국제학석사학위논문

Contributions of Education to Economic Growth Among OECD Nations

OECD 국가들의 경제성장에 대한 교육의 영향

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Contribution of Education to Economic Growth Among OECD Nations

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Abstract

Since the early 1980s, there has been a revival of interest in human capital with the development of "new growth theory". The concept of human capital led many economists such as Paul Romer and Robert Lucas to question and propose channels through which human capital can promote economic growth and eventually built a widely accepted theoretical understanding of importance of human capital accumulation, which stimulates productivity, improves innovative capacity and facilitates diffusion and adoption of new technologies; hence, promotes growth. Thus, voluminous empirical research has been attempting to investigate growth effects of human capital through quantifying various aspects of human capital.

Among several proxies for human capital, 'education -average years of schooling' has been often placed in the center of attention. In fact, along with a world-wide steady increase in demand for higher education, growing body of growth literature has stressed the role of education as a core driving force of growth. However, majority of the existing studies focus on less-developed countries while little is known about growth effects of education within advanced countries.

Despite the long existence of varying approaches on the role of education in growth literature, the empirical evidence and analysis on full dynamics of education on economic growth of advanced countries remains unclear. In this regard, this paper raises

a question whether previous studies' results are applicable to advanced countries and aims to validate the relationship between education and growth for sample restricted to OECD countries. The paper provides a cross-country growth regression analysis on effects of education on economic growth for 36 OECD countries with the intervals of 5 years-, 10 years- and 20 years period from 1970 to 2010. Additionally, gender-specific panel growth regressions are also performed to distinguish gender effects of education.

This paper reveals that average years of schooling is statistically insignificant to the growth rate of GDP, which implies that a mere quantitative expansion of education creates trivial or no changes in knowledge and productivity level. Oppose to a general assumption on growth-enhancing effects of education, this result indicates that additional years of education insignificantly contribute to growth rate of GDP; therefore, a weak link to economic growth occurs in case of advanced countries with high initial level of education. Furthermore, female years of schooling appears to have significantly negative effects on growth for all short, mid, and long-term period, reflecting an underutilization of educated female labor.

Overall, this paper highlights a systematic problem in education centered around a quantity expansion and calls for a reassessment of education policies within OECD countries.

Keywords: education, government expenditure on education, economic growth, OECD, growth regression

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I. Introduction

A history of recorded economic growth reveals an undeniable phenomenon that the advancement in human capital facilitates a country's regime shift from a poor economic standing to a richer and healthier lives. It is, indeed, needless to exhaustively narrate the importance of human capital on growth. Since the early 1980s, there has been a revival of growth theory regards to human capital with the development of "new growth theory", which led to countless empirical research studies on determinants of growth. In the spirit of verifying the relationship between human capital and growth, various components of human capital, such as education, productivity, health and social attributes, are employed as a specification on growth regressions. Among several proxies for human capital, education -especially years of schooling- is often placed in the center of attention. In fact, along with a steady increase in demand for education, there has been a growing body of growth literature that further stresses the role of education as the core driving force of growth around the world.

With a strong theoretical support for the importance of education in growth process by Romer (1990), Mankiw et al. (1992), Aghion (1998) and many others, it has been widely accepted that the expansion of education, hence the accumulation of human capital, stimulates productivity, improves innovative capacity and facilitates diffusion and adoption of new information and technologies; therefore promotes growth. However, the empirical evidence on the effect of education on growth remains controversial. For instance, Barro (1991) argues there is a strong positive correlation between years of schooling and the subsequent growth rate of per capita GDP using full sample of countries; while Benhabib and Spiegel (1994) and Pritchett (2006) finds

no significant effects of years of schooling on economic growth. In this regard, despite the long existence of varying approaches on the role of education in growth literature, the empirical approaches and analysis on its full dynamics on economic growth is rather unclear.

