such as the continent of Africa, the main focus of development through education lies on primary and secondary education. The logic behind this idea is that investments in tertiary education are of little benefit if there are not enough students that have acquired the necessary preceding primary and secondary education. A shift in focus has recently been occurring, with more countries acknowledging the developments tertiary education can bring (Bloom et al., 2014), with tertiary education being defined as a tool to catch-up on other countries technologically and output wise (Bloom et al., 2006). The need for an alternative approach to implement higher education in an area that is culturally and economically much less knowledge- and education-based has also been acknowledged (Montanini, 2013).

Other studies investigating Tertiary Education produce similar results. Such as a study from Aghion et al. conducted in the United States, which found that all states see a positive effect on growth by investing in ‘four-year-college-type-education’ (Aghion et al., 2009). A different result is found for a two-year-college-education, which does not yield any benefit to economic growth in any state. An explanation for this is that this investment ‘crowds out’ equal or higher benefits that spending in other sectors or types of education would have brought. This raises the question whether there may be a threshold level of education or investment in education which is optimal.

The overall consensus is that investments in education positively affect output and economic growth. It is therefore no surprise, that spending on education is seen as a priority for many countries. A more recent discussion has put this assumption into question. As explained in the previously mentioned article, higher education is not found to benefit economic growth in all cases (Aghion et al., 2009). As such, the basis on which public expenditures for education are made may not lie on such a strong foundation as often assumed. The question arises, whether these expenditures are actually legitimate in the case that they do not contribute in a positive way to a countries economy. If not the case, spending and the utilization of spending should be re-evaluated. If they do, the nature and dynamics of the relationship between governmental spending on education and economic growth is still of great importance and should be investigated.

4. Data

In order to answer the research question, data has been compiled from three major recognized data sources, the UNESCO Institute for Statistics, the OECD and the World Bank[1].

The type of data used in this investigation is panel data. Panel data combines the characteristics of time-series and cross-sectional data into one, making it a multidimensional dataset. As such, important aspects of panel data include the number of observations *(n)* on differing individuals (ranging from $i=1,\dots,n$) observed over the same time at equal intervals, with T denoting the times the data set is observed. Unfortunately, some countries have incomplete data for some of the variables used in this analysis, making this panel unbalanced. In order to resolve this issue, some variables have been excluded from the analysis and some gaps in the data have been interpolated, by which a gap of one or two data points have been filled by the previous year's figure in order to prevent the software (STATA) to exclude that particular variable or country from the analysis on the grounds of incompleteness. Another characteristic of this dataset is that it follows the same individuals (countries), making it a fixed panel. As such, the dataset under investigation is a fixed and balanced (if interpolated) set of panel data (Greene, 2011).

This particular dataset comprises data of 11 countries over a time span of 41 years; from 1971 to 2011. As this also paper investigates the long-run relationship between education spending and economic growth, a data panel of a long time series is imperative in order to make any proper investigation into the long-run relation. This prerequisite forms a restriction on the countries that can be investigated, as data is not available for the different variables fundamental for this investigation for every country. As such, the selection of countries is largely based on the availability of the relevant data. The 11 countries evaluated in this paper are: Austria, Canada, Finland, France, Great Britain, Ireland, Israel, the Republic of Korea, the Netherlands, Norway and Portugal.

All countries are current members of the OECD, as the member countries of this organization are counted are being among the most developed and emerging economies in the world, the drawback of great heterogeneity among countries in panel data analysis may be less of an issue (OECD, 2015). However, problems such as measurement error remain and the tools and definitions used to assess variables may differ even among OECD countries.

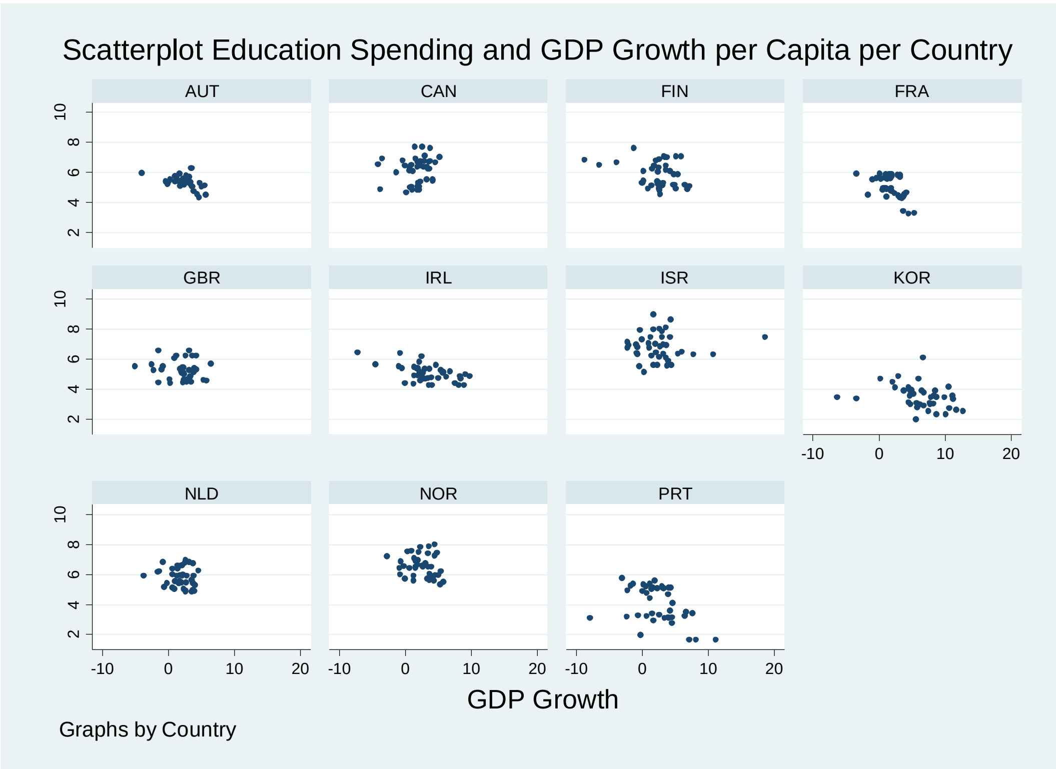
[1] (UNESCO Institute for Statistics, 2015), (The World Bank, 2015) (OECD, 2015)

4.1 Independent Variables

Barro (2013) provides a selection of different independent variables considered as important contributors to economic growth. The independent variable of interest is education spending, reflected by the annual % of GDP Government spends on education per country for 41 years. This variable of interest will be included in the model in two versions, in its original form to look at the short run relationship and in different lagged forms to investigate the long run relationship. While the dependent variable is economic growth, which is given by GDP per capita growth as an annual percentage, there are other independent variables included in the analysis.

A first look at the relationship between the dependent variable and the independent variable is given by the individual country's scatterplots in *Figure 1.* While no linear relationship can be identified, as no clear line connects the data points, most countries show a concentration of most data points in one particular area. Norway, for example, shows a very compact concentration of these data points while most other countries display several outliers.

Figure 1: *Scatterplot of GDP per capita growth (annual %) and Government Expenditure on Education (as annual % of GDP) per country*



The previously presented scatterplot does not provide evidence for a clear positive or negative linear association between GDP Growth and Education Spending, it does however not rule out the possibility of some correlation between these two variables.

As illustrated in *Figure 1.01 and 1.02* in the Appendix 8.1, further observations on these variables include their apparent difference in yearly fluctuation, which is experienced far stronger by GDP Growth than by Education Spending. GDP Growth trends are also more similar between countries than education spending trends are. The reason for this could be the strong interdependence between countries' economies; a good example is the economic crisis, which sharply decreased all countries GDP growth rates in 2008 and 2009 (see *Figure 1.01*). A further interesting aspect, is that there seems to be a convergence of the levels of education spending per country, with countries with high education spending (such as Israel, Norway and Canada) and countries with much lower education spending rates (such as Portugal, the Republic of Korea and France) in the 1980's decreasing and increasing, respectively, over the years.

All further independent variables included in this analysis are part of the World Development Indicators, a broad set of principle indicators of development compiled by the World Bank. The indicators used in this analysis can be distinguished between socio-economic and human capital indicators.

Socio-Economic Indicators

- The *level of GDP per capita* measures the total output level of a country's economy relative to its population. This indicator is often used to measure the total well-being and level of development of a country as it reflects the total production and income of per head (UN, 2015). As can be seen in *Figure 1.03* in the appendix, GDP per capita of the countries included in this analysis has experienced a relatively steady upward trend for most countries.
- *General government final consumption expenditure as % of GDP* includes the individual country's government expenditure figures for goods and services, also including expenditure of defense and security. Like the level of per capita GDP, general government consumption is also taken from the World Development Indicators (The World Bank, 2015).
- *International Openness*, also known as Trade percentage of GDP gives the sum of trade (exports and imports) of goods and services as a percentage of GDP, this figure is also known as the openness ratio.
- The *inflation rate* indicates the annual percentage rise in the cost of acquiring a basket of goods and services; it is a reflection of the actual purchasing power of a unit of a

currency. The inflation rate affects an economy in several different ways and is also an indicator of development and a reflector of stability within an economy.

