Title

How does government expenditure and specific reforms in education affect economic growth? Evidence from OECD countries and policy implications.

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Academic years: 2017-2019

In order to obtain the Double Degree

Master 120 en Sciences économiques orientation générale finalité spécialisée (UCL/UNamur)

and

Master of Science in Economic Studies (Maastricht University)

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Acknowledgements

I would like to thank everyone who played a role in my academic accomplishments. First of all, to my supervisors Fabio Mariani and Lex Borghans for their engagement and constructive criticisms. Furthermore, to my family, who supported me with love, understanding and also funding. Finally, I would thank my close friends for their support despite being thousands of miles away.

"Education is the most powerful weapon which you can use to change the world".

- Nelson Mandela, 1990

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Introduction

Education is one of the vehicles driving economic growth and individual development, and it definitely pushes toward inequality reduction. First of all, education is a human right, and it is a fundamental determinant for human, social and economic development. The government expenditure on education plays a crucial role for economic growth, in fact, an increase in expenditure on education generates accumulation of human capital, which allows people to be more productive and have increasing returns, thereby a higher real GDP per capita. The economic literature widely states a positive causal relationship between the stock of human capital and subsequent growth. The real GDP per capita is the indicator that has been largely used to measure economic performance, and also to compare the standard living between countries over time. Specific policy reforms in education are definitely one of the reasons why countries experiencing improvements in human capital grow (Lim et al., 2018).

This paper aims at investigating the crucial role of public expenditure on education for economic growth (indexed by real GDP per capita) in generating human capital accumulation, and its response both in the short run and in the long run. A lot of findings show a positive causal relationship between public expenditure on education and economic growth, especially for samples of developing countries (Mishra, 2015). Other findings, however, show a negative causal relationship between those two. Although countries experiencing higher levels of growth and development are likely to invest more in education (reverse causality), the marginal effect of per capita GDP diminishes as education expenditure increases all else equal (Appiah, 2017).

We investigate the causal relationship between the government expenditure on education and economic growth (indexed by real GDP per capita). Additionally, we would also scrutinize how

education expenditure is allocated to the different levels of education (primary, secondary, tertiary), and which one affects the economic growth. We perform our analysis over all OECD countries through linear regression models both in OLS (Ordinary Least Squares), and in fixed effects, in order to control for time-invariant and individual-invariant characteristics. The panel data also includes India, which is an interesting case worth of consideration because both government education expenditure and reforms on education have had a relevant effect on real GDP per capita, over time. However, due to the few numbers of observations for India, we do not empirically demonstrate the relationship between expenditure on education and economic growth. Therefore, India is only used as support for our findings. Since 1990s, the patterns of real GDP per capita has overall increased, while for education expenditure the trend has fluctuated more. In the past decades, India has implemented several educational reforms and it is still improving its educational system resulting, however, to be one of the largest in existence today. This has largely affected its economic growth.

In regard to OECD countries, the expenditure for primary, secondary, and tertiary education has increased everywhere since 2010. In particular, it is hypothesized that a 1% increase in tertiary education is equivalent to 13% decrease in illiteracy rate (Windolf, 1992). Furthermore, it has been found that an increase in government expenditure on education induce people to stay in school longer, and this has a subsequent effect on economic growth. Our findings reveal that the government expenditure on education negatively (positively) affects the growth rate of real GDP per capita in the short run (long run). There exist several possible explanations why the effects of investments are not immediately present. In regard to India, government expenditure on education has increased over time, and this has represented a breakthrough for its economic growth. The effective government expenditure on education is around 4% and, with the onset of the 21th century, the demand for skilled workers has increased in India. We will also explain our study limitations, and if these findings are consistent with the main hypotheses.

The rest of the paper is organized as follows. Section 2 introduces why and to what extent investments in education matters for economic growth and the impact the government expenditure on education has on real GDP per capita. A more detailed presentation of educational reforms and their impact on human capital and productivity in OECD countries is provided. We also present policy implications for economic growth in India. Section 3 presents data used for the analysis and the empirical method applied to investigate the relationship between education and economic growth. In section 4, we report and discuss our main empirical findings. Section 5 discusses the main tests implemented in order to assess the validity and appropriateness of the model, and the possible limitations of our study. Finally, Section 6 brings the paper to a close with some further discussion and concluding remarks.

2

Theoretical Framework

2.1 Education as Engine of Economic Growth

Education is one of the most important components of long run economic growth and development, and it is a considerable contribution to human capital accumulation, both in developed and in developing countries (Barro, 2013). There exists a relationship between education, economic growth and social sector. Education allows for improving knowledge and acquiring the skills needed to promote economic efficiency and social cohesion. A higher level of education makes people be open minded, increases the tolerance and acceptability, and removes prejudice and discrimination. Education also leads to an increase of participation in developmental activities (Mishra, 2015).

However, economic growth can be explained by other determinants as real domestic product (gdp), capital, and labor, but the effect of education is the most important one (Mekdad et al., 2014). Many authors in the economic literature, including Romer (1990) and Barro (1991), consider education as the main form of human capital. Neoclassical growth models of Solow (1957) and Romer (1990) show the link between education and economic performance, but there exists also a relationship between education, economic growth and development. Education is indeed recognized as the engine of social and economic development.

Psacharapolous's studies explain the contribution of returns to education in terms of both private and social returns. The former is related to individual earnings, while the latter to external marginal benefits or also called positive externalities. These externalities can be translated into individual's human capital accumulation enhancing productivity within a country and they might not be internalized at the individual level (Psacharapolous, 2004).

However, benefits of education are more likely to have a long-term effect, not only within a country's growth and development, but also with regard to social sector and personal development. If investments on education generate educated workers, they will be able to make other workers also more productive. Thus, the overall level of education can benefit society because human capital spillovers are likely to increase productivity above the direct effect on individual productivity (NBER, 2005). Therefore, the magnitude of social returns to education is a crucial tool to assess the efficiency of public investment in education (NBER, 2005). Education rewards, not only the individual, but it also creates benefits that are shared by society at large (NBER, 2005). Since there are evidences in regard to human capital increasing productivity, we can say that education is productivity-enhancing. Education affects both short run and long run growth, although with a different degree of effectiveness. It is estimated that one year more of education would increase the per capita output by between three and six percent (augmented neo-classical growth theory), and by an over one percentage point (new growth theories) (Sianesi and Reenen, 2003).

2.2 The crucial role of government expenditure on education and human capital for productivity and economic growth in OECD countries.

In OECD countries more than 12% of public expenditure is invested in education. In particular, public and private expenditure on educational institutions accounts for about 6% of collective GDP of OECD member countries (Temple, 2000). According to OECD Publishing on Education (2018), expenditure per student in primary, secondary and post-secondary non-tertiary education, has increased everywhere in OECD countries since 2010. Governments typically have a strong direct involvement in the financing and provision of schooling at various levels. Hence, public policies in these areas have major effects on a country's accumulation of human capital (Barro and Lee, 1993-1996).

One of the key factors driving economic growth is human capital, and it is considered a complement of physical capital accumulation (Mankiw, Romer, and Weil 1992; Islam 1995). Themba's and

Odhiambo's (2016) findings, show that both in developing and in developed countries, human capital is one of the macroeconomic determinants of economic growth, and they are significantly positive correlated. However, human capital accumulation derives from investments in education. A country that invests in education is more likely to increase its development also in terms of labor productivity, income, and poverty reduction. On the other hand, many developing countries face a lot of challenges with regard to unemployment, inequality and poverty. In fact, they need better education facilities, but unfortunately the education expenditure is still low (OECD, 2007).

Developing countries attempted to stimulate the accumulation of human capital through public spending on education. In regard to the analysis conducted on countries as USA, Pakistan, Tanzania and Zambia, Nigeria and India, findings reveal that education expenditure positively affects growth (Grimaccia and Lima, 2013). In regard to European countries, the share of expenditure on education has remained the same on average in the last decade. Some countries, as Italy, lagged behind in terms of investments and improvements in education, with a public expenditure on education decreasing by 1.4% (Grimaccia and Lima, 2013).

In developing countries, the 40% of people are illiterate; the 25% of children between 6 to 12 years old are not able to attend primary school, and the 80% of children between 12 and 18 years old do not enter the secondary school (Todaro, 2000). On the contrary, by completing the upper secondary education helps to prevent unemployment, and payments jobs are more likely to be higher (Todaro, 2000). Countries recording poor levels of education are those ones experiencing unskilled labor and unemployment, and this may have serious impact on economic growth. It is widely known that people with education earn more than those without, and that the level of output per hour worked in a country should depend on educational attainment of population (Geraint and Jill, 2004). Education, however, influences economic growth through its effects on education of individuals.

Governments have been initiated to allocate part of public expenditure on intellectual property rights (IPR) which represent an important challenge for OECD countries (OECD, 2007). When the government facilitates the access to the education system, innovation is more likely to occur. In fact, an increase in public expenditure on education results in a more developed R&D sector. Education policy makers have been developing reforms and agenda for economic growth paying a lot of attention to innovation outcomes (OECD, 2007). In many OECD countries, in fact, growth in output per employed person is partly attributable to their increase in human capital (OECD-Innovation and Growth, 2007).

It is largely known that more educated individuals result to be more efficient and more productive, and this can be explained by the causal link between education and human capital accumulation. Individuals with a high level of education allow to promote innovation and to improve the state of technology, thus fostering economic growth and development of a country in the long-run (Barro, 2013). In fact, due to the close relationship between economic growth and economic development, we can see that an increase in years of schooling and in the level of health and life-expectancy, leads to a raise in productivity and in real national income (Barro, 2013).

Human capital can be considered as an input in the production process, and its accumulation would accelerate economic growth until it reaches the steady state growth level (Lucas, 1988). The level of output is a function of the stock of human capital, and only if human capital grows without any bound, it is possible to have sustained growth in the long-run (Uzawa, 1965 & Lucas, 1988). The stock of human capital could increase in such a way to drive rising levels of output, even when the average educational attainment is constant over time (Temple, 2000). Human capital also enhances the capacity of nations to innovate and it represents a stimulus for technological catch-up and diffusion.

According to Barro, the average years of school attainment at the secondary and higher levels, for males ages 25 and over, has a positive and significant effect on the subsequent rate of economic

growth. The estimated coefficient implies that an additional year of schooling (roughly a one-standard-deviation change) raises the growth rate by % per year (Barro, 2013)[1]. A possible interpretation might be that a workforce educated at the secondary and higher levels facilitates the absorption of technologies from more advanced foreign countries (Barro, 2013). Therefore, the implied social rate of return on schooling is somewhat involved. An additional year of average school attainment impacts the growth rate of GDP, and then, it also gradually affects the level of GDP over time (Barro, 2013).

Educational expenditure changes are also related to changes in teachers' salaries. Since salaries have increased over time, the expenditure on education has increased too. Expenditure by non-tertiary educational institutions increased in most countries by 4% on average between 2010 and 2015. The enrolment rate, instead, have fallen over the same period. Therefore, a combination of these two events results in a higher expenditure per student, in particular 5% higher in 2015 than in 2010. This increase in expenditure on education regards most of the OECD countries, apart from United States and some European countries due to the economic crisis of 2008.

Another important finding that is widely known in economic literature, is the positive relationship between school enrolment and economic growth. In particular, a study conducted by Castellò-Climent and Mukhopadhyay (2013) says that a large share of population completing tertiary education has a large impact on the economy. In fact, a 1% increase in tertiary education is equivalent to 13% decrease in illiteracy rate. "According to human capital theory, university enrolment expands in time of economic growth and contracts in times of economic recession" (Windolf, 1992). The level of human capital within a country, in fact, increases with an increase in the enrolment rate in tertiary education.