Furthermore, majority of the existing studies focus on less-developed countries or all samples and little is known about the sample restricted to OECD or advanced countries. Despite the fact that most OECD countries manifest persistent effort and increasing demand for higher and better education, only few studies covers education and growth analysis within OECD countries. Therefore, this paper is an attempt to analyze contributions of education on economic growth in the context of OECD countries. Using time series data from 1970 through 2010 on educational attainment and economic growth, the analysis on cross-country growth regressions estimated by OLS reveals short and long-term growth determinants. Although there are other encompassing specifications of human capital that must not be ignored when performing growth regression, the main focus of the present study is on the role of education, measured by average years of schooling, as a core economic growth determinant.

This paper is organized as follows:

First part of the section 2 surveys the theoretical and empirical foundation of human capital, education and economic growth, beginning with the basic idea of human capital developed by Schultz (1961) and Becker (1964). This survey includes brief outlines of varying approaches to human capital over time and theoretical role of education supported by previous empirical analysis. Nonetheless, this survey of the

literature does not provide a complete review of this field but serve as a guide for a basic understanding of studies in education and economic growth. Following the brief cover of the related theories and empirical evidence, the overview of OECD countries' profile on their education standing and the reason behind for selectively choosing OECD countries as sample countries. This section closes with a discussion on the ongoing controversy that lies in the issue of measurement of education and presents both drawbacks and justification for using the conventional measure of education, average years of schooling.

Section 3 includes explanation of a framework for cross-country growth regressions and data constructed to serve the purpose of this paper. This modelling of a panel growth regression for 36 OECD countries observed from 1970 to 2010 is originally derived from the extended neoclassical growth model and variables are selected by referencing previous work of Barro (1997, 2001) and Krueger and Lindahl (2001). It aims to examine the key determinants of economic growth and how education contributes to growth within OECD countries. There are four key features of this framework. First, there are two dependent variables: growth rate of GDP per capita and ratio of investment to GDP. Second, effects education and other determinants on economic growth are estimated over 5 year-, 10 year- and 20 year- periods. Third, average years of schooling is chosen as a proxy for education and government consumption for education and for all other sectors are separately added as explanatory variables. Lastly, another set of regressions are performed with a gender specific education variable-male or female average year of schooling- to distinctively measure and compare the education effects differ by gender.

In section 4, empirical results of cross-country growth regressions for growth rate of GDP per capita and investment ratio to GDP are elaborated in detail. These analysis attempts to provide empirical assessment of the short-term and long-term growth effects of education variables and other determinants to possibly suggest policy implications specifically for advanced countries. The main results indicate that in case of OECD countries, education appears to have a statistically insignificant or marginally negative effect on growth. The gender -specific regression, on the other hand, shows significantly negative effects of female years of education on growth irrespective of any period interval.

Section 5 concludes.

II. Literature Review

2.1 Human Capital, Education and Growth

Does the accumulation of human capital positively contribute to the economic growth? Such issues of human capital have been largely debated due to the varying approaches on human capital analysis and mixed empirical evidence in the long-term effects of human capital are still in dispute.

The studies on human capitals travels far back. One of the initial basis idea of human capital was formulated in *The Wealth of Nation (1776)* by Adam Smith where he states "the acquisition of such talents[useful abilities]…during his education, study, or apprenticeship…make a part of his fortune…likewise that of the society…though it costs a certain expense, repay that expense with a profit". Its concept was further developed by Schultz (1961) and Becker (1964) that human capital is defined as acquired human capabilities including education and skills in a form of capital that yields economic returns both in private and public spheres.

In fact, the idea of human capital led to many economists to question and propose channels through which human capital may affect or perhaps even promote economic growth. Over the past three decades, the approaches on human capital continued to evolve. In the early 1990s, by conceptualizing the creation of human capital as endogenous response to market incentives, the "new growth" literature emerged and emphasized human capital's impact on generating long-term sustainable growth (Romer, 1986 & 1990). Later, the extended neoclassical model-based framework, which argues the empirical shortcoming of the Solow growth model due to

an omission of human capital in the traditional Cobb-Douglass function[1], was introduced (Mankiw, Romer and Weil ,1992).