- The *fertility rate* indicates the total number of births per woman, assuming that she were to live until the end of her childbearing years. A lower fertility rate usually reflects a more economically developed society, where cultural, socioeconomic and religious changes have caused for a decrease in the rate of children born.
- The *investment ratio*, also known as gross capital formation as percentage of GDP, displays the change in the level of fixed assets of the economy as well as the changes in inventory levels.

As can be seen in the *Figures 1.01 to 1.08* in the appendix, most indicators show similar trends between countries. Only the indicator International Openness lacks this characteristic and also shows a greater fluctuation over the years that the other indicators (*Figure 1.05*). The similar trends between counties of these World Indicators may be the result of similarities between OECD countries, such as societal, cultural and political similarities, which are often complementary for countries of similar levels of economic development.

Human Capital Indicators

This analysis uses different dimensions of human capital as indicators. The human capital indicator reflecting the education of a country is its *quality of schooling*, which is measured by its *pupil teacher ratio*, a measure of the number of pupils enrolled in primary school divided by the number of teachers teaching at the primary school level.

Further indicators of human capital include health indicators, such as *life expectancy at birth*, a reflection of the number of years a newborn is expected to live following the mortality pattern at its time of birth, or the *infant mortality rate*, which gives the number of infant deaths (before reaching a first birthday) per 1,000 births in a year (The World Bank, 2015).

The health indicators used in this analysis display similar characteristics as the previously described socio-economic trend rates. As presented in *Figure 1.10 and 1.11* in the Appendix 8.1, the indicators appear to be relatively steady, without large fluctuations during the years, and show a steady trend to which countries seem to be converging. Life expectancy shows and increasing trend (*Figure 1.10*) and the infant mortality rate a decreasing trend (*Figure 1.11*). The Quality of schooling indicator on the other hand provides a less clear picture as there are considerable fluctuations, compared to the other variables. However, one can still identify a slight downward trend.

4.2 Summary Statistics

The dataset includes 451 observations for all variables, besides the educational quality variable, with 41 per country for all 41 years (see *Table 1.1* in Appendix 8.2). Due to data problems and particularly incompleteness, Switzerland, Pakistan and Hungary where excluded from the original dataset, as well as the variables *rule of law*, *terms of trade* and *years of schooling*. The variable representing the quality of schooling is also incomplete (less than the other variables) and therefore only partly used in the analysis.

Before proceeding to the Methodology and the eventual analysis of the data, a few tests and diagnostics are performed on the data to investigate its validity and suitability for further analysis. A first investigation is made into the stationarity of the for this analysis relevant variables.

Unit Root Tests

Stationarity is both a tool and an assumption used to evaluate data. A time-series is stationary, if it reverts to a set mean and variance, without following a trend or altering over time. The importance of stationarity of data lies in the danger of receiving regression results that are significant although these are unrelated to the nonstationary series (Hill et al., 2008).

The most common unit root test for stationarity in time series data is the Dickey-Fuller test. An issue with this unit-root test is that it is frequently not able to reject the hypothesis of a series containing a unit root for macroeconomic variables. The use of panel data unit root tests is more likely to find macroeconomic variables to be stationary and increases the power of the test (Hadri, 2000). While a panel data unit root tests is more applicable, particularly to this dataset, it is also more complicated and results in several difficulties when using these tests. These include the introduction of a substantial amount of unobserved heterogeneity, complications with the assumption of cross-sectional dependence, ambiguity surrounding the extent of the relationship when the assumption of a unit root is rejected and the concern of cointegration across and within groups (Breitung & Pesaran, 2005).

STATA provides a variety of different unit root tests for panel datasets with different characteristics. While these tests are named panel unit root tests, they are usually just an extension of the multiple time series unit root tests, such as the Dickey-Fuller test. The different panel unit root tests make different assumptions about the characteristics of the panel dataset, such as the composition of time and individuals, as well as other characteristics of the dataset. This paper uses the Im-Pesaran-Shin unit root test, which is based on the (augmented) Dickey-Fuller test and focuses on more heterogeneous panels and does not assume that the panel is balanced (Im, Pesaran, & Shin, 2003).

The Table 1 below summarizes Stata's output for the Im-Pesaran-Shin unit root test on all relevant variables excluding and including a trend. Including the 'trend' option in the analysis means that a linear time trend in included in the model. The null hypothesis states that all panels contain a unit-root, this hypothesis can be rejected for all variables accept for Government Consumption and International Openness. The Quality of Schooling variable does not provide any results due the incompleteness of the data. All variables that do not contain a unit root are considered stationary I(0) and their current form can be maintained during the analysis. The non-stationary variables I(1) need to be excluded from the regression model unless the variables are shown to be cointegrated or are changed to their first difference form, in which they do show stationarity.

Table 1
Im-Pesaran-Shin unit root test

Variable	*t-bar statistic*	*t-bar statistic including time-trend*
GDP Growth	-4.248**	-4.513 **
Education Spending	-1.893*	-2.256*
Log(GDP per Capita)	-2.313**	-2.318
Government Consumption	-2.318	-1.641
International Openness	-1.235	-2.344
Inflation	-1.749	-2.858**
Fertility	-4.651**	-3.576**
Investment	-2.253**	-2.631*
Quality of Schooling	Not available	Not available
Life Expectancy	0.132	-2.691**
Infant Mortality	-13.774**	-5.726**
∆(Government Consumption)	-10.501**	-10.202**
∆(International Openness)	-11.133**	-10.843**
(Education Spending)^2	-1.908*	-2.325**
H0: All panels contain unit roots	***significant at 1% critical value*	
Ha: some panels are stationary	**significant at 5% critical value*	

The non-stationarity problem can be resolved by taking the first difference of the variables containing a unit root and hereby converting these to stationary variables, in this case Government Consumption and International Openness. Two new variables, which are the first differences of the unit root containing variables, are generated. As can be seen in the above table, the first differences of these variables are stationary. As such, these transformed variables can be used for further investigation.

Multicollinearity

The issue of collinearity and multicollinearity reflect the proportional relationship between some or several of the independent variables used in a regression. The problem with such a relationship lies in the difficulty of determining or isolating the different explanatory variables effect on the dependent variable if these are correlated between each other. In order to exclude such a problem, a 'robustness check' is performed. This procedure includes measuring the correlation between the different variables and examining the behavior of the regression coefficients and their significance when including or excluding certain variables that show a high level of correlation with other variables.

As can be seen from the correlation *Table 2* below, the variable showing the highest correlation with other variables is Log(GDP per Capita). This variable is strongly correlated with the human capital indicators, including this variable from the regression may therefore result in some bias in the results. Both Quality of Schooling and Life Expectancy also show somewhat higher correlations with other variables.

Table 2: Variable Correlation Table

Variables	GDP Growth	Education Spending	Log(GDP per Capita)	Δ(Government Consumption)	Δ(Government Consumption)	Inflation	Fertility	Investment	Quality of Schooling	Life Expectancy	Infant Mortality
GDP Growth	1.000										
Education Spending	-0.383	1.000									
Log(GDP per Capita)	-0.332	0.409	1.000								
Δ(Government Consumption)	-0.240	-0.009	0.151	1.000							
Δ(International Openness)	0.042	-0.012	0.130	0.313	1.000						
Inflation	-0.062	0.260	- .238	0.024	-0.001	1.000					
Fertility	0.087	0.075	-0.493	-0.198	-0.105	0.362	1.000				
Investment	0.343	-0.469	-0.392	0.043	-0.042	0.002	-0.078	1.000			
Quality of Schooling	0.491	-0.563	-0.637	-0.082	-0.040	-0.065	0.311	0.300	1.000		
Life Expectancy	-0.381	0.504	0.922	0.095	0.110	-0.164	-0.371	-0.438	-0.678	1.000	
Infant Mortality	0.150	-0.348	-0.821	-0.130	-0.101	0.242	0.514	0.277	0.354	-0.769	1.000

It could be that some variables coefficients are not significant due to the correlation with the variable Log(GDP per Capita). The regressions are run with and without these variables, the results of which can be found in *Table 1.2* in the Appendix 8.2. Performing these checks showed that only the exclusion of the Quality of Schooling (2a) variable had an effect on the significance of the Life expectancy and International Openness variable coefficients and the Constant. Only excluding Log(GDP per Capita) did not change the significance of any coefficients. This suggests that the Quality of Schooling variable could be excluded.

5. Methodology

5.1 Empirical Model

One of the main reasons for using the panel is the large number of observations that come with a panel dataset due to its multidimensional characteristic, which allows it to include numerous observations for various individuals over a long period of time. The use of Fixed Effects allows a reduction in the bias of omitted variables in the analysis as unobserved time and country effects can be captured through this medium. Omitted variables are variables that are not observed in the dataset but still have an effect on the dependent variable (Wooldridge, 2010). In the case of economic growth, it is agreed that a vast variety of variables affect economic growth and capturing all these factors in a dataset is very difficult, this leads to the assumption of the existence of unobserved effects. A first formulation of this idea can be made through the basic unobserved effects model (UEM):

$$Y_{it} = \beta_1 x_{it} + \alpha_i + \epsilon_{it}\,, \qquad t = 1, 2, \dots, T;\ i = 1, 2, \dots, I \qquad \textbf{(1)}$$

Where Y_{it} is the dependent variable (*i* = entity and *t* = time) and x_{it} represents one independent variable with β_1 being its coefficient. α_i is the unknown intercept, also called the individual effect of the individual heterogeneity, it reflects the unobservable variable that explains the inherent differences between the different individuals, which are indexed by *i*. The last term, ϵ_{it}, is the error term capturing the 'idiosyncratic errors' or 'idiosyncratic disturbances'.