[1] (Barro, 2013) Education and Economic Growth.

Furthermore, Romer's findings (1990) yield the result that the steady-state growth rate partly depends on the level of human capital. In fact, a rise in the level of human capital is likely to be associated with a potentially substantial rise in the level of output and welfare, brought about through a transitional increase in growth rates. Overall, education can affect growth due to the relationship between individuals' education and their levels of productivity. Therefore, there is a large body of evidence that education can be seen as a fundamental determinant of growth outcomes, even when data on earnings are used (World Bank, 2007). The World Bank has recently introduced the "Human Capital Project" in order to understand the link between investments in people and economic growth, and to accelerate the financing for human capital investments (Lim et al., 2018).

The relationship existing between schooling and growth can be explained by two channels. A higher level of schooling determines growth, but it is also established a reverse causal relationship that a faster growth induces people to stay in school longer (Bils and Klenow, 1998). Therefore, we can say that the country's long-run rate of growth is affected by the level of schooling which, in turn, is affected by policies (Bils and Klenow, 1998). It is estimated that most of the workers with more years of schooling exhibit steeper earnings profiles because teaching allows students to learn. Therefore, if countries with greater schooling exhibit both more growth and more investment, and learning on the job, this would create a positive correlation between schooling enrolment and the growth rate of per capita GDP (Bils and Klenow, 1998).

2.3 The implications of specific educational reforms for the economic growth trajectory in India.

In this paper, I have found as interesting and worth of investigation, the relationship between the government expenditure on education and economic growth in India because its educational system has highly been developing as a consequence of rapid economic, demography and technological

changes over time. However, we limit to explain such evidence only theoretically because the low number of observations is likely to determine a biased empirical estimation.

With the onset of the 21th century, India has expanded its educational system, raised the educational attainment level, and has started to provide adequate infrastructure to young people. However, there are still many issues to be addressed and, securing access to quality education, is one of them.

Since May 2007, India has become one of the five OECD key partners. “In less than ten years, sustained growth supported by fiscal, structural and social reforms has lifted about 140 million people out of extreme poverty” (Angel Gurrìa, Secretary-General, OECD, 2018). “The OECD actively supports India in its role within the G20 Framework Working Group, by providing new sources of growth and boosting the structural reform agenda” (Angel Gurrìa, Secretary-General, OECD, 2018). In order to explain to what extent educational reforms and public expenditure on education matters for economic growth, in this paper, we will have a look at educational reforms jointly with the development agenda. The key challenges of Indian government are: improving access and quality at all levels of education, increasing funding, especially with regard to higher education, and improving literacy rates (Lall, 2005).

India has experienced a high-growth trajectory since 1990s also due to important structural changes in the economy. As India became the key partner of OECD in 2007, its real GDP per capita has been affected. Our findings reveal that, after 2007, both the real GDP per capita and the government expenditure on tertiary education increased overall (OECD structural agenda mainly focused on innovation outcomes). Therefore, the implementation of educational reforms, its participation to the OECD as key partner, and all the measures concerning the structural agenda on education sectors, have made the real GDP per capita pattern deviate from the standard one.

As we have already discussed, education expenditure matters for economic growth in India. In order to highlight the possible effectiveness of educational reforms after their implementation (DPEP,

1993) and (Fundamental Right, 2001), we have analyzed the trend of both expenditure and real GDP per capita. In the range of years 1997-2000, and 2009-2013, the government expenditure on education has noticeably increased. We can say, although without any empirical analysis for India, that such reforms have been likely to contribute to the increase of education expenditure. However, it is worth of mentioning, that India has experienced a high trajectory growth since 1991 also due to economic reforms.

We have found that the real GDP per capita in India has tendentially increased, while expenditure on education has fluctuated by more, since 1990 (*Figure B.9 - B.10*). India has become the OECD key partner in 2007, and education policy makers provided the structural reforms agenda mainly focused on innovation outcomes and research. This may be a possible explanation for the increase in government expenditure on tertiary education since 2007.

The school enrollment ratio both on primary and on secondary education shows an increasing trend over time, and the same occurs for total years of schooling (*Figure B.13*).

The increasing trend of government expenditure, in India, can be definitely seen as a breakthrough in economic growth. Education is provided by both public schools (controlled and funded by three levels: central, state and local) and private schools. Both central and state government have the responsibility to maintain quantity, quality, access and equity in education. Centre, State and Union-Territories government are the main sources of financing education sectors. One of the main structural reforms regards fostering education and skills for the future. India has actively worked on education in order to identify and develop knowledge and skills driving better jobs and better lives, generating prosperity and promoting social inclusion. Expanding the access to education, while focusing on ensuring quality education for all, is one of the objectives (OECD, 2018).

India participated in the Programme for International Student Assessment (PISA) and it has been involved in the OECD's project "The Future of Education and Skills" (Education 2030 project). This project helps to find both knowledge, skills and attitudes, and support students to shape their future

(OECD, 2018). Although India has made progress on access to primary education, the share of younger adults not completing upper secondary education is still high (about 65%).

Strategies to enrol out-of-school children have been implemented in the district of Rajasthan. According to Sharma R. and Ramachandran V. (2009), the "Madrassa strengthening programmes" is a specific strategy in order to reach out children from minority communities. Alternative education centres have also been set up in small habitations and for children who had dropped out. In 1990s, the government implemented the DPEP programme (District Primary Education Programme) by engaging with the community on a large scale. Community-based bodies, such as Village Education Committees (VECs, Parent Teacher Associations (PTAs) and Mother Teachers Associations (MTAs), were set up and trained to monitor school enrolment and attendance. The participation of the community has been also associated with attempts to improve the quality of schools (Sharma R. and Ramachandran V., 2009). The rapidity by which schooling has increased has meant a need for an improvement of school infrastructure.

Over the last fifteen years, Pratham, one of India's largest NGOs, has implemented strategies in order to improve children's learning (Banerjee, 2016). An experiment has helped to see if training teachers will properly increase children's educational attainment. Pratham, however, has provided appropriate teaching materials in the school under the analysis. In some Indian states, as Haryana and Uttar Pradesh, the school-year intervention, led by government teachers and supported by government supervisors, increased both reading scores and test scores in math and language. Pratham's Program focused on pedagogy with "Combined Activities for Maximized Learning (CAMaL) and "Teaching at the Right Level" (TaRL). Pratham, in principle, has implemented trainings for government teachers, but it has also provided trainings for community-based volunteers (Banerjee et al. 2016).

India has experienced important radical changes thanks to educational reforms. The timeframe of any reform is difficult to specify and, if they succeed, their impact on the economy would not be immediate. Some time is needed, and the fact that the new graduates will constitute the labour force

at different stages in time, could be also one of the reasons (World Bank, 2007). Investments and government expenditure on education have determined economic advances and have generated many skilled individuals in both IT and engineering sectors. The effective government expenditure on education is around 4 per cent, although it had been planned to increase by 6 per cent of GDP. India's business schools, Indian Institutes of Technology (IITs) and Management (IIMs), and universities, produce global competitive graduates (Lall, 2005). Mathematics and Science have always been prioritizing in India.

On the other hand, there are still issues regarding the high drop-out rate. Furthermore, a combination of both inadequate school infrastructure and poorly functioning schools, and the high teacher absenteeism with the poor quality of education, are still persisting issues (Lall, 2005).

Although enrolment in primary education has increased, it is estimated that, at least 35 million of children aged 6-14, are not in school. As for primary and secondary schools, the standard of educational facilities and the quality of education are generally higher in richer states than in poorer ones (Lall, 2005). In higher education, instead, different human skills have led to economic differences. In fact, southern states succeeded in IT because they have a higher number of engineering colleges, and this means also graduates (Lall, 2005). As a consequence, in these countries, there is a high concentration of high-technology industries.

Disparity between states is inevitable. The growth of IT and BPO (Business Process Outsourcing) industries, and the spread of the computer use had a significant impact on the expansion of both highly skilled labour market and higher education (ADB, 2015). The widening access to universities has been an issue in terms of funding. The challenge was to balance public and private spending in order to guarantee as much as possible wide access to universities without creating disparities among communities (ADB, 2015). The University Grants Commission (UGC)[2] is responsible for ensuring

[2] UGC India (University Grants Commission) is a statutory body set up by the Indian Union government in accordance to the UGC Act 1956 under Ministry of Human Resource Development and is charged with coordination, determination

excellence, but also equity in education in order not to create disparities. The UGC, not only provides grants to universities and colleges, but it also maintains and tries to raise academic standards in higher education and advise central and state governments about expanding and improving higher education. A National Policy on Education (NPE) has been implemented to satisfy the India's great need for change. This new policy aims at raising education standards and increasing access to education. Another change regards the increase of financial and organizational support from private sector to complement government funds. But what really matters is the quality of education. Therefore, several initiatives have been developed (Lall, 2005):

1) Operation Blackboard (1987-1988): to improve human and physical resources available in primary schools.
2) Restructuring and Reorganization of Teacher Education (1987): to upgrade teachers' knowledge and competence.
3) District Primary Education Programme (DPEP) (1993): to improve teaching and learning materials, and school effectiveness.
4) Fundamental Right (2001): aims at providing free and compulsory education, declared to be the basic right for children aged between 6 and 14 years.

According to some Human Development indicators of the Asian Development Bank (ADB), the adult literacy rate has increased by 22% from 1986 (40.8) to 2006 (62.8). As for primary, secondary, and tertiary school enrolment, there has been an increase respectively by 34.4%, 44.6%, and 18.3%. Years of schooling have also raised by 3.6% (for students of 15 aged and above), with a consequent increase in educational attainment trends for the period 1960-2010 (ADB, 2015).

India has experienced technological advancement and industrial structural change over time, combined with a higher quality of schooling. Graduates from good colleges and universities have had

and maintenance of standards of higher education. It provides recognition to universities in India, and disbursements of funds to such recognized universities and colleges.

the opportunity to be hired by global firms and foreign enterprises (ADB, 2015). This has contributed to increase the rate of returns to schooling. In turn, this also represents an incentive to achieve higher levels of schooling. An increase in the rate of returns can be translated into a higher economic growth due to a rise in GDP per capita. Towards the beginning of the 21th century, in India, the demand for skilled workers, especially for skilled woman, has increased.

In the first decade of 2000s, the system of higher education has expanded with the addition of 20,000 colleges and more than 8 million students enrolled (ADB, 2015). However, only few universities are globally recognized, while the most have poor quality education and need of infrastructure improvements (ADB, 2015). Public investments in education have increased in the past decade, but, however, they are still low compared to the average of the rest of OECD countries (ADB, 2015). With regard to the emerging-markets countries, as India, improving access to quality-education and addressing physical and legal infrastructure issues represent huge needs (ADB, 2015). Although economic growth is increasing at fast paced, there are still some issues as unemployment and other shortcomings within educational infrastructures (ADB, 2015).

2.4 The Economic Convergence Process

Neoclassical growth models for closed economies show that per capita growth rate is inversely related to the starting level of output or income per person. Poor economies grow faster than rich ones if economies have the same level of technology and preferences. There is a force that promotes convergence in level of per capita product and income. We can say that economies tend to converge when they are below the steady-state position (*catch-up* effect). The convergence force allows poor economies to catch-up the rich ones. In open economies, instead, the mobility of labour and technology tend to speed up the rate of convergence (Barro and Martin, 1992).

There exist two types of convergence: absolute and conditional convergence. Absolute convergence is related to neoclassical growth theory which assumes that countries will reach the same steady state

income if they start with the same level of savings, population growth, and technology. Conditional convergence, instead, concerns countries having different savings rates and population growth; the growth rates of these countries eventually convergence over time (Wilson, 2017).

Different initial stages of development between countries imply different economic growth patterns, and also the causal effect of one variable on another is likely to differ. Inequality may lead to under-investment in human capital and reduce growth (Berg and Ostry, 2018). In the modern growth regime, human capital accumulation has become the main driver of economic growth, and inequality increases the fertility of poor thereby reducing human capital accumulation and growth (Berg and Ostry, 2018). Therefore, inequality is harmful and initial differences between countries matters for economic growth.

3
Empirical Analysis

This section illustrates the empirical approach and it deeply investigates the relationship between government education expenditure and real GDP per capita. The first subsection summarizes the data coverage and the construction of this paper. It consists of two separate parts: the data description in the former, and an explanation of variables of the dataset in the latter. The second subsection describes the empirical model. An explanation of the methodology used in support to answer my research question will be provided.

3.1 Data

The database used for the empirical analysis is a panel based on data from World Bank and it consists of 36 OECD countries and India (37 countries in total), over the period 1990-2016. The Barro-Lee dataset, instead, has been used for years of schooling variable, that we have used as proxy for human capital (T*able A.5 Descriptive statistics of the variables*). The real GDP per capita, in billions of US dollars, is used as an indicator for economic growth. The government expenditure on education, expressed as % of GDP, indicates the investments in education made by government. Government expenditure on primary, secondary, and tertiary education as % value of total government expenditure on education have also been provided in order to see how government allocates the expenditure to the different levels of education. Another education variable, that is likely to be correlated with education expenditure and useful to explain the growth rate of an economy, is school enrollment. In our dataset, we take school enrolment ratio (as % of gross enrollment) for primary and secondary education, into account. The gross enrollment index is defined as a statistical measure to determine the number of students enrolled in school at several different grade levels. Percentage above 100 per cent indicates repetition and/or late entry. Age group is the variable identifying the age of population to be considered for average years of schooling. In order to avoid correlation issue between years of schooling and government education expenditure we take only the age group of 45-49 years into account. The variable of population has also been added to the model because it matters for economic growth, therefore it is important to control for population. Finally, our model includes the dummy variable for countries (called “developed”) in order to allow for an explanation of economic growth rate between developed and developing countries. The methodology employed to construct estimates of the main variables is provided below.

3.2 Empirical Specification

3.2.1 Econometric Techniques

In our econometric analysis, the panel data contains observations expressed in two dimensions: country and time. The former assumes that differences in data occur across individuals and not across time, the latter, instead, assumes differences in data across time and not across individuals. The cross-sectional dimension is represented by 37 countries (36 OECD and India), while the time dimension spans over the period 1990-2016. The panel specification allows for more accurate estimates, and so improves the efficiency of econometric estimates, because we can model the evolvement of variables through time and space, which helps to avoid omitted variable bias.

One of the econometric issues is the correlation of certain variables with the explanatory variables. The panel data specification tackles this issue allowing for controlling the effects of missing or unobserved variables. In order to have more accurate estimates, one of the most common techniques is fixed effects model. This model, in fact, allows to control for time-invariant and individual-invariant unobserved characteristics, specific of each country, that can be correlated with the observed independent variables, with subsequent effect on the outcome of interest.

As for the interpretation of coefficients in the linear regression models, we refer to statistical p-values and we consider the 95% confidence interval. The confidence intervals are related to p-values[3] such that the coefficient will not be statistically significant if the confidence intervals includes 0. Significant p-values assume values lower than 0.05, while non-significant p-values higher than 0.05,

[3] P-value. In statistical hypothesis testing, the *p*-value or probability value or significance is, for a given statistical model, the probability that, when the null hypothesis is true, the statistical summary (such as the absolute value of the sample mean difference between two compared groups) would be greater than or equal to the actual observed results.

at the confidence interval of 95%. Significant p-values indicate that the coefficients are statistically significant, and so the variable of interest has effect on the dependent variable.

In order to perform our analysis about government expenditure on education and economic growth, we have used the linear regression model. This is an econometric model that approaches to modelling the relationship between the dependent variable and one or more explanatory variables. This model allows to explain the variation in the response variable (dependent variable) that can be attributed to the variation in the explanatory variables (independent variables), and also to find if there exist causal relationship between those.

The linear regression model used in our analysis, is of the type of "Ordinary Least Squares" (OLS), that is a method helpful to estimate the unknown parameters in a linear regression model. OLS chooses the parameters of a linear function of a set of explanatory variables by the principle of least squares. This means minimizing the sum of squares of the differences between the observed dependent variable in the given dataset and those predicted by the linear function. The OLS estimator is consistent when regressors are exogenous, and optimal in the class of linear unbiased estimator when the errors are homoscedastic[4] and serially uncorrelated[5].

[4] Homoscedastic errors. The assumption of homoscedasticity (meaning "same variance") is central to linear regression models. Homoscedasticity describes a situation in which the error term (that is, the "noise" or random disturbance in the relationship between the independent variables and the dependent variable) is the same across all values of the independent variables.

[5] Serially uncorrelated errors. When error terms from different (usually adjacent) periods (or cross-section observations) are correlated, the error term is serially correlated. Serial correlation occurs in time-series studies when the errors associated with a given period carry over into future periods.

3.2.2 Linear Regression Models

Methodology

In order to investigate if there exists a causal relationship between government expenditure on education and real GDP per capita, we have regressed the growth rate of real GDP per capita (dependent variable) on the explanatory (independent) variables. These are: one-year lag of real GDP per capita logarithm ($\alpha lnGDP_{i,t-1}$), where the α coefficient reflects the existence and the speed of GDP per capita convergence, government expenditure on education as total (% of GDP), school enrollment ratio on primary and secondary education (as % gross enrollment ratio), average years of total schooling, and population. The error term $\epsilon_{i,t}$ is also included in each regression. We have used the growth rate of real GDP per capita both annually and over the five-year period as dependent variables, in order to see if the government expenditure on education has a different impact on those two. We assume that the lag 1 variables represent the short run, and lag 5 variables the long run. Furthermore, we have performed different linear regressions and we have noticed that, depending on the variables included in the model, coefficients have changed due to variables correlation issue. We have also performed regressions on primary, secondary, and tertiary education in a separate model and we have found that the expenditure is differently allocated to the three levels of education. In order to have more accurate estimates, we have performed the regressions in fixed effects.

Short-run Regression

The following linear regression models have the annual real GDP per capita growth rate as dependent variable.

(*i*= country, *t* = time)

Convergence effect

- $GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_2 population_{i,t-1} + \epsilon_{i,t}$

(1)

$$GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_1 ExpEduc_{i,t-1} + \beta_2 population_{i,t-1} + \epsilon_{i,t} \quad (2)$$

$$GDPgrowth_{i,t} = \beta_0 + \beta_1 Exp/GDPc_{i,t-1} + \beta_2 population_{i,t-1} + \epsilon_{i,t} \quad (3)$$

$$GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_1 ExpEduc_{i,t-1} + \beta_2 population_{i,t-1} + \beta_3 developed + \epsilon_{i,t} \quad (4)$$

$$GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_1 Exp\_prim_{i,t-1} + \beta_2 Exp\_sec_{i,t-1} + \beta_3 Exp\_ter_{i,t-1} + \beta_4 population_{i,t-1} + \epsilon_{i,t} \quad (5)$$

$$GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_1 ExpEduc_{i,t-1} + \beta_2 Enrol\_prim_{i,t-1} + \beta_3 Enrol\_sec_{i,t-1} + \beta_4 AvgYosTot_{i,t-1} + \beta_5 developed_{i,t-1} + \beta_6 population_{i,t-1} + \epsilon_{i,t} \quad (6)$$

Table A.1: Short-run Regressions

(a)

Dependent variable: real GDP per capita growth rate (one-year lag)

Independent variables	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
Constant	0.286***	0.0810***	0.353***	0.360***	-0.166	0.0389***
	(0.0361)	(0.0196)	(0.0427)	(0.0465)	(0.166)	(0.00434)
lag1lnGDP	-0.0246***		-0.0333***	-0.0343***	-0.0234	
	(0.00356)		(0.00435)	(0.00532)	(0.0163)	
lag1Exp_Educ		-0.007480*	0.00382	0.00399	0.0193	
		(0.00362)	(0.00361)	(0.00367)	(0.00592)	
lag1pop	-3.02e-11**	-4.84e-12	-2.18e-11*	-2.05e-11	-8.90e-11	-1.25e -11
	(9.39e-12)	(9.63e-12)	(9.90e-12)	(1.14e-11)	(4.60e-11)	(9.53e-12)
developed				0.00372	0.0186	
				(0.0107)	(0.0351)	
lag1Enrol_prim					0.00185	
					(0.00109)	
lag1Enrol_sec					-0.00136**	
					(0.000486)	
lag1lnAvgYosTot					0.160**	
					(0.00706)	
ratio (lag1Exp/GDP)						10.74***
						(4.893)
R^2	0.05	0.006	0.07	0.072	0.16	0.005
Observations	967	746	746	746	132	746

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(b)

Allocation of Expenditure into different levels of Education

Dependent variable: real GDP per capita growth rate (one-year lag)

Independent variables	OLS (1)	OLS (2)	OLS (3)	OLS (4)
Constant	0.0403*	0.00459	0.0768***	0.0331
	(0.0160)	(0.0249)	(0.0166)	(0.0725)
lag1Exp_prim	-0.0000278			0.000146
	(0.000572)			(0.000934)
lag1Exp_sec		0.000910		0.00105
		(0.000624)		(0.000927)
lag1Exp_ter			-0.00159*	-0.00176
			(0.000722)	(0.00101)
lag1pop	4.57e-12	3.09e-12	2.74e-12	5.12e-12
	(1.04e-11)	(1.03e-11)	(1.02e-11)	(1.05e-11)
R^2	0.0001	0.0040	0.0068	0.0136
Observations	642	649	708	635

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(c)

Average Years of Schooling as Proxy of Human Capital

Dependent variable: Average Years of Total Schooling in log (one-year lag)

Independent variables	OLS (1)
Constant	2.060***
	(0.0998)
lag1Exp_Educ	0.0612***
	(0.0167)
lag1population	-7.32e-10***
	(7.92e-11)
R^2	0.45
Observations	116

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$$lnAvgYosTot_{i,t} = \beta_0 + \beta_1 ExpEduc_{i,t-1} + \beta_2 population_{i,t-1} + \epsilon_{i,t} \quad (7)$$

Long-run Regression

The following linear regression models have the real GDP per capita growth rate over the five-year period as dependent variable.

$$GDPgrowth5_{i,t} = \beta_0 + \alpha lnGDP_{i,t-5} + \beta_1 ExpEduc_{i,t-5} + \beta_3 developed + \beta_2 population_{i,t-5} + \epsilon_{i,t} \quad (8)$$

$$GDPgrowth5_{i,t} = \beta_0 + \beta_1 Exp/GDP_{i,t-5} + \beta_2 population_{i,t-5} + \epsilon_{i,t} \quad (9)$$

$$GDPgrowth5_{i,t} = \beta_0 + \alpha lnGDP_{i,t-5} + \beta_1 ExpEduc_{i,t-5} + \beta_2 Enrol\_prim_{i,t-5} + \beta_3 Enrol\_sec_{i,t-5} + \beta_4 AvgYosTot_{i,t-5} + \beta_5 developed_{i,t-5} + \beta_6 population_{i,t-1} + \epsilon_{i,t} \quad (10)$$

Table A.2 Long-run Regressions

(a)

Dependent variable: real GDP per capita growth rate (five-year lagged)