Fixed Effects Model

The fixed-effects model is a regression analysis model that focuses on the relationship between the dependent and the independent variables of different countries over time. Fundamental differences exist between all countries, some of which are unlikely to be reflected by the different independent variables used in the analysis. The fixed-effects model accounts for these differences through the inclusion of a constant term displaying these time-invariant characteristics, such as the term α_i in *Equations 1 and 2*. A correlation between the distinct terms reflecting the country's 'fixed' differences as well as the countries error terms should not exist.

If we extend the model to include the 10 independent variables that will be used for the purpose of this research, it takes the following form:

$$Y_{it} = \beta_1 x_{it} + \beta_2 x_{it} + \beta_3 x_{it} + \dots + \beta_{10} x_{it} + \alpha_i + \epsilon_{it} \qquad \textbf{(2)}$$

Where x_{it} is one of the independent variables, for example education spending, for *i* country at time *t*. The coefficient β_1 measures the effect of the independent variable on the dependent variable, Y_{it}, which in this analysis is economic growth. The effect size reflects the strength and the sign the direction of association between the independent and the dependent variable.

The previously mentioned components of the empirical model of this analysis include: dependent variable, independent variables and coefficients, fixed effects or more specifically 'country effects' and the error term. Next to the previously described 'country effect', which is particular to every country, the fixed-effects model also allows the inclusion of 'time effects'α_t. The following equation includes all the before mentioned components (including both country and time fixed effects):

$$Y_{it} = \beta_1 x_{it} + \beta_2 x_{it} + \beta_3 x_{it} + \cdots + \beta_{10} x_{it} + \alpha_i + \alpha_t + \epsilon_{it} \qquad \textbf{(3)}$$

While the fixed country effects manifest themselves through the country-specific intercept(α_i), the addition of fixed time effects (α_t) provides a comparison to the base period and reflect the contrast from one period to the next (Greene, 2011).

6. Results

This section will provide the results of the data analysis aimed at answering the following research question: '*Does government expenditure on education influence economic growth?'* An attempt at answering this question shall be given by focusing on the two partial hypotheses specifying the relationship to be investigated.

Short-Run Relationship

The first hypothesis states that education spending is positively related to economic growth. The focus in this statement lies on the short-run effect of the education spending on the economy. In this context, the theoretical approach would explain such an effect not through the human capital channel, but through the channel of investment and spending in the economy by the government, a far more direct channel. The fixed effect regression is performed on the previously described dataset with two varieties, once including and once excluding a time trend, as well as both including and excluding the independent variable quality of education. The results of this procedure are summarized in Table 3.

Table 3
Fixed Effects Regression

Independent Variables	*Country Fixed Effects*			*Country Fixed Effects and Time Fixed Effects*		
Education Spending	-.434*	-.509*	-4.362*	-.1226	-.1126	-2.488*
	(.179)	(.228)	(1.159)	(.166)	(.215)	(1.090)
(Education Spending)^2			.361*			.222*
			(.107)			(.100)
Log(GDP per Capita)	-.178	.510	-.174	-3.030*	-2.095*	-2.336*
	(.442)	(.566)	(.592)	(.746)	(.983)	(982)
Δ (Government Consumption)	-.364*	-.566*	-.609*	-.201*	-.136	-.179
	(.072)	(.102)	(.101)	(.068)	(.114)	(.115)
Δ (International Openness)	.001	.064*	.061*	-.070*	-.046	-.044
	(.014)	(.021)	(.020)	(.018)	(.026)	(.026)
Inflation	-.012*	.002	-.008	-.007	.000	-.006
	(.005)	(.006)	(.006)	(.005)	(.005)	(.006)
Fertility	-1.046*	-2.598*	-2.606*	-2.463*	-3.209*	-3.186*
	(.478)	(.657)	(.645)	(.576)	(.746)	(.740)
Investment	.115*	.146*	.152*	.169*	.217*	.211*
	(.039)	(.046)	(.0445)	(.041)	(.052)	(.051)
Quality of Schooling		.332*	.297*		.268*	.245*
		(.066)	(.066)		(.067)	(.067)
Life Expectancy	-.238*	-.103	-.023	-.400*	-.223	-.180
	(.113)	(.130)	(.130)	(.133)	(.163)	(.163)
Infant Mortality	-.018	-.015	-.095	.048	.077	.021
	(.044)	(.056)	(.060)	(.041)	(.057)	(.062)
Constant	24.148*	3.179	14.727	54.550*	27.397*	34.018*
	(6.343)	(8.233)	(8.779)	(11.400)	(15.405)	(15.576)
R^2	0.19	0.25	0.29	0.48	0.52	0.53

Dependent Variable: Economic Growth as % of GDP; * denotes significance at 5% level
The standard errors are shown in parenthesis. The variables Government Consumption and International Openness are given by their first difference.

Focusing on the output of the fixed effects regression excluding the time trend, the first apparent observation are the significant negative coefficients, -0.434 and -0.509, of education spending implying a negative relationship between education spending an economic growth, a similar result can be observed for government consumption.

The model with the highest R^2 is the model including the variables quality of schooling, as well as the year dummy used to for the time and country fixed effects regression. While the R^2 is generally considered as less relevant during the interpretation of the different coefficients, it does provide some indication on the accuracy of the prediction of the regression model, with a higher number indicating a better fit. The R^2 reflects which portion of the variation of the dependent variable economic growth is reflected by the independent variables. It is therefore logical that the inclusion of an additional variable and time dummy variables gives a more accurate prediction.

Looking at the time fixed effect regression, we find somewhat different result concerning the independent variable of interest of education spending, the coefficient being insignificant and smaller, -0.113. Again, the variable government consumption behaves similarly as for the fixed effect regression without a trend, possibly reflecting the similarities, as both of these variables are components of the public budget. Independent variables with significant negative coefficients include GDP per capita and fertility, a significant positive coefficient of 0.217 is estimated for investment.

A further extension, used as an additional robustness check and an investigation into the exact nature of the relevant relationship between education spending and economic growth, is the addition of a squared education spending variable next to the education spending variable itself, as can be seen in *Table 3.* A reason for this addition is that the scatterplot shown in the data section does not provide sufficient evidence of a linear or other form of relationship between the two variables, giving rise to the idea that the relationship may not be a linear one. As presented in *Table 3*, the inclusion of a squared education spending term in the regression gives two significant coefficients. While the coefficient for education spending itself is negative, the coefficient for its quadratic equivalent is positive. This means that the relationship between education spending and economic growth is not linear but quadratic and presents itself in a parabola U-shaped form. In an economic context, the interpretation of the relationship is the following: while at a very low level, education spending is negatively related to economic growth; as the level of education spending increases however, after reaching a certain threshold, the effect becomes positive. The global minimum of the parabola reflecting this relationship and representing this turning point is the point after which economic growth is positively affected by education spending. This information does not coincide with the proposed first hypothesis of positive relationship.

If indeed correct, this finding means that when focusing only on education spending's contribution to economic growth in the short run, such an investment would only be effective over the threshold level. Any spending below this threshold does not positively but even negatively affect economic growth by for example. A closer investigation of this threshold level for every individual country could provide more explanation as to the context or reason behind this relationship; such an investigation goes beyond the scope of this paper.

Long-Run Relationship

While *Table 3* provides an overview of the regressions aimed at investigating the first hypothesis, *Table 4* gives a summary of the results of the regressions run in connection with the second hypothesis. The relationship between economic growth and education spending, according to literature and theory, may not be direct or in the short run, but rather only become apparent in the long-run. The response to this is the use of several 6 lags separated by 5 year spans; the result of this approach is summarized in *Table 4*, which provides an overview of all the regressions with the different lags both including and excluding country and time fixed effects[2]. A simple linear regression is included next to the fixed effect regressions to investigate the possibility of the lagged education spending variables being included in the country fixed effects; this would results in an inaccurate depiction of the relationship. While the figures of these coefficients are indeed different, -.143 and -.132 for the 5-year lagged education spending coefficient in the simple linear and country fixed effects regression, they do not differ too meaningfully, just as for the further lags.

A first look at the different coefficients estimated for the lagged education spending variables of the time fixed effects regression allows the identification of a changing relationship with economic growth over time. The coefficient describing the relationship between education spending and economic growth changes from negative to positive over the years.

[2] The investigation into the non-linear effects of education spending by inclusion of a squared education spending term in the lagged regressions did not provide sufficient evidence of a non-linear relationship.