Independent variables	OLS (1)	OLS (2)	OLS (3)
Constant	1.630***	1.366*	0.228***
	(0.123)	(0.505)	(0.0129)
lag5lnGDP	-0.153***	-0.253***	
	(0.0148)	(0.0412)	
lag5Exp_Educ	0.0255*	0.00971	
	(0.00990)	(0.0197)	
lag5population	-1.34e10**	-2.83e-10***	-8.52e-11*
	(3.49e-11)	(8.96e-11)	(2.65e-11)
developed	-0.0203	0.190*	
	(0.0279)	(0.0646)	
ratio (lag5Exp_Educ/GDP)			61.77**
			(19.00)
lag5Enrol_prim		0.00341	
		(0.00363)	
lag5Enrol_sec		-0.00247	
		(0.00158)	
lag5lnAvgYosTot		0.443*	
		(0.138)	
R^2	0.114	0.34	0.016
Observations	612	132	612

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.3: Long-run Regressions

(b) Average Years of Schooling as Proxy of Human Capital

Dependent variable: Average Years of Total Schooling in log (five-year lag)

Independent variables	OLS (1)
Constant	2.038***
	(0.0829)
lag5Exp_Educ	0.0714***
	(0.0149)
lag5population	-7.45e-10***
	(7.51e-11)
R^2	0.47
Observations	108

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Our linear regression models present variables in levels. The dependent variable is represented by the growth rate of real GDP per capita expressed as the difference of logarithm of real GDP per capita between time t and time $t-1$. As for the explanatory variables, $\alpha lnGDP_{i,t-1}$ represents the one-year lag logarithm of real GDP per capita, and this is useful to investigate the growth process (convergence) (*Equation 1*). The α coefficient captures the potential convergence effect, and it assumes a negative value which is associated, in fact, with faster subsequent growth. In this regard, we recall the Solow convergence where countries grow at faster rate, the further they are from the steady-state. The regression has been estimated with vce (robust) option, in order to obtain unbiased standard errors of OLS coefficients under heteroskedasticity.

In our model, the "years of schooling" variable is a useful indicator which contributes to determine economic growth. Years of schooling are linked to academic performance, and higher academic

performance is likely to make individual wages go up, which can be translated into higher real GDP per capita. However, pupils as well as graduate students are likely to achieve higher results if the education quality is good, proper education infrastructure are properly planned, and educational reforms are implemented in order to improve the education system. All of this depends on government expenditure on education, since investments aimed at achieving an effective teaching and learning will lead students to stay in school longer. Therefore, we can say that years of schooling is a potential channel through which the government expenditure on education influences economic growth (Berg and Ostry et al., 2018).

Fixed-effect Regressions

Our analysis also includes estimates in fixed effects in order to investigate, more specifically, the relationship between dependent and independent variables of different countries over time. The aim is to control both for time-invariant, and for country-invariant characteristics. The fixed effects estimator (also known as "within" estimator), θ_i, is used to refer to an estimator for the coefficients that include those fixed effects. The following equations represent estimates in fixed effects with the annual growth rate of real GDP per capita, and the growth rate over a five-year period as dependent variables.

Dependent variable: real GDP per capita growth rate (one-year lag)

$$GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_1 ExpEduc_{i,t-1} + \beta_6 population_{i,t-1} + \theta_i + \epsilon_{i,t} + dtime* + dcountry*. \quad (11)$$

$$GDPgrowth_{i,t} = \beta_0 + Exp/GDP_{i,t-1} + \beta_6 population_{i,t-1} + + dtime* + dcountry* + \theta_i + \epsilon_{i,t} . \quad (12)$$

$$GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_1 Exp\_prim_{i,t-1} + \beta_2 Exp\_sec_{i,t-1} + \beta_3 Exp\_ter_{i,t-1} + + \beta_5 developed_{i,t-1} + \beta_6 population_{i,t-1} + \theta_i + \epsilon_{i,t} + dtime* + dcountry*. \quad (13)$$

$$GDPgrowth_{i,t} = \beta_0 + \alpha lnGDP_{i,t-1} + \beta_1 ExpEduc_{i,t-1} + \beta_2 Enrol\_prim_{i,t-1} + \beta_3 Enrol\_sec_{i,t-1} + \beta_4 AvgYosTot_{i,t-1} + \beta_5 developed_{i,t-1} + \beta_6 population_{i,t-1} + \theta_i + \epsilon_{i,t} + dtime* + dcountry*. \quad (14)$$

Dependent variable: Average Years of Total Schooling in log

$$lnAvgYosTot = \beta_0 + \beta_1 lag1ExpEduc_{i,t-1} + \beta_6 population_{i,t-1} + + dtime* + dcountry* + \theta_i + \epsilon_{i,t} . \quad (15)$$

Dependent variable: real GDP per capita growth rate (five-year lagged)

$$GDPgrowth5_{i,t} = \beta_0 + \alpha lnGDP_{i,t-5} + \beta_1 ExpEduc_{i,t-5} + \beta_6 population_{i,t-5} + \theta_i + \epsilon_{i,t} + dtime* + dcountry*. \quad (16)$$

$$GDPgrowth5_{i,t} = \beta_0 + \beta_1 Exp/GDP_{i,t-5} + \beta_6 population_{i,t-5} + \theta_i + \epsilon_{i,t} + dtime* + dcountry*. \quad (17)$$

$$GDPgrowth5_{i,t} = \beta_0 + \alpha lnGDP_{i,t-5} + \beta_1 Exp\_prim_{i,t-5} + \beta_2 Exp\_sec_{i,t-5} + \beta_3 Exp\_ter_{i,t-5} + \beta_5 developed_{i,t-5} + \beta_6 population_{i,t-5} + \theta_i + \epsilon_{i,t} + dtime* + dcountry* . \quad (18)$$

$$GDPgrowth5_{i,t} = \beta_0 + \alpha lnGDP_{i,t-5} + \beta_1 ExpEduc_{i,t-5} + \beta_2 Enrol\_prim_{i,t-5} + \beta_3 Enrol\_sec_{i,t-5} + \beta_4 AvgYosTot_{i,t-5} + \beta_5 developed_{i,t-5} + \beta_6 population_{i,t-5} + \theta_i + \epsilon_{i,t} + dtime* + dcountry*. \quad (19)$$

Dependent variable: Average Years of Total Schooling in log

$$lnAvgYosTot = \beta_0 + \beta_1 lag1ExpEduc_{i,t-5} + \beta_6 population_{i,t-5} + \theta_i + \epsilon_{i,t} + dtime* + dcountry*. \quad (20)$$

Table A.4: Country and Time Fixed Effects (short-run)

(a)

Dependent variable: real GDP per capita growth rate (one-year lag)

Independent variables	FE (1)	FE (2)	FE (3)	FE (4)
Constant	1.484***	0.748*		0.0303
	(0.165)	(0.357)		(0.0686)
lag1lnGDP	-0.126***	-0.0753**		
	(0.0137)	(0.0278)		
lag1Exp_Educ	1.06e-12	-0.0295**		
	(1.48e-10)	(0.0110)		
lag1pop		-3.64e-10	1.22e-10	4.13e-11
		(4.35e-10)	(1.84e-10)	(1.88e10)
developed		0.465***	0.0499	
		(0.139)	(0.0626)	
lag1Enrol_prim		0.00104		
		(0.00186)		
lag1Enrol_sec		-0.000888		
		(0.00763)		
lag1Exp_prim			-0.00275**	
			(0.000898)	
lag1Exp_sec			-0.00188*	
			(0.000875)	
lag1Exp_ter			-0.000987	
			(0.00123)	
lag1lnAvgYosTos		-0.0458		
		(0.0753)		
Ratio (lag1Exp/GDP)				-1.10
				(7.864)
R^2	0.64	0.68	0.61	0.59
Observations	746	132	635	746

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A.6: Country and Time Fixed Effects Regressions (long-run)

(a)

Dependent variable: real GDP per capita growth rate (five-year lags)

Independent variables	FE (1)	FE (2)	FE (3)	FE (4)
Constant	6.311***			-0.00926
	(0.359)			(0.196)
lag5lnGDP	-0.563***	-0.579***		
	(0.0290)	(0.0786)		
lag5Exp_Educ	-0.0449***	-0.0494		
	(0.0103)	(0.0312)		
lag5pop	4.68e-10	1.53e-09	9.75e-10	4.07e-10
	(3.26e-10)	(1.23e-09)	(5.07e-10)	(5.20e-10)
developed		0.683	-0.386*	
		(0.393)	(0.196)	
lag5Enrol_prim		0.00204		
		(0.00527)		
lag5Enrol_sec		-0.000117		
		(0.00216)		
lag5Exp_prim			-0.00702**	
			(0.00257)	
lag5Exp_sec			-0.00254	
			(0.00240)	
lag5Exp_ter			-0.00299	
			(0.00360)	
lag5lnAvgYosTos		0.128		
		(0.213)		
Ratio (lag5Exp/GDP)				-35.17
				(26.27)
R^2	0.84	0.82	0.73	0.73
Observations	612	132	509	612

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Dependent variable: Average Years of Total Schooling in log (one-year lag)

(b)

Independent variables	FE (1)
Constant	1.623***
	(0.0664)
lag1Exp_Educ	0.0315*
	(0.0123)
lag1population	-5.03e-10
	(4.57e-10)
R^2	0.96
Observations	116

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Dependent variable: Average Years of Total Schooling in log (five-year lags)

(b)

Independent variables	FE (1)
Constant	1.741***
	(0.0801)
lag5Exp_Educ	0.0117
	(0.0129)
lag5population	6.57e-10
	(8.66e-10)
R^2	0.94
Observations	108

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4

Empirical Results

4.1 Hypotheses

According to the economic literature, there exists a positive relationship between education and human capital, but its effect on economic growth may be positive or negative, or there may be no effect at all. There are findings showing that public expenditure on education is positively associated with future economic growth, while the contemporaneous effect is negative (Chandra, 2010). It is widely known that the real GDP per capita is likely to be higher in developed countries than in developing ones, and this causes the government expenditure on education also to be higher (reverse causality) (Appiah, 2017). It has also been found that returns to education favour developed countries at the expense of developing ones (Chandra, 2010). Investments in education are likely to increase development and labor productivity, and income per capita (Appiah, 2017). Furthermore, the easier access to education is likely to increase the level of human capital, which is expected to increase innovation and boost the R&D sector, thereby affecting the growth rate of productivity (real per capita GDP).

According to Barro (2013), the years of schooling at the secondary level for males aged over 25 has a positive and significant effect on the subsequent economic growth rate. It is estimated that an additional year of schooling raises the economic growth rate by 0.44 % per year. Furthermore, we can see that tertiary education plays a crucial role. It has been found, in fact, that an increase by 1% in expenditure on tertiary education causes the illiteracy rate to decrease by 13%, and a close relationship between human capital and enrolment on tertiary education has also been found.

4.2 Linear Regression Results

This section will provide results of our analysis in order to answer the research question. Our findings reveal that the α coefficient of initial GDP is significant, and this means that there has been a convergence process of economic growth in the function. The total government expenditure on education is positively and statistically significant at 5% level of confidence interval, when we considering the growth rate of real GDP both in the short run and in the long run. But the difference between the two is that the government expenditure on education has effect on the annual growth rate of GDP only when the regression does not include any other variables, the one-year lagged GDP also not included. We can say that there exists correlation between education expenditure and the real GDP in the previous year, as well with the rest of variables. In our analysis, an increase of expenditure on education by 1 percentage point causes the real GDP per capita to decrease by 0.75% in the subsequent year, and to increase by 2.55% after five years.