Table 3
Regressions with lags

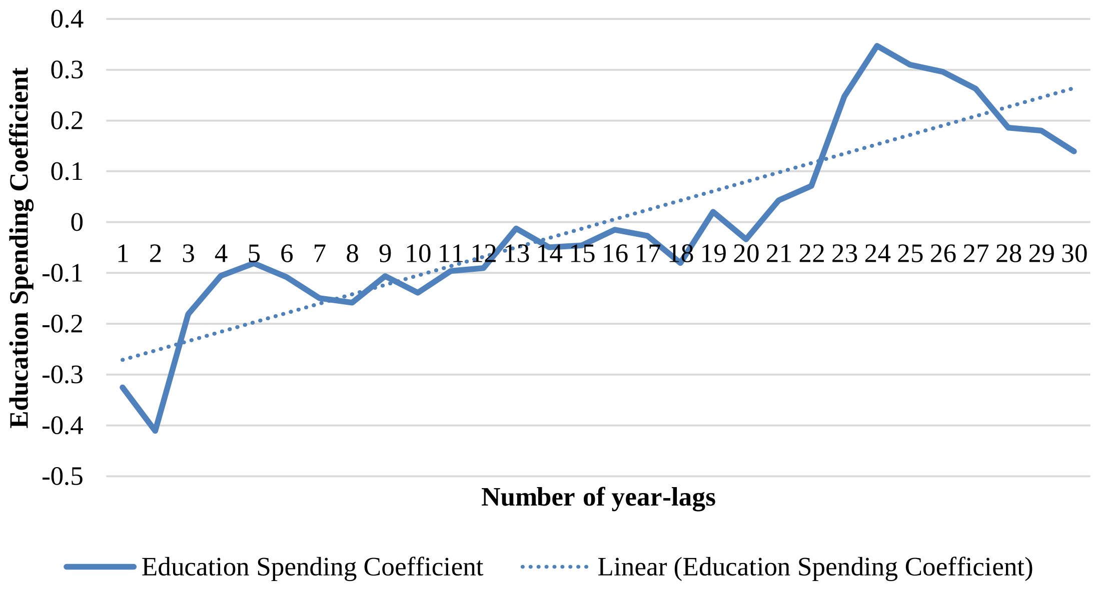
Independent Variables	Simple Linear Regression						Country Fixed Effects Regression						Fixed Effects Regression including Country and Time Fixed Effects					
Lag5 Education Spending	-.143 (.142)						-.132 (.155)						-.080 (.146)					
Lag10 Education Spending		-.268 (.137)						-.193 (.146)						-.139 (.135)				
Lag15 Education Spending			-.179 (.148)						-.112 (.166)						-.046 (.152)			
Lag20 Education Spending				-.036 (.163)						-.011 (.193)						-.034 (.185)		
Lag25 Education Spending					.127 (.159)						.291 (.205)						.310 (.187)	
Lag30 Education Spending						.029 (.154)						.054 (.207)						.140 (.190)
Log(GDP per Capita)	.181 (.461)	.205 (.469)	.247 (.486)	.101 (.497)	.082 (.498)	.048 (.527)	.730 (.561)	.721 (.562)	.803 (.566)	.779 (.575)	.746 (.569)	.723 (.620)	-2.102* (.990)	-1.983 (1.024)	-2.149* (1.008)	-2.156 (1.025)	-2.374* (1.011)	-2.501* (1.037)
Δ (Government Consumption)	-.583* (.104)	-.588* (.105)	-.587* (.106)	-.580* (.107)	-.577* (.107)	-.593* (.106)	-.561* (.104)	-.565* (.105)	-.566* (.105)	-.567* (.106)	-.547* (.106)	-.577* (.106)	-.126 (.116)	-.124 (.117)	-.115 (.118)	-.116 (.120)	-.084 (.118)	-.115 (.119)
Δ (International Openness)	0.063* (.021)	.063* (.021)	.061* (.021)	.061* (.021)	.062* (.021)	.066* (.021)	.063* (.021)	.063* (.021)	.061* (.021)	.062* (.021)	.060* (.021)	.066* (.021)	-.044 (.026)	-.0430 (.027)	-.046 (.027)	-.046 (.027)	-.050 (.027)	-.045 (.027)
Inflation	-.001 (.005)	.001 (.005)	.001 (.006)	-.001 (.006)	-.002 (.005)	-.001 (.005)	-.002 (.005)	-.000 (.006)	-.000 (.006)	-.002 (.006)	-.004 (.006)	-.002 (.005)	-.001 (.005)	.000 (.005)	-.001 (.005)	-.001 (.005)	-.004 (.005)	-.001 (.005)
Fertility	.013 (.331)	-.088 (.330)	-.111 (.335)	-.104 (.336)	.096 (.360)	-.016 (.351)	-2.792* (.658)	-2.785* (.667)	-2.864* (.678)	-2.744* (.705)	-2.471* (.706)	-2.600* (.706)	-3.215* (.748)	-3.296* (.768)	-3.448* (.774)	-3.414* (.803)	-3.287* (.810)	-3.364* (.830)
Investment	.151* (.036)	.157* (.036)	.159* (.037)	.148* (.038)	.143* (.037)	.152* (.037)	.162* (.047)	.161* (.047)	.160* (.047)	.151* (.048)	.157* (.047)	.160* (.049)	.223* (.051)	.233* (.052)	.234* (.053)	.232* (.054)	.257* (.054)	.258* (.056)
Quality of Schooling	.113* (.028)	.110* (.027)	.113* (.027)	.111* (.028)	.122* (.028)	.116* (.028)	.348* (.068)	.335* (.069)	.342* (.071)	.349* (.071)	.383* (.071)	.350* (.069)	.269* (.069)	.277* (.070)	.286* (.074)	.284* (.078)	.346* (.074)	.309* (.072)
Life Expectancy	-.187 (.110)	-.184 (.110)	-.200 (.111)	-.202 (.115)	-.173 (.117)	-.173 (.123)	-.138 (.131)	-.136 (.131)	-.154 (.132)	-.176 (.136)	-.097 (.139)	-.131 (.143)	-.190 (.166)	-.165 (.169)	-.173 (.172)	-.180 (.180)	-.030 (.181)	-.076 (.183)
Infant Mortality	-.096* (.046)	-.095* (.046)	-.094* (.047)	-.101* (.047)	-.100* (.047)	-.098* (.047)	.012 (.055)	.014 (.059)	.019 (.062)	-.008 (.066)	.016 (.067)	.011 (.075)	.096 (.057)	.125 (.064)	.135 (.069)	.128 (.076)	.120* (.080)	.174* (.087)
Constant	10.638 (7.277)	10.981 (7.296)	11.299 (7.368)	12.424 (7.628)	8.969 (7.897)	9.971 (8.082)	1.315 (8.310)	1.811 (8.409)	2.053 (8.577)	3.452 (9.160)	-5.475 (9.783)	-.533 (10.064)	24.512 (15.605)	21.378 (15.936)	22.564 (16.274)	23.293 (16.917)	8.375 (17.092)	15.272 (17.717)
R^2	0.36	0.36	0.36	0.35	0.36	0.36	0.24	0.24	0.24	0.23	0.24	0.24	0.51	0.51	0.51	0.51	0.52	0.52

Dependent Variable: Economic Growth as % of GDP; * denotes significance at 5% level
The standard errors are shown in parenthesis. The variables Government Consumption and International Openness are given by their first difference.
Note: the exclusion of the Quality of Schooling variable in these regressions effected the significance of Δ (International Openness) and Life Expectancy.

Up until the 20-year lag, the coefficient of education spending is negative, for all forms of regressions. The positive coefficient at the 25-year lag indicates that there is a turning point, with a negative relationship turning into a positive one with a coefficient of 0.310. Effectively, if economic growth is to increase by 0.310 percentage points if education spending is increased by 1 percentage point. As the coefficients are not significant, the likelihood of this variable being reflective of the reality lies below the standard of the 95% critical-value.

In order to illustrate this turning point and delineate the long-run relationship between economic growth and education spending, all the fixed time effects regression coefficients for education spending have been estimates with lags up to 30 years. The regressions where estimated with the same independent variables and in the identical manner of *Table 4*. The results are presented in *Figure 2*.

Figure 2: Education Spending Coefficients



While a change in the relationship already becomes apparent when investigating the results presented in *Table 4, Figure 2* manages to illustrate this relationship better as it contains the coefficients of the variables lagged for 30 years and visualizes it. While the figure depicts a general linear trend, the line representing the coefficient values also exhibits a relatively positive relationship surge of 4 and 5 years beginning at the 3 and 22-year lag respectively. This suggests that the relationship of economic growth and education spending of OECD countries can be split into different ‘episodes’.

From a theoretical perspective, the illustrated relationship could make sense if one attributes the different 'episodes' to different aspects of the education spending variable as an economic growth indicator. On the one hand, education spending is supposed to increase the productive capacity of an economy by increasing its labor capacities through an increase in human capital. On the other hand, and increase in education spending is an additional investment into an economy, generating jobs and increasing demand for further educational and secondary goods and services. As such, a simple interpretation of the results could be that the former effect is reflected in the first surge in the relationship, 3 to 7 years after increases in education spending, and the second surge can be attributed to the former, with the effects of higher human capital through education entering the labor market 22 to 27 years after spending.