In regard to the government expenditure allocated into the different level of education, only expenditure on tertiary education has a significant effect on real GDP per capita. An increase by 1 percentage point in expenditure on tertiary education leads to a decrease by 0.16% for the GDP growth rate in the short run. However, it needs to be mentioned, that expenditure on primary, secondary and tertiary education are likely to be correlated, in fact, the significance of their coefficients changes in the various regression models regression models (*Table A.1 b*).

As stated in the hypotheses, the growth rate of GDP is correlated with human capital, in fact, an increase in years of schooling determines the economic growth thanks to the accumulation of human capital which is fundamental for productivity (Temple, 2000). This means that there exists correlation between government expenditure on education and years of schooling. In fact, the more the government spends on education (higher quality of education), the higher is the incentive to stay in school longer. Our results, in fact, show that an increase by one-point percentage in expenditure on

education, induce people to spend more years in schooling. In fact, the average years of total schooling has increased over time (*Figure B.6*).

However, the more a country devotes resources to education, the higher the level of human capital. If we consider years of schooling as a proxy for human capital, we find that an increase in expenditure on education leads people to stay in school longer, and this means an improvement in human capital over time. In our analysis, we have regressed the average years of total schooling on government expenditure on education, and we have found that the expenditure coefficient is positive, but statistically significant only in the short-run *(Figure B.7*). One more year of schooling leads to an increase of the annual GDP growth rate by 0.16% and 0.44% of the growth rate of real GDP per capita in the short run and in the long run, respectively. The latter result is consistent with Barro's findings (2013).

In regard to the ratio of government expenditure on education to real GDP per capita, in OLS regressions the growth rate of GDP depends positively, and it is marginally significant, on expenditure ratio, both in the short run and in the long run. The progressive enhancement in the education system combined with a constant increase in government expenditure on education is important for economic growth. We have included the ratio of initial expenditure to GDP in order to control for economy's growth rate dynamics, and we have definitely concluded the positive impact it has on real GDP per capita growth rate. As for the school enrollment in primary and secondary education, in our OLS linear regressions, only school enrollment in secondary education has an impact on the annual real GDP growth rate, which results to be lower by 0.013% after an increase by 1% in school enrollment.

We have also included the dummy variable "developed" which assumes value 1 if countries are developed, and 0 if developing. Results reveal that the coefficient of dummy "developed" is positive

and statistically significant, and so developed countries experience a higher economic growth with respect to developing ones after an increase in government expenditure on education. Our findings reflect the hypothesis of reverse causality, that is richer and more developed countries spend more in education allowing them to experience a higher growth. Developed countries, in fact, perform above the OECD average in terms of real GDP (*Figure B.2*).

Fixed Effect Results

Focusing on the output of fixed effect regressions, results are different from OLS estimates. Since the initial level of real GDP per capita is likely to be correlated with the initial level of expenditure on education, the negative sign of initial level of GDP explains the catch-up effect of a nation, also in fixed effect models. The government expenditure on education, in fixed effect estimates, has a negative impact on economic growth, both in the short-run and in the long-run.

The estimated coefficient of the ratio of initial expenditure to GDP is not significant in fixed effect regressions, neither in the short run nor in the long run. When we analyze the average years of total schooling, we find that, in fixed effects, they have no effect on the real GDP per capita growth rate. When we consider the years of schooling variable, as proxy for human capital, as dependent variable, we have found that an increase in government expenditure on education induce people to stay on school longer, but only in the short run. The model which includes the dummy variable "developed" shows that developed countries experience a higher economic growth only in the subsequent year, and not over the five-year period.

Fixed effect models show the highest R^2, the indicator measuring the variability of the dependent variable reflected by the independent variables. The R^2 value provides an indication of the accuracy of the model estimated, and it gives a more accurate prediction in fixed effects estimation due to the highest number of variables.

4.2.1 OECD Countries. Do developed and developing countries differ to each other? Evidences from our findings.

A wide range of literature has found the existence of a positive causal relationship between education and economic growth. But the growth inequality may impair the political and economic stability of a country, thereby investments in education are also affected (Kolev &Niehues, 2016). In fact, growth inequality may impede the access to education, constraining in this way human capital accumulation (Kolev &Niehues, 2016). On the other hand, if the rate of return on investment in education is high, inequality may represent an incentive for people to seek education (Kolev & Niehues, 2016).
The government plays an important role in driving the economic growth of a country. Governments influence the income distribution in different ways and attempt to address inequality issues through redistribution. Education spending, in fact, is important for inequality that, in turn, matters for the economic growth of a country (Berg and Ostry et al., 2018). Government spending on education allows to generate human capital which represents a fundamental contribution to economic growth.

Different initial conditions and stages of development of a country, matter for economic growth. Inherited economic conditions, natural resources, histories, and institutions are likely to affect the economic growth process (Melo, 1997). This is one of the reasons why each country differently allocates the government expenditure and implements "*ad hoc*" reforms in the education system. Initial conditions might affect policies and make the outcomes even more likely to vary, and they also contribute to determine the effectiveness of policies (Melo, 1997).

In our analysis, we have included the dummy (*developed*) for countries in order to investigate if developed and developing countries differ to each other in terms of economic growth rate when investments on education are done. Our results reveal that the real GDP per capita, on average, is higher in developed countries with respect to developing ones, and the same happens when

considering the total government expenditure on education. Developed countries experience a higher economic growth (higher real GDP per capita growth rate) after investments in education. In regard to the allocation of expenditure into different levels of education, both developed and developing countries spend more on secondary education with respect to primary and tertiary, and this holds also for India (*Figure B.15*).

However, it is worth of mentioning that rich countries are more likely to have tools to make educational policies more effective which, instead, is very difficult in poor countries. Furthermore, in countries where people invest both more money and more time in education, there may be also other factors influencing economic growth. In our analysis, the causality effect of expenditure on GDP is positive, and its effect is stronger in the long-run.

4.3 Returns to education and cyclical fluctuations of real GDP per capita

Education is an important contribution to economic growth, and the real GDP per capita can also be interpreted as the "macroeconomic" return to education, because investments in education has an impact on real GDP. However, returns to education can be found both at microeconomic and at macroeconomic level since education is a fundamental contribution to both individual and social development. There exist some externalities in relation to investments in education as, for example, fostering technological innovation, which makes both labor and capital more productive and it allows income to grow (Temple, 2000).

In our analysis, we did not discuss "microeconomic" returns to education, neither we have considered individual wages. We have focused, instead, on "macroeconomic" returns and we have found that expenditure on education affects the productivity of a country and, in turn, the real GDP per capita through human capital accumulation (Appiah, 2017). Furthermore, GDP tends to increase or decrease

over time depending on different factors which can be endogenous or exogenous and, years of schooling, is one of them.

Our interpretation is that the real GDP per capita pattern assumes the form of a business cycle which fluctuates over time. In this way, economic fluctuations may determine the GDP "volatility" depending on changes in expenditure on education, educational reforms, and years of schooling. However, it needs to be mentioned that richer countries are more likely to have tools to make educational policies more effective which, instead, is less likely in poor countries.

5

Tests and Limitations

5.1 Diagnostic Tests

➢ Breusch-Pagan test

In our analysis, we have performed the Breusch-Pagan test in order to test for heteroscedasticity. In particular, we want to see whether the variance of errors from a regression is dependent on the values of independent variables. In that case, heteroskedasticity is present, and the estimate is biased. Test results are (Prob > chi2 = 0.0119) and (Prob > chi2 = 0.0450), respectively for the short-run and long-run real GDP growth rate. Therefore, we reject the null hypothesis of constant variance, and so heteroskedasticity is present.

Test Results: Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of *GDPgrowth*
chi2(1) = 6.33
Prob > chi2 = 0.0119

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of *GDPgrowth5*
chi2(1) = 4.02
Prob > chi2 = 0.0450

Source: STATA Output

➢ Cointegration test

We have performed the xtcointtest in order to test cointegration on our panel dataset. We have rejected the null hypothesis, therefore there exists cointegration between the real GDP per capita and government expenditure on education (H_o= no cointegration). Therefore, the real GDP per capita and government expenditure on education have non-stationary time series with variance and mean varying over time. The presence of cointegration also means that there exists a long run relationship between the two variables. From our findings, in fact, a relationship between real GDP per capita and expenditure on education over time emerges.

Kao test for cointegration

Ho: No cointegration		Number of panels	= 38
Ha: All panels are cointegrated		Avg. number of periods	= 14.816
Cointegrating vector:	Same		
Panel means:	Included	Kernel:	Bartlett
Time trend:	Not included	Lags:	1.18 (Newey-West)
AR parameter:	Same	Augmented lags:	1

	Statistic	p-value
Modified Dickey-Fuller t	3.6452	0.0001
Dickey-Fuller t	2.7581	0.0029
Augmented Dickey-Fuller t	2.2330	0.0128
Unadjusted modified Dickey-Fuller t	3.4386	0.0003
Unadjusted Dickey-Fuller t	2.4703	0.0067

Source: STATA Output

5.2 Theoretical and Empirical Limitations

There may be some limitations in our study, also in the dataset. There are variables presenting missing observations in some years, and this does not help for an accurate estimate of the model. Another issue regards the period of time taken into consideration that, in our case, spans over 1990-2016, but this may be not sufficient to capture the real effect of government investments and educational reforms on real GDP per capita. Larger samples, in general, allow to detect changes in variables better. Furthermore, in order to effectively see the real effect of educational reforms and government expenditure on education in India, we should estimate the model by using data only for India. This definitely biases the estimate because of too few observations. For this reason, we did not perform the analysis for India as separate from the rest.

Another potential limitation is the omitted variable bias which is likely to distort the estimates. In fact, the estimated coefficients vary according to the variables included in the regression model. This means that explanatory variables are correlated to each other and, omitting one of them, causes biased estimates. In fact, in our regression models, coefficients change and their level of significance too, when introducing new variables.

5.3 Does population matter for economic growth?

It is largely known from economic literature, that the real GDP per capita results to be lower if the growth rate of population increases over time. In fact, we can say that the real GDP per capita is affected by population density. Furthermore, although the government spends more on education and implements *ad hoc* educational reforms, this "effort" cannot keep up with an increase of the growth rate of population. In fact, the literature also states that the government expenditure on education per student is higher the lower the number of students.

Furthermore, children at the first stage of education tend to have an impact on productivity sector only in subsequent years, and this impact is captured by the real GDP. Educated children, however, have the opportunity to acquire skills and enhance their capabilities thanks to investments and educational reforms made by government. If they continued their studies at the secondary and tertiary level of education, instead of entering the labour market, they would contribute to the economic growth process at later stages.

If we think of people as the "raw material" of economic growth, we can say that countries with larger populations might enjoy, however, economic advantages in the long run, although the real GDP per capita appears to be lower than in countries with smaller populations. Furthermore, how population evolves over time has an impact on different channels (manufacturing sector, R&D sector, etc) linked with the economy of a country. Furthermore, population can be seen as the growth engine when it is considered as representation of cultural diversity (flexibility and advancement of knowledge) which has a positive impact on economic development (Ashraf & Galor, 2012). Furthermore, the size of population matters for the technological progress which determines the speed of productivity growth. This definitely affects the economic growth of a country (Ashraf & Galor, 2012).

6
Discussion and Concluding Remarks

Many authors state that the government expenditure on education and educational reforms represent a significant contribution for economic growth. Empirical findings in the literature show that a higher level of average education, often determined by the contribution of government through education expenditure, could make a country grow faster, but empirical results do not always go in the same direction. The purpose of this paper is to examine whether the government expenditure on education affects the economic growth rate of a country, through a panel data analysis. Furthermore, several hypotheses tell us how public expenditure affect the economy through other channels, for example years of schooling, and why investments in education are so important and crucial to determine human capital.