However, these results cannot be interpreted too carefully, there remains the fact that all estimated regression coefficients are insignificant and no causal relationship can be established. Nevertheless, the results do provide some room for interpretation and grounds for further exploration of the nature of this relationship.

Regarding the other independent variables in *Table 4*, there are many similarities with the results of *Table 3* and there seem to be several consistencies. A first consistency is the significant negative coefficient of GDP per capita and inflation; further significant results include the positive coefficients of investment and quality of schooling. While the other independent variables do not demonstrate consistent significant coefficients, most to attain to a certain pattern, with government consumption, international openness, inflation and life expectancy persistently showing negative coefficients and the infant mortality rate, surprisingly, showing a positive coefficient.

Considering the large scope of element that play into the determination of the rate of economic growth, it is safe to say that the independent variables used in this analysis only reflect a fraction of the actual variables that indeed affect the dependent variable. While this shortcoming has tried to be rectified through the use of the fixed effects regression, which accounts for the constant differences between countries, naturally, omitted variables remain. Although it is safe to say that including all variables into one analysis is considered beyond what is possible, there are several ways in which this research could be improved or expanded. Examples include the addition of more countries, more explanatory variables and the use of a wider variety of data tests and approaches towards the overall analysis.

7. Conclusion

The focus of this paper has been to investigate the relationship between economic growth and education spending through a panel data analysis. A review of the relevant economic theory and literature provided the basis for the theoretical foundations and assumptions made throughout the examination. The dataset comprises data of 11 OECD countries during a period of 41 years for 10 different indicators as well as data on economic growth.

In order to report upon the research question, whether public spending on education has an effect of education growth, the investigation was split into two components for coherence. The first component focused on the short-run or immediate relationship between economic growth and education spending, for which the significant squared education spending, as well as the education spending variable itself, provided evidence for a quadratic relationship in U-shaped form. This result gives evidence of a certain education spending threshold level, after which its effect of economic growth turns from positive to negative.

The second hypothesis targeted the long-run relationship between the two variables of interest through the help of lags on the education spending indicator. The results of the coefficients are insignificant. The interpretation of the results is therefore quite ambiguous but nonetheless notable. While the results seem to indicate a negative relationship in the beginning, a minor effect can be gathered in the early years of spending, with an actual positive effect only becoming apparent after 21 years.

While it can be concluded that there is evidence to suggest positive short run effects after a threshold level and some evidence to suggest that education spending does have a positive effect on economic growth in the long run, proposing a concrete and definite answer to the research question would be unreasonable. Both hypotheses cannot be confirmed; with regard that the relationship between economic growth and education spending is far more complicated, as can be expected.

There remains room for further improvements of data and analysis. Further additions could include expansion of independent variables of indicators of human capital or maybe another determinant to represent education. However, this paper does show that, while very difficult to investigate and to interpret, the connection between the education and economic growth remains a compelling relationship.

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8. Appendix

8.1 Figures

Figure 1.01: *Display of GDP per capita growth (annual %) by country*

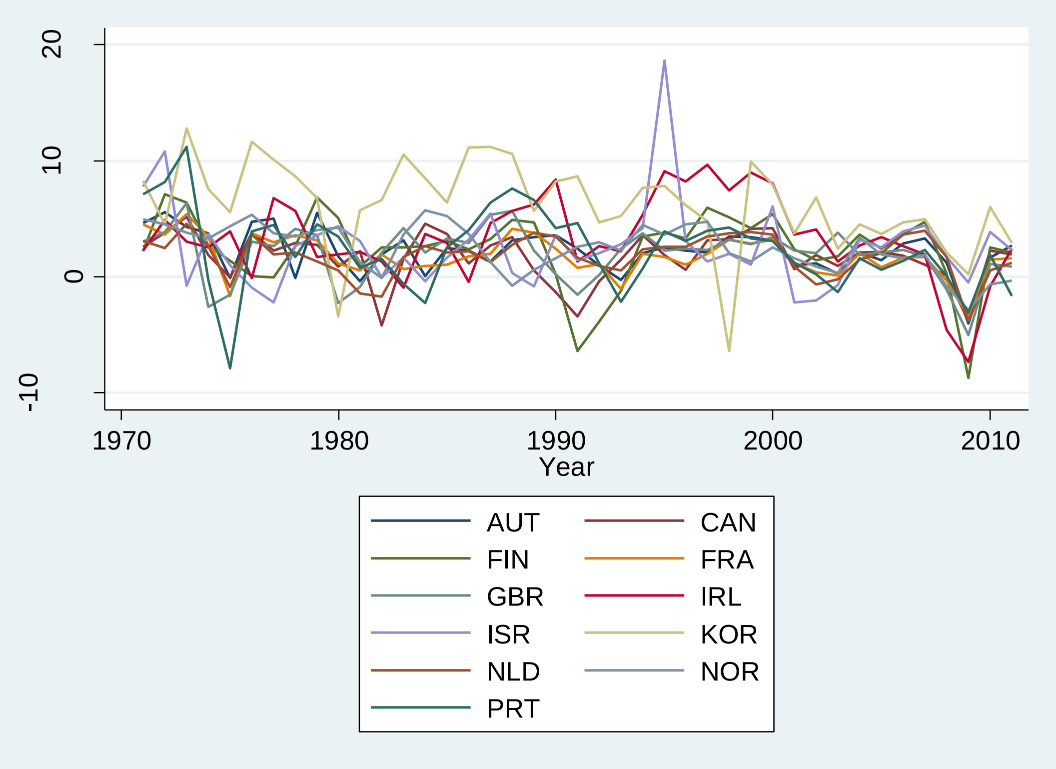


Figure 1.02: *Display of Education Spending as % of GDP by country*

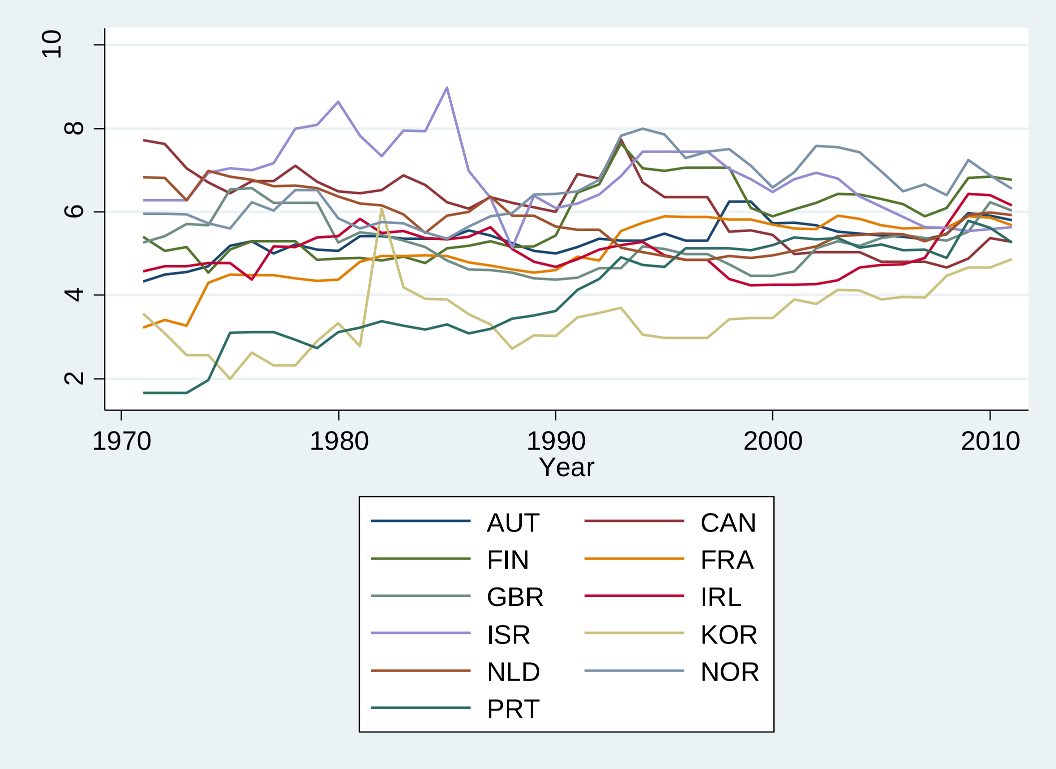


Figure 1.03: *Display GDP per capita by country*

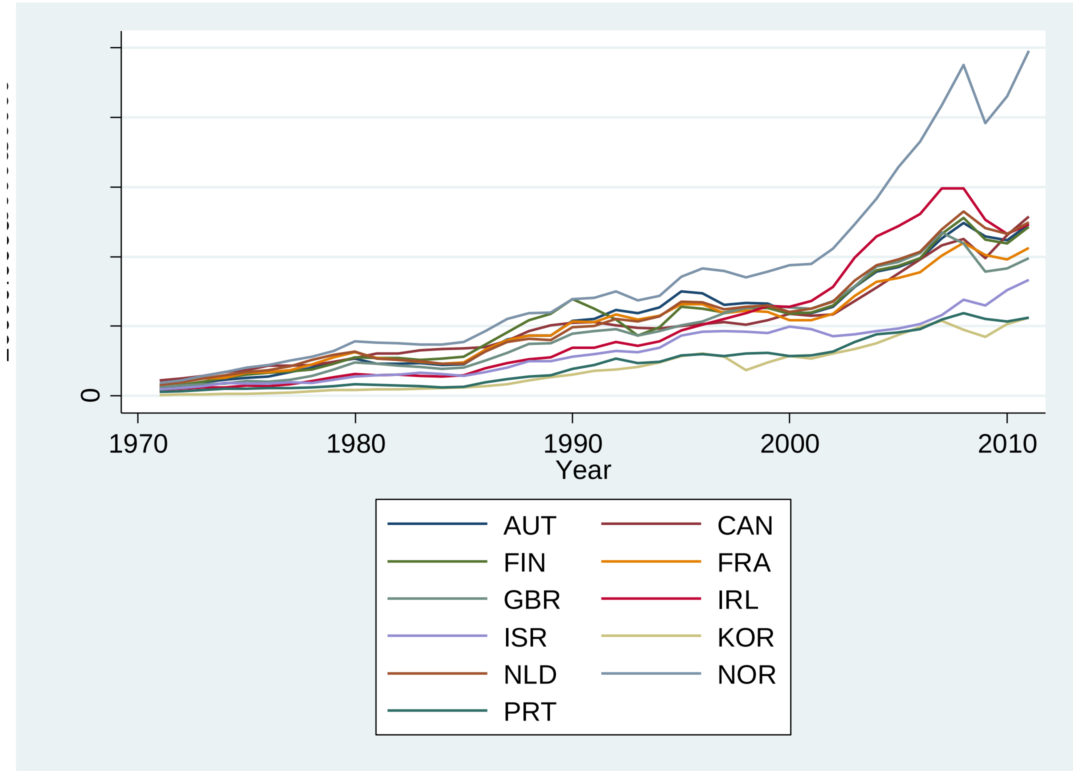


Figure 1.04: *Display of Government Consumption as % of GDP by country*

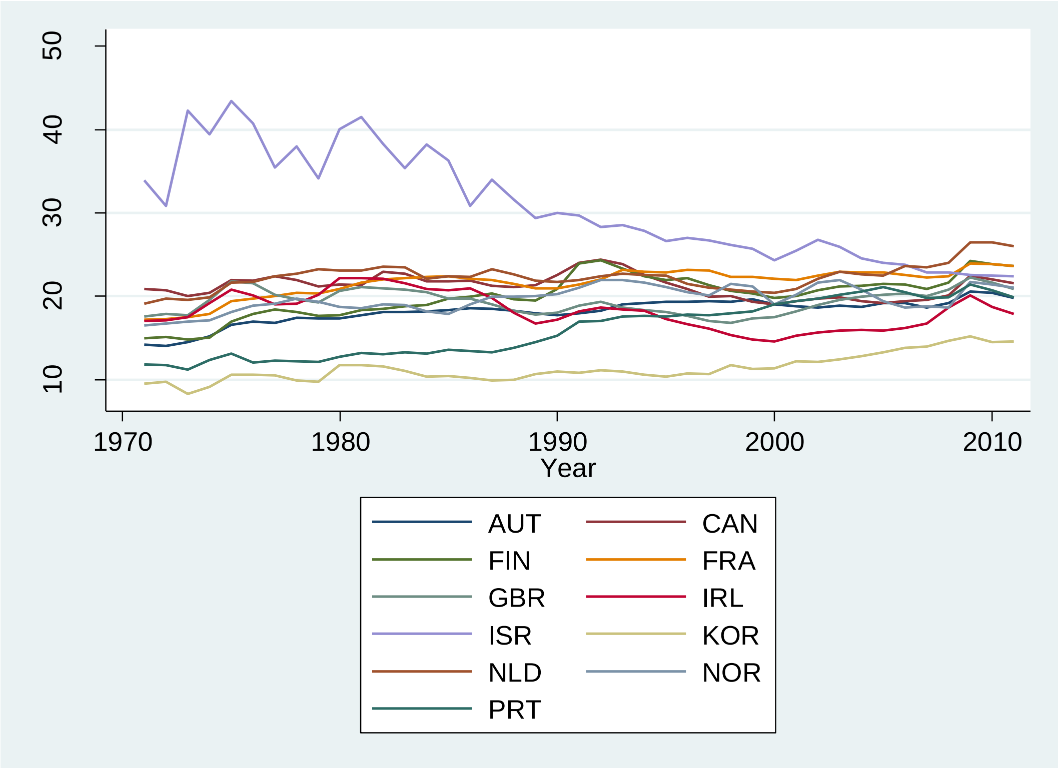


Figure 1.05: *Display of International Openness through the sum of exports and imports as % of GDP*

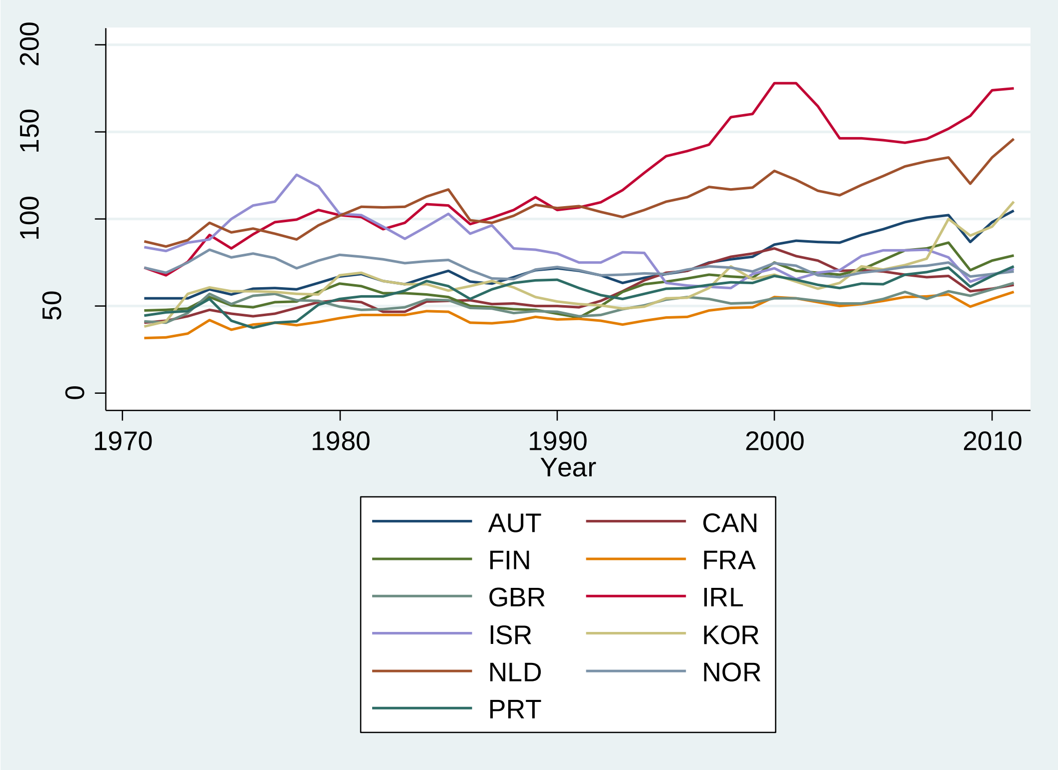


Figure 1.06: *Display of the Inflation Rate by Country*

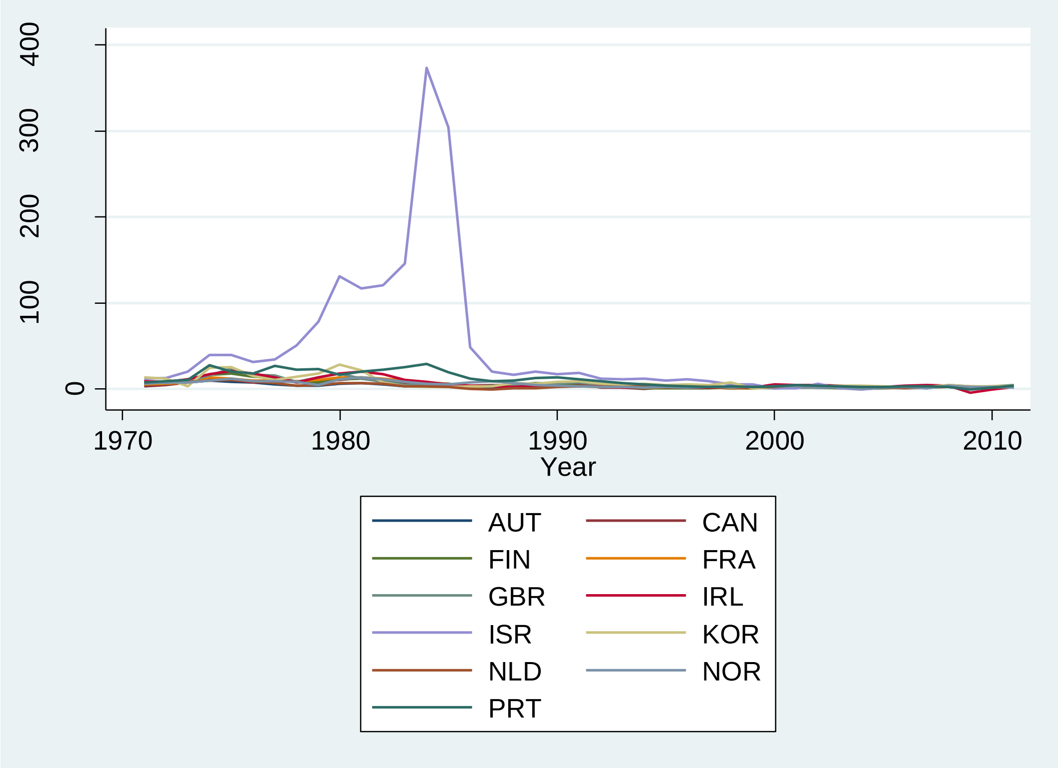


Figure 1.07: *Display of the Fertility Rate as the number of births per woman by country*