Results of our empirical analysis support the view that education, in particular public expenditure on education, contributes to economic growth. Our findings reveal that expenditure on education negatively (positively) contribute to economic growth in the short run (long run). We have extended our analysis by including also other variables as years of schooling and school enrollment since they are determinants for economic growth. In fact, an increase in government expenditure on education leads students to stay in school longer, which determines accumulation of human capital and, in turn, productivity. Therefore, we can say that, if we start with investments in education, we will achieve economic growth, both directly and indirectly, through various channels.

Only expenditure on tertiary education affects the real GDP per capita with a negative effect both in the short run and in the long run. Finally, the average years of total schooling also matters for the growth rate of an economy, with a positive effect when we consider the real GDP per capita both in the short run and in the long run. The OLS regression shows that there is a significant and crucial role

of expenditure on education in leading economic growth, although we have found a non-monotonic response of GDP to education expenditure over the period.

Our conclusion is that the government expenditure takes time before affecting the economic growth of a country therefore, a longer term allows the expenditure to be more effective. But when we control for specific characteristics fixed over time and/or common to all countries (time and country fixed effects), we have different results.

However, our findings show that not always expenditure on education has effect on economic growth. Our approach for results interpretation is that adverse macroeconomic conditions are likely to reduce the government's capacity to expand education expenditure, therefore expenditure may be not high enough to be translated into human capital accumulation, and so economic growth.

The main contribution of this thesis is threefold. Firstly, our model performs well in examining the impact that the government education expenditure has on economic growth, and to what extent education matters for growth. Secondly, our analysis conducted over the OECD panel allows to confirm that developed countries spend on average more in education with respect to developing countries, and that developed countries experience a higher economic growth. Thirdly, the case of India has been worth of investigation and useful as support for our findings, both for the structural agenda in education system and for the effort put into enhancing education expenditure. In fact, reforms implemented in the last decades, and the increase in government expenditure on education have significantly contributed to the economic growth in India.

Finally, we recognize the importance played by the government education expenditure on the economic growth of a country. However, governments in developing countries should continue to invest in education and improve educational reforms in order to achieve higher growth.

Appendix A

Tables

Table A.5: Descriptive statistics of the variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDP	1,005	27272.16	19804.51	302.2495	118823.6
Exp_Educ	751	5.132412	1.184635	0	8.55955
Exp_prim	652	27.38308	8.151577	1.258	60.52566
Exp_sec	658	39.05278	7.33843	13.68655	71.51826
Exp_ter	723	22.18045	5.509931	0.11096	36.81221
Enrol_prim	976	101.6092	4.938819	77.88938	124.8505
Enrol_sec	951	102.1752	17.92696	43.24251	163.9305
AvgYosTot	185	10.33714	2.272466	2.58	13.49
population	1,026	9.14e+07	2.55e+08	254826	1.32e+09

Table A.6: Correlation of variables

Variables	GDP	Exp_Educ	Exp_prim	Exp_sec	Exp_ter	Enrol_prim	Enrol_sec	AvgYosTot	population
Gdp	1000								
Exp_Educ	0.4295	1.0000							
Exp_prim	-0.0542	-0.1610	1.0000						
Exp_sec	-0.0633	-0.1909	-0.6631	1.0000					
Exp_ter	0.2971	0.2769	-0.3485	-0.1161	1.0000				
Enrol_prim	-0.0410	-0.0895	0.0387	0.0834	-0.0578	1.0000			
Enrol_sec	0.4051	0.5518	-0.2406	0.0125	0.2754	0.0823	1.0000		
AvgYos	0.4331	0.4881	-0.3148	0.1050	0.1298	-0.1341	0.5254	1.000	
population	-0.1332	-0.1502	0.0195	0.0218	0.0285	0.0467	-0.3384	-0.4360	1.000

Table A.7: List of 36 OECD Countries

Country name	Country Code
1. Australia	AUS
2. Austria	AUT
3. Belgium	BEL
4. Canada	CAN
5. Chile	CHL
6. Czech Republic	CZH
7. Denmark	DNK
8. Estonia	EST
9. Finland	FIN
10. France	FRA
11. Germany	DEU
12. Greece	GRC
13. Hungary	HUN
14. Iceland	ISL
15. Ireland	IRL
16. Israel	IRL
17. Italy	ITA
18. Japan	JPN
19. Korea	KOR
20. Latvia	LVA
21. Lithuania	LTU
22. Luxembourg	LUX
23. Mexico	MEX
24. Netherlands	NLD
25. New Zealand	NZL
26. Norway	NOR
27. Poland	POL
28. Portugal	PRT
29. Slovak Republic	SVK
30. Slovenia	SVN
31. Spain	ESP
32. Sweden	SWE
33. Switzerland	CHE
34. Turkey	TUR
35. United Kingdom	GBR
36. United States	USA

Note: India (OECD Key Partner, 2007)

Appendix B

Figures

Figure B.1: Real GDP per capita growth rate (1990-2016)

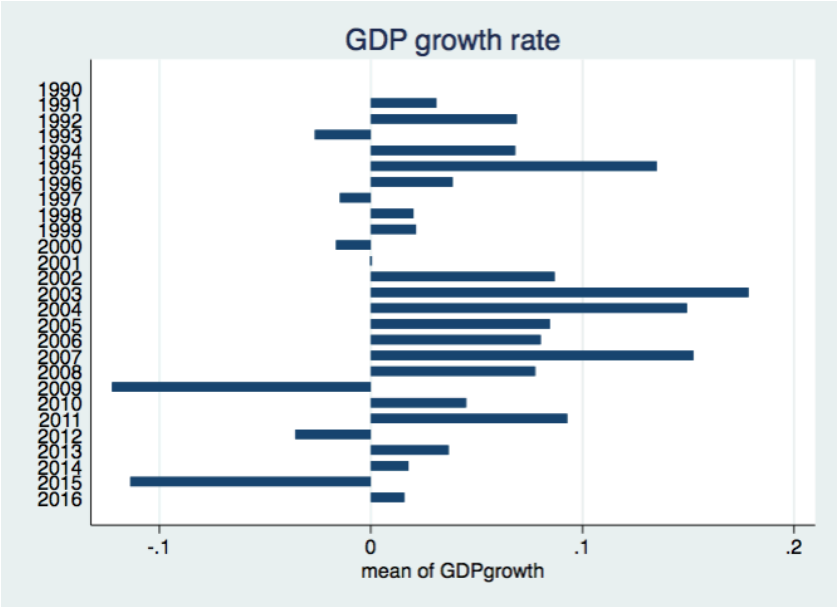
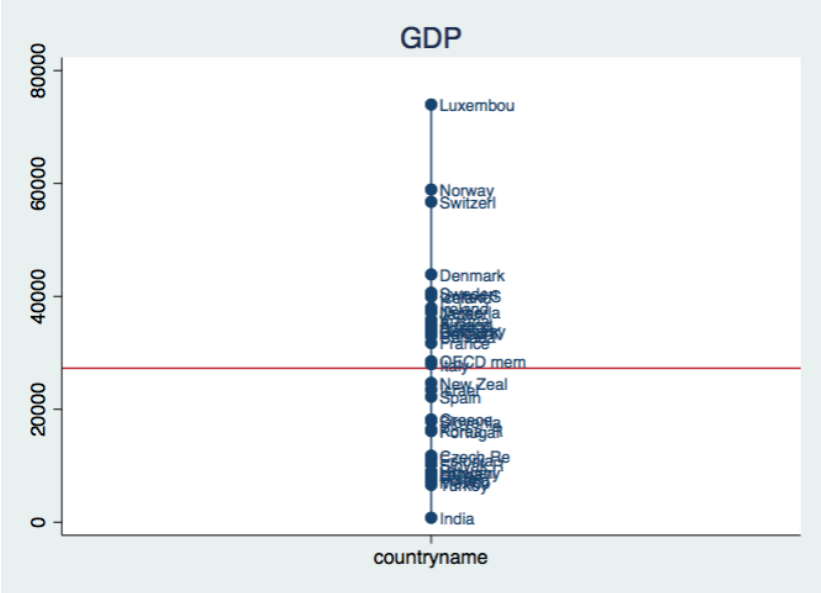


Figure B.2: Real GDP per capita (1990-2016)



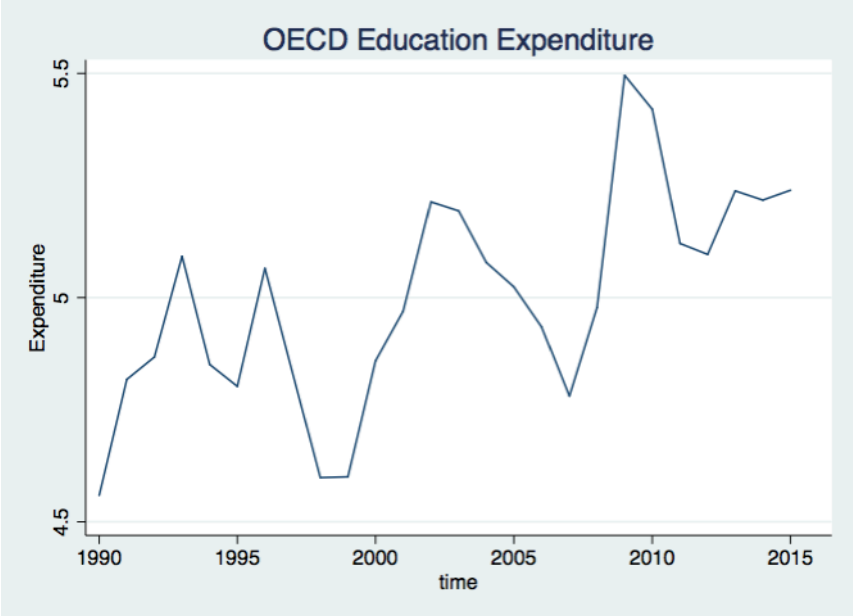
(Graph by scatterplot) Note: red line GDP mean for OECD members

Figure B.3: Trend of Real GDP per capita in OECD countries (1990-2016)

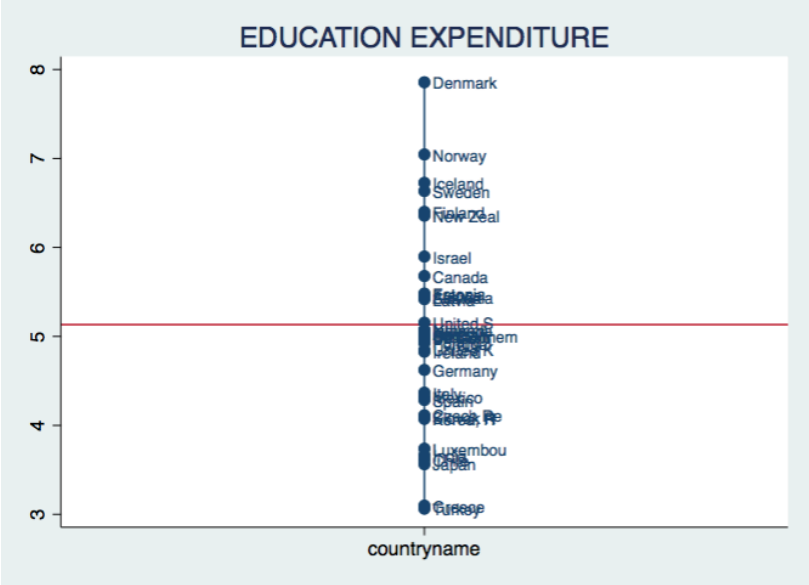
(Twoway graph)

Figure. B.4: Trend of Total Government Expenditure on Education in OECD countries (1990-2016)

(a) Twoway



(b) scatterplot



(c) Grmeanby (Graphs means and medians by categorical variable)