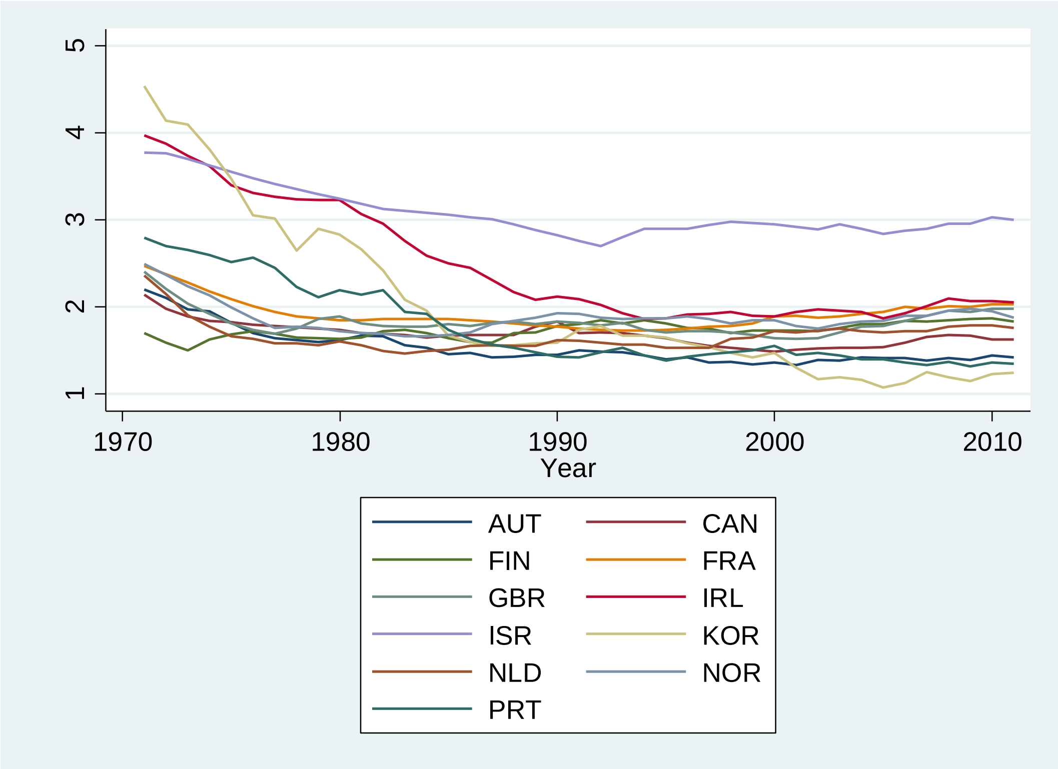


Figure 1.08: *Display of the Investment Ratio as % of GDP by country*

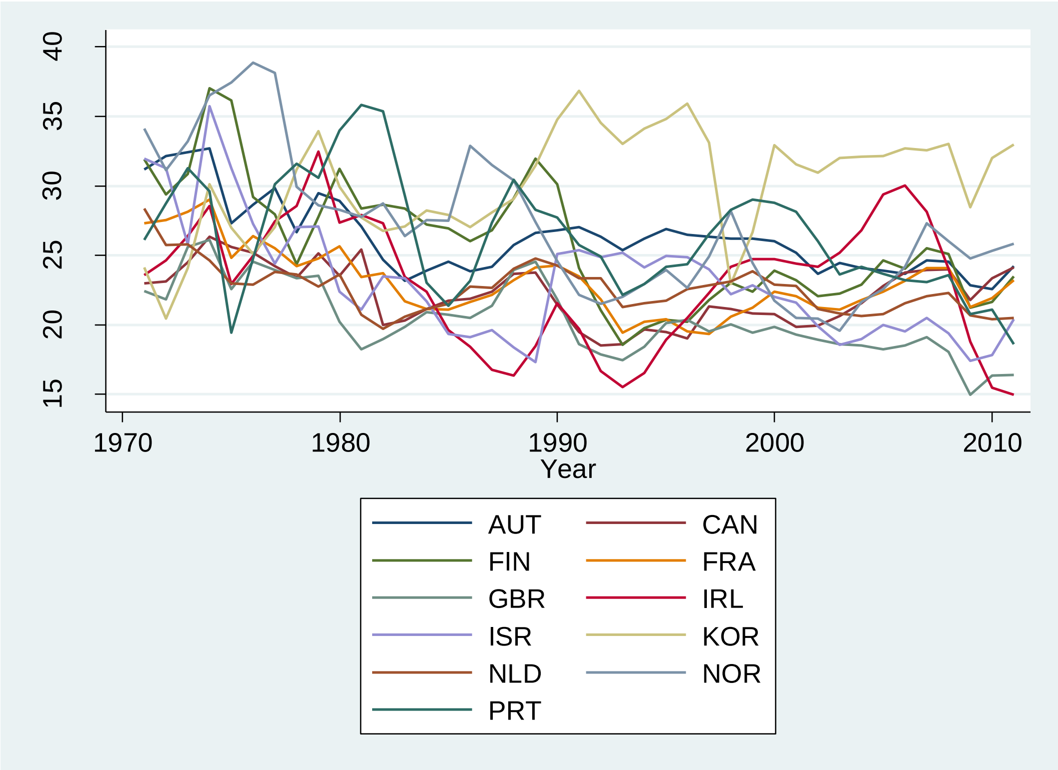


Figure 1.09: *Display of the Quality of Education through the Pupil-Teacher ratio by country*