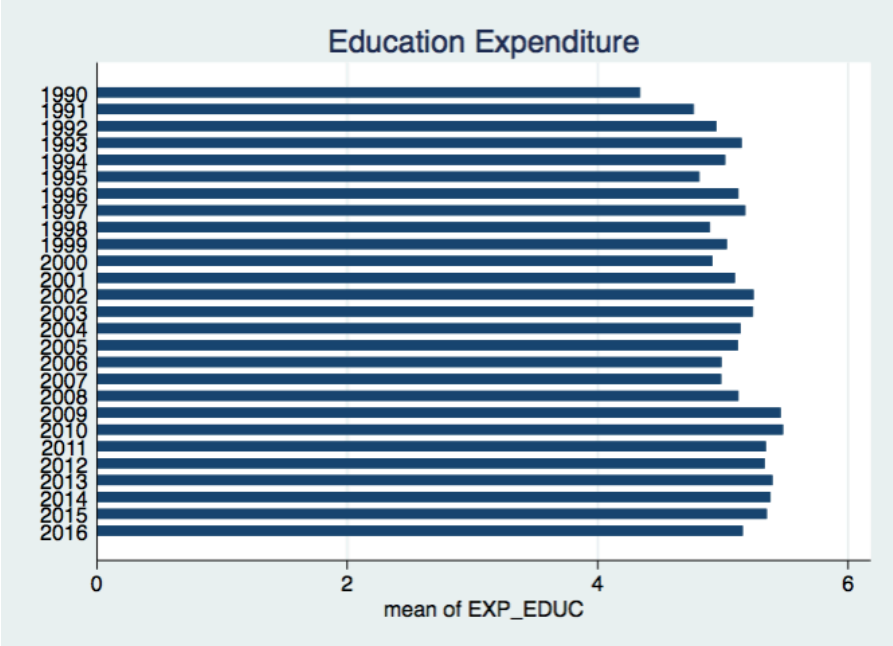
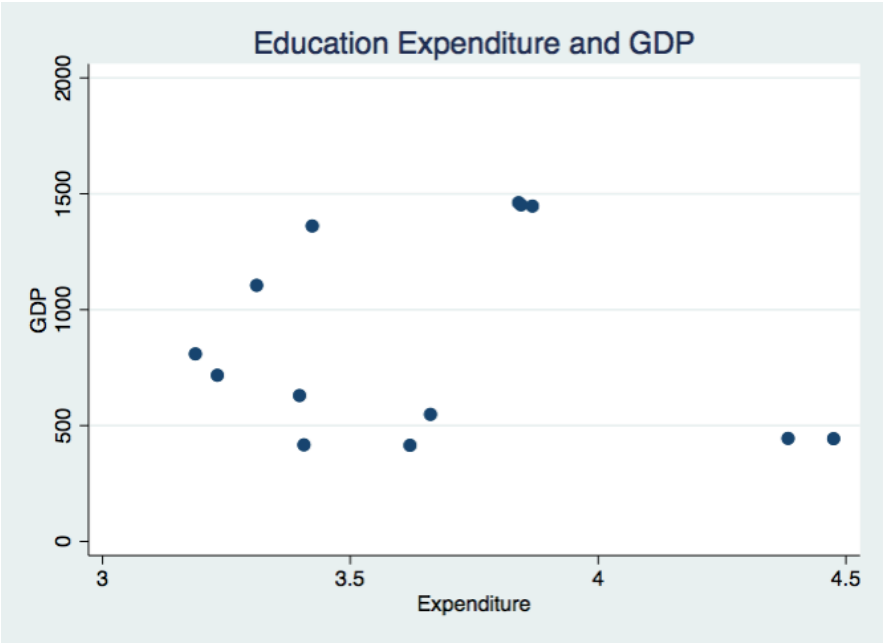
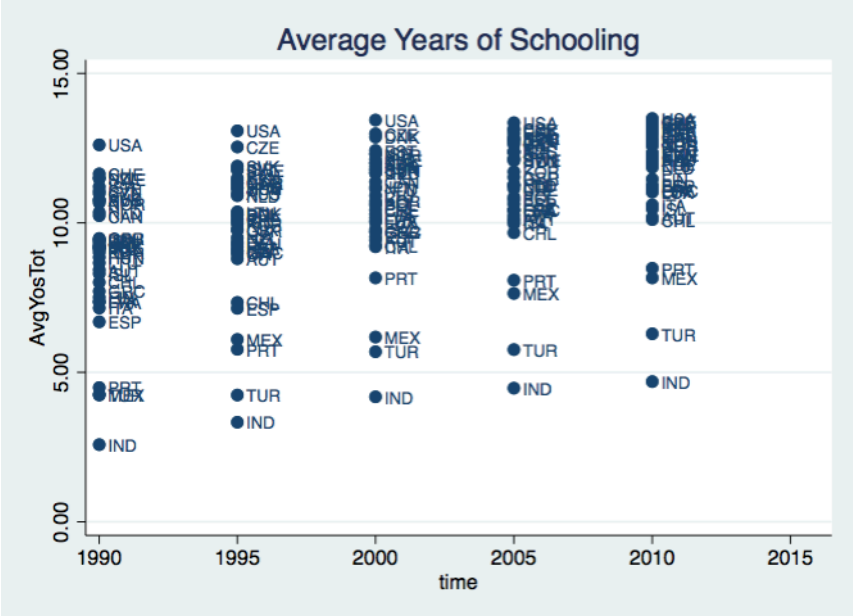


Figure B.5: Education Expenditure and Real GDP per capita in OECD countries



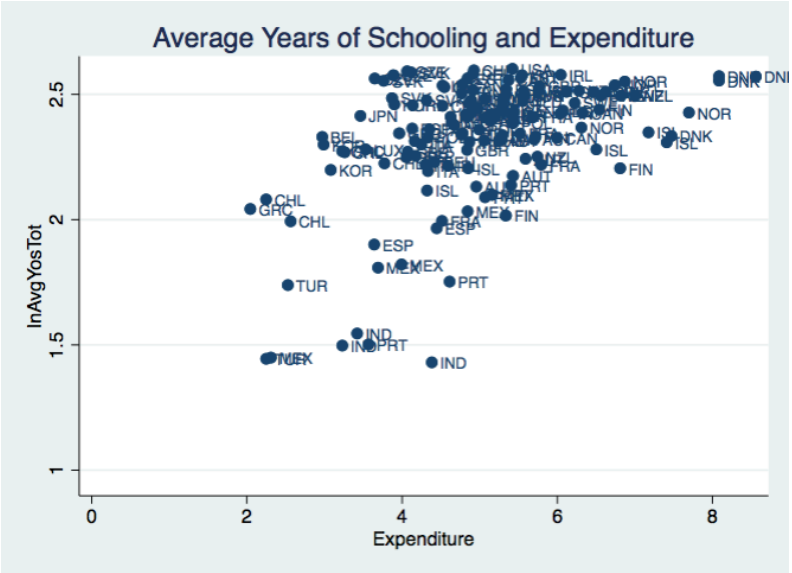
(Graph by scatterplot)

Figure B.6: Average Years of Total Schooling (1990-2016)



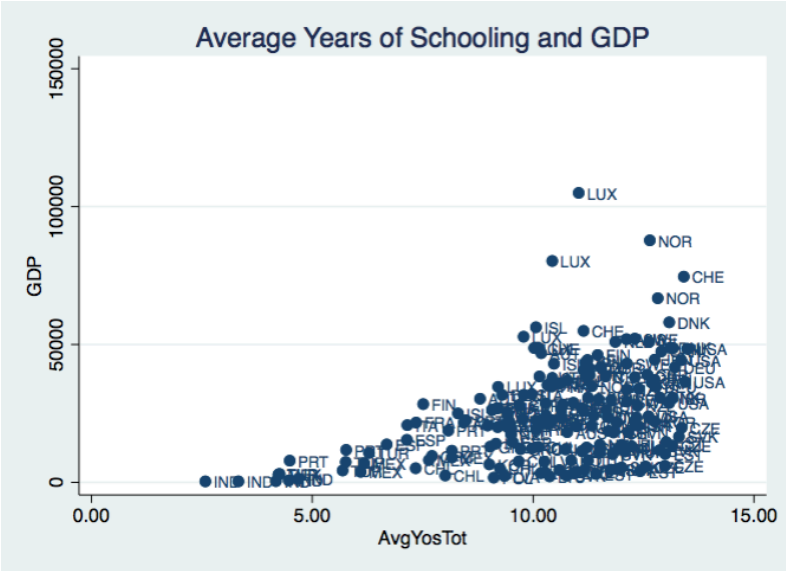
(Data by country, over time)

Figure B.7: Average Years of Total Schooling and Education Expenditure



(Graph by scatterplot)

Figure B.8: Average Years of Total Schooling and Real GDP per capita



(Graph by scatterplot)

Figure B.9: Trend of Real GDP per capita in India (1990-2016)

(a) Twoway

(b) Grmeanby

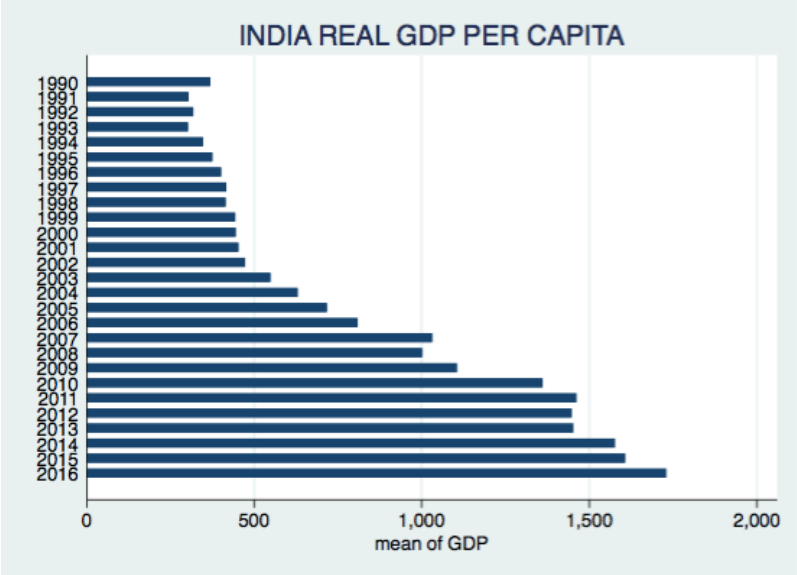
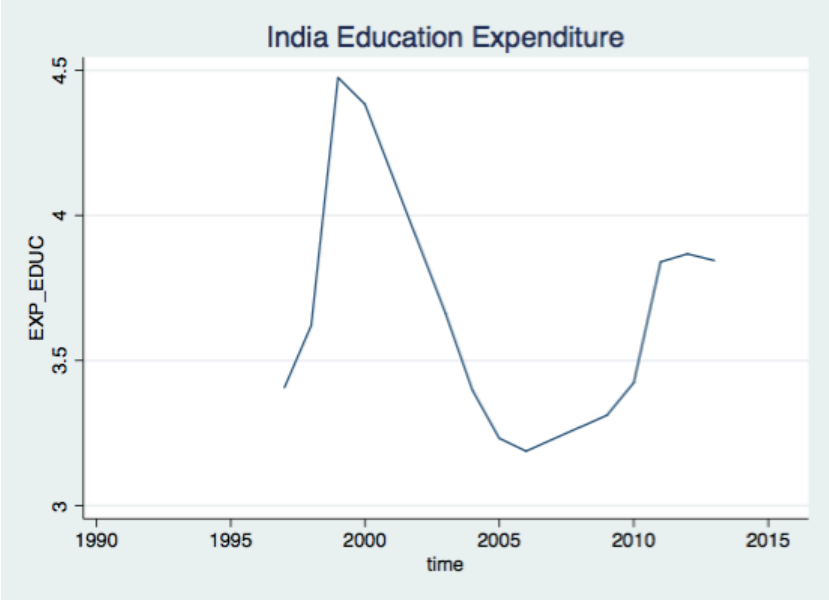