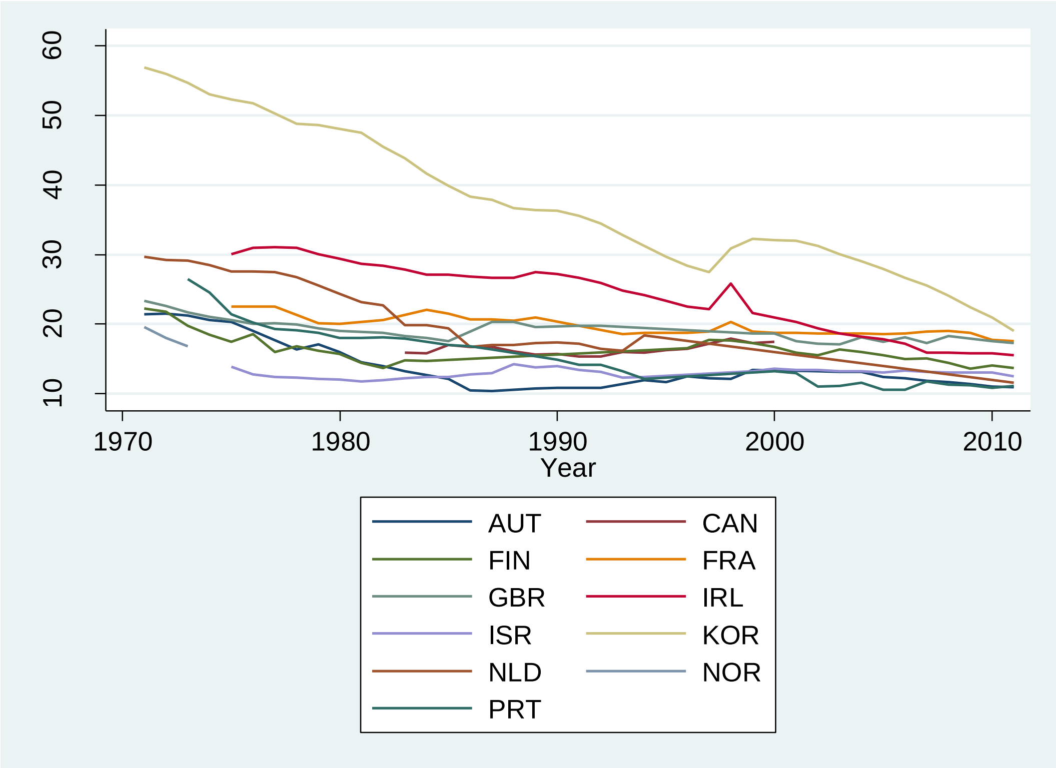


Figure 1.10: *Display of the Life Expectancy at birth (in years) by country*

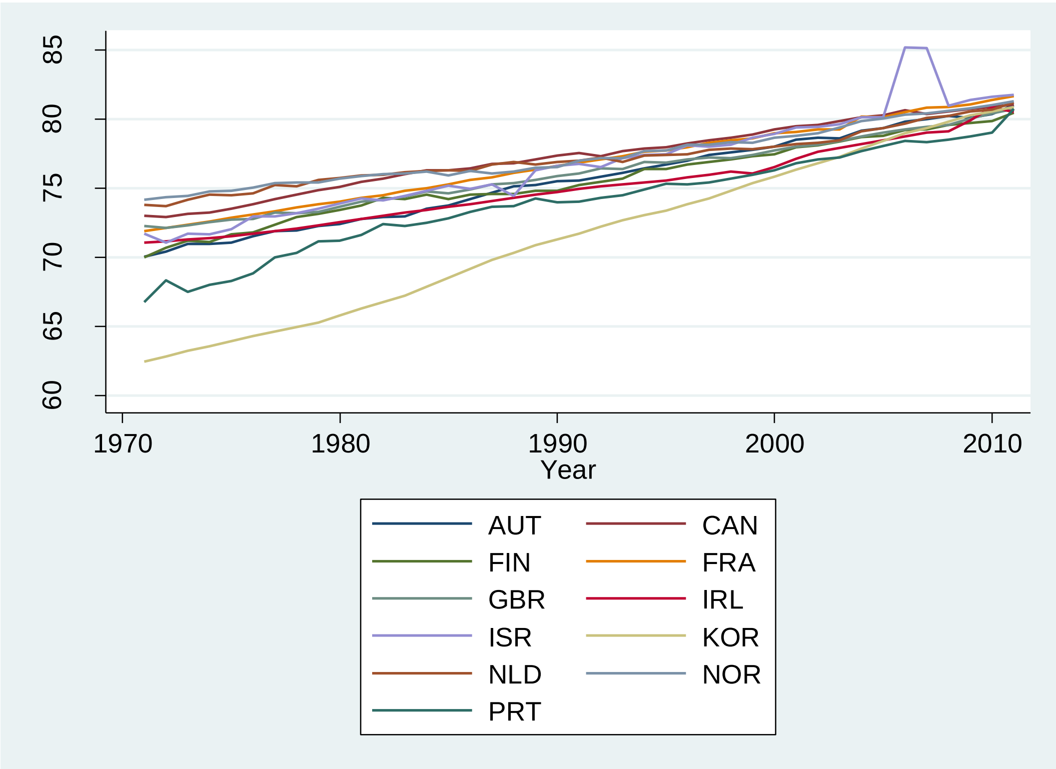
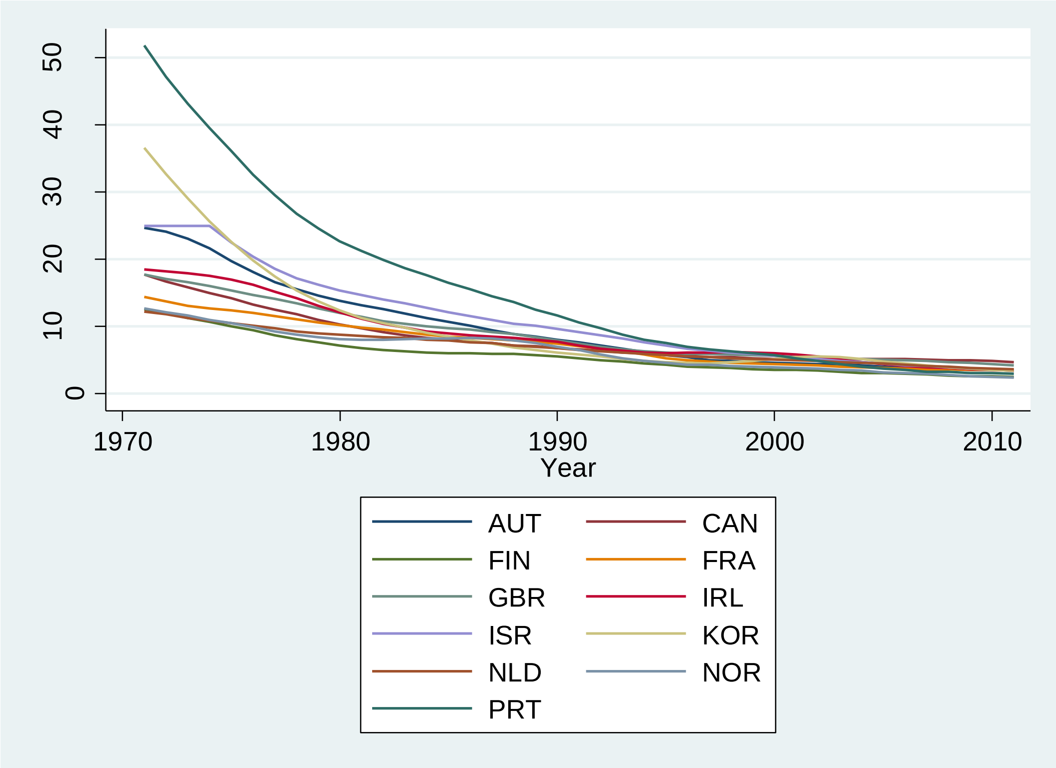


Figure 1.11: *Display of the Infant Mortality Rate by country*



8.2 Tables

Table 1.1: Summary of Variable Statistics

Variable	*Mean*	*Std. Dev.*	*Min.*	*Max.*	*Observations*
Year	1991	118,453	1971	2011	N = 451, n = 11, T = 41
GDP Growth	2.627	3.026	-8.707	18.621	
Education Spending	5.394	1.227	1.65601	8.978	
GDP per Capita	18920.21	15552.5	302.228	99143.17	
Log(GDP per Capita)	9.465	0.983	5.711	11.504	
Government Consumption	19.889	5.221	8.273	43.406	
International Openness	72.838	27.109	31.733	178.254	
Inflation	9.126	26.128	-4.48	373.821	
Fertility	1.959	0.585	1.076	4.54	
Investment	24.56	4.464	14.968	38.888	
Life Expectancy	75.732	3.598	62.444	85.163	
Infant Mortality	8.936	6.627	2.4	51.8	
Quality of Schooling	20.207	8.811	10.363	56.87	N = 319, n = 11, T-bar = 29
Δ(Government Consumption)	0.0125	1.715	-12.927	16.042	N = 450, n = 11, T-bar = 40.55
Δ(International Openness)	0.0408	8.869	-91.208	22.691	

Table 1.2: Fixed Effects Regression (extended version of Table 2)

Independent Variables	*Fixed Effects*				*Fixed Effects including Time Effects*			
	(1a)	(2a)	(3a)	(4a)	(1b)	(2b)	(3b)	(4b)
Education Spending	-.509*	-.434*	-.422*	-.410*	-.1126	-.1226	-.236	-.265
	(.228)	(.179)	(.177)	(.172)	(.215)	(.166)	(.167)	(.258)
Log(GDP per Capita)	.510	-.178			-2.095*	-3.030*		
	(.566)	(.442)			(.983)	(.746)		
Δ (Government Consumption)	-.566*	-.364*	-.367*	-.365*	-.136	-.201*	-.126*	-.217*
	(.102)	(.072)	(.072)	(.071)	(.114)	(.068)	(.070)	(.069)
Δ (International Openness)	.064*	.001	.001	.001	-.046	-.070*	-.062*	-.061*
	(.021)	(.014)	(.014)	(.014)	(.026)	(.018)	(019)	(.019)
Inflation	.002	-.012*	-.012*	-.012*	.000	-.007	-.007	-.007
	(.006)	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
Fertility	-2.598*	-1.046*	-1.017*	-1.092*	-3.209*	-2.463*	-1.048*	-1.059*
	(.657)	(.478)	(.472)	(.407)	(.746)	(.576)	(.485)	(.456)
Investment	.146*	.115*	.118*	.116*	.217*	.169*	.121*	.119*
	(.046)	(.039)	(.038)	(.038)	(.052)	(.041)	(.040)	(.003)
Quality of Schooling	.332*				.268*			
	(.066)				(.067)			
Life Expectancy	-.103	-.238*	-.273*	-.260*	-.223	-.400*	-.444*	-0.454*
	(.130)	(.113)	(.070)	(.056)	(.163)	(.133)	(135)	(.001)
Infant Mortality	-.015	-.018	-.014		.077	.048	.003	
	(.056)	(.044)	(.043)		(.057)	(.041)	(.041)	
Constant	3.179	24.148*	24.935*	23.936*	27.397*	54.550*	33.548*	34.704*
	(8.233)	(6.343)	(0.028)	(5.127)	(15.405)	(11.400)	(10.358)	(10.127)
R^2	0.25	0.19	0.18	0.18	0.52	0.48	0.46	0.46

Dependent Variable: Economic Growth as % of GDP; * denotes significance at 5% level
The standard errors are shown in parenthesis. The variables Government Consumption and International Openness are given by their first difference.