Figure B.10: Trend of Total Government Expenditure on Education in India (1990-2016)

(a) Twoway



(b) Grmeanby

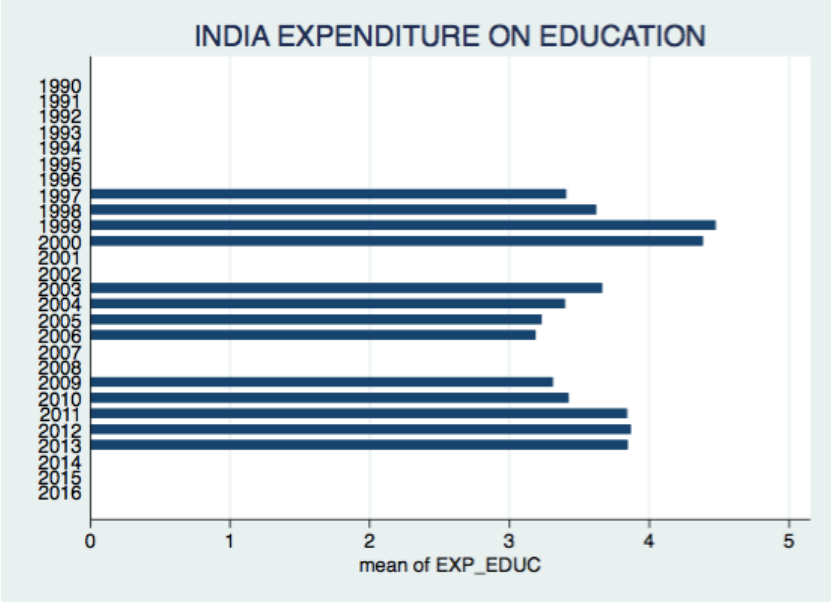
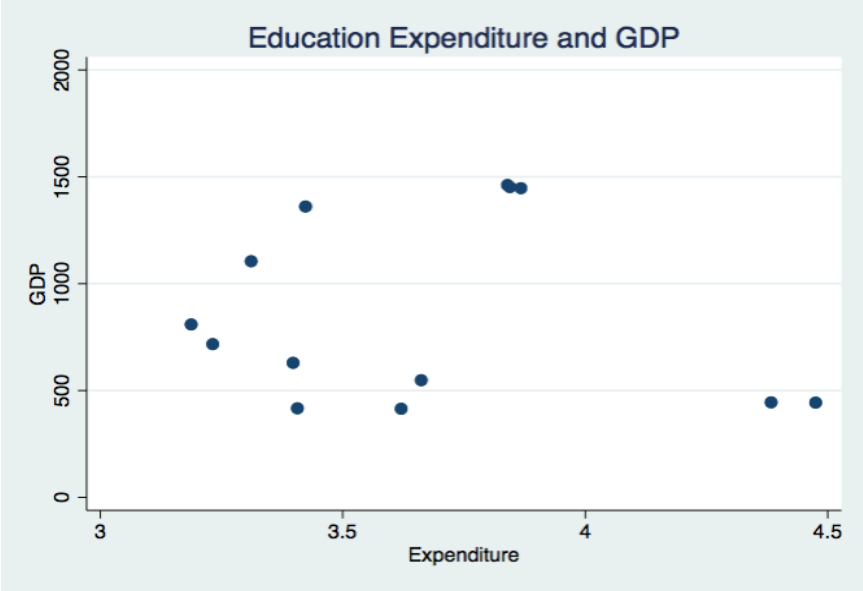


Figure B.11: Education Expenditure and Real GDP per capita in India (1990-2016)



(Graph by scatterplot)

Figure B.12: Average Years of Total Schooling (1990-2016)

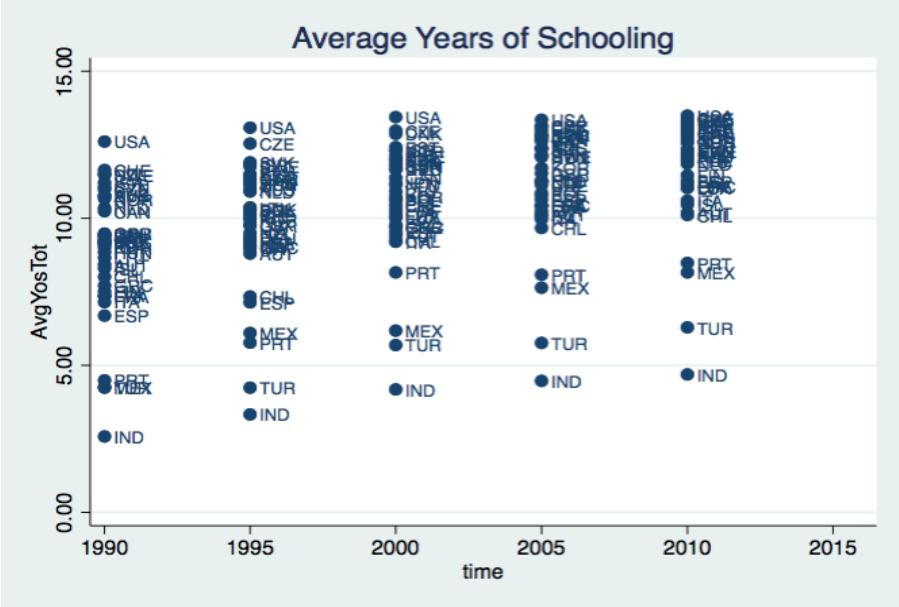
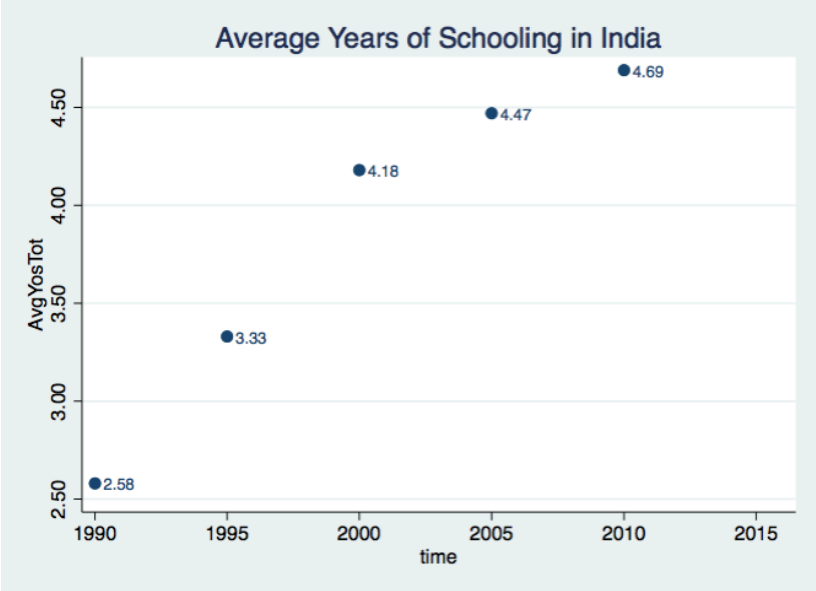


Figure B.13: Average Years of Total Schooling in India (1990-2016)



(Graph by scatterplot)

Figure B.14: Average Years of Total Schooling and GDP in India (1990-2016)

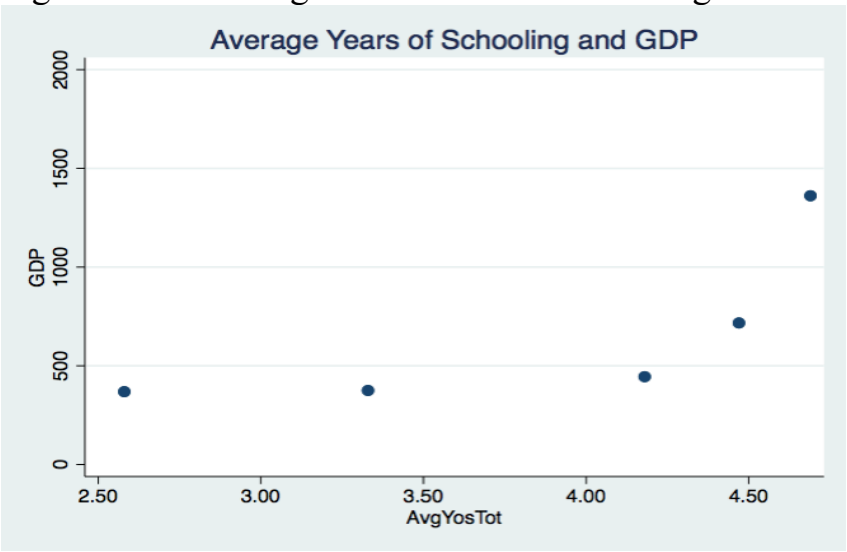
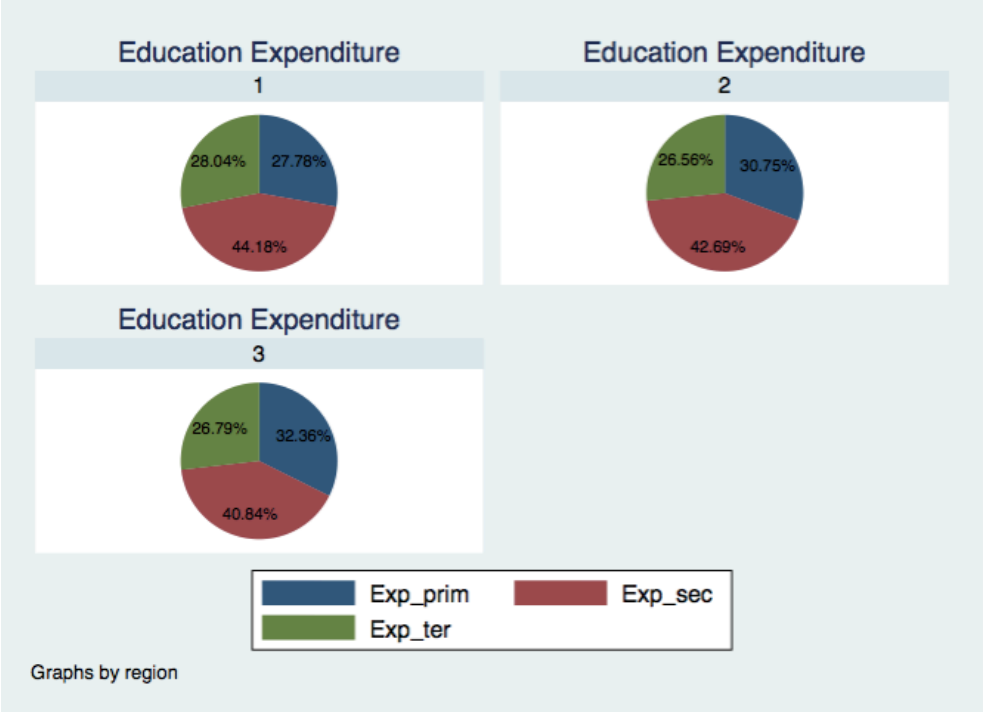


Figure B.15: Allocation of Expenditure on Primary, Secondary, and Tertiary Education between Regions



(Graph by region)

1= "developing"
2 = "developed"
3 = "India"

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