In the late 1990s and the early 2000s, a "new revisionist"[2] view emerged claiming for a re-evaluation of the positive role of human capital on growth opposed to the previous findings on a strong positive cross-country correlation between initial schooling and the subsequent GDP per capita growth (Barro, 1991; Krueger and Lindahl, 2001). Such view raises skeptical questions on the issue of causality and reliability of previous growth models and suggests a possibility that there is a weak and even negative empirical relationship between education and growth (Bils and Klenow, 2002). Studies on human capital and its relations to growth persistently received a great academic attention throughout the course of the history of development economics yet there remains little agreement on the exact analysis mechanism on measurement and interpretation. Nevertheless, countless economists' previous attempts and continuing effort to investigate and to build consensus on the impacts of human capital on economic growth prove the overall magnitude of this matter.

Such importance in analyzing relationship of human capital and economic growth bring to the next challenge: quantitatively measuring human capital. One of the widely known and popularly used proxy for the level of human capital is "average years of schooling". Among multiple components of human capital, education has long

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[1] Traditional Cobb-Douglass function: $Y = f(AL^{\beta}K^{\alpha})$, where Y is total income, A is total factor productivity, L is labor input and K is capital input. The extended model argues for rate of human capital accumulation as an ordinary factor in macroeconomic production function. The extended Cobb-Douglass function: $Y = A(L)^{1-\alpha-\beta}K^{\alpha}H^{\beta}$, where H is the human capital.

[2] Cohen and Soto (2007).

been accepted as a significant determinant of economic growth. According to the theoretical growth literature, the role of education has three mechanism in which it promotes economic growth (Hanushek and Woessmann, 2010). First, increasing attainment of education promotes labor productivity which in the end accomplish higher equilibrium level of output production. Second, education allows for a larger scope of innovation and capacity for new skills, knowledge, and technology. Third, education can promote knowledge diffusion and transmission that ultimately leads to economic growth.

Given the theoretical role of education and the general notion that education fundamentally brings benefits to both private and public development, the number of previous literatures has surged high to estimate the impacts of education. Several cross-country regression studies were undertaken using varying time period, selection of sample countries and levels of educational attainment. For instance, Sianesi and Van Reenen (2003) reveal a positive impact of average years of schooling as it is associated with the rise of per capital income by 3 to 6 percent. Barro and Sala-i-Martin (1995) and Barro (2001) estimate a growth regression on the effects of different levels of education on growth and showed that average years of secondary education showed a stronger effect compared to average years of primary education for the sample of overall countries. Another interesting result on importance and demands for education indicates that despite of the benefits of education in increasing total productivity, education is under-invested and acquired less than socially optimal outcome (Rustichini and Schmidt, 1991)[3].

[3] Refer to Temple (2002) for further detailed reviews.

Education is evidently crucial to growth for overall sample; yet, it is unclear that such results are applicable to analysis for OECD countries. There are comparably lack of studies with direct relevance to OECD countries, which hinders one to draw close examination policy implication for advanced countries. Also, previous studies' large cross-country samples are clearly dominated by developing countries. Some of OECD-included studies, Barro (1991) and Gemmell (1996), find insignificant or marginally positive correlation between the educational attainment and subsequent growth. These studies, however, include limited numbers of OECD countries and mainly focus on higher level of education rather than overall education.

Building on previous literature described above on education and growth, this paper aims to identify the contribution of education, measured by average years of schooling, on economic growth within all 36 OECD countries during 1970-2010. This study's emphasis and restriction on the sample exclusively to OECD countries is further explained in the following section.

2.2 Education in OECD

One basic fact is that average years of schooling has dramatically increased over the past several decades for all countries around the world. Amongst all countries, OECD countries serve as a central role as a leading indicator of educational performance and system management. In the early 1960s, strictly limited numbers of people were able to acquire higher education as it was still a privilege of the few. Now a days, majority of the young adults in OECD have a relatively easier access to all levels and institutions of education and more than one third seeks for even higher education (OECD, 2011).

Table 1 Changes in Average Years of Schooling Among 35 OECD (1950-2010)

year	Age	
	15-34	15-64
1950	6.38	5.77
1955	6.63	6.03
1960	7.06	6.37
1965	7.58	6.80
1970	8.32	7.36
1975	9.00	7.93
1980	9.56	8.47
1985	9.96	8.88
1990	10.33	9.42
1995	10.66	9.99
2000	10.80	10.48
2005	11.12	11.02
2010	11.34	11.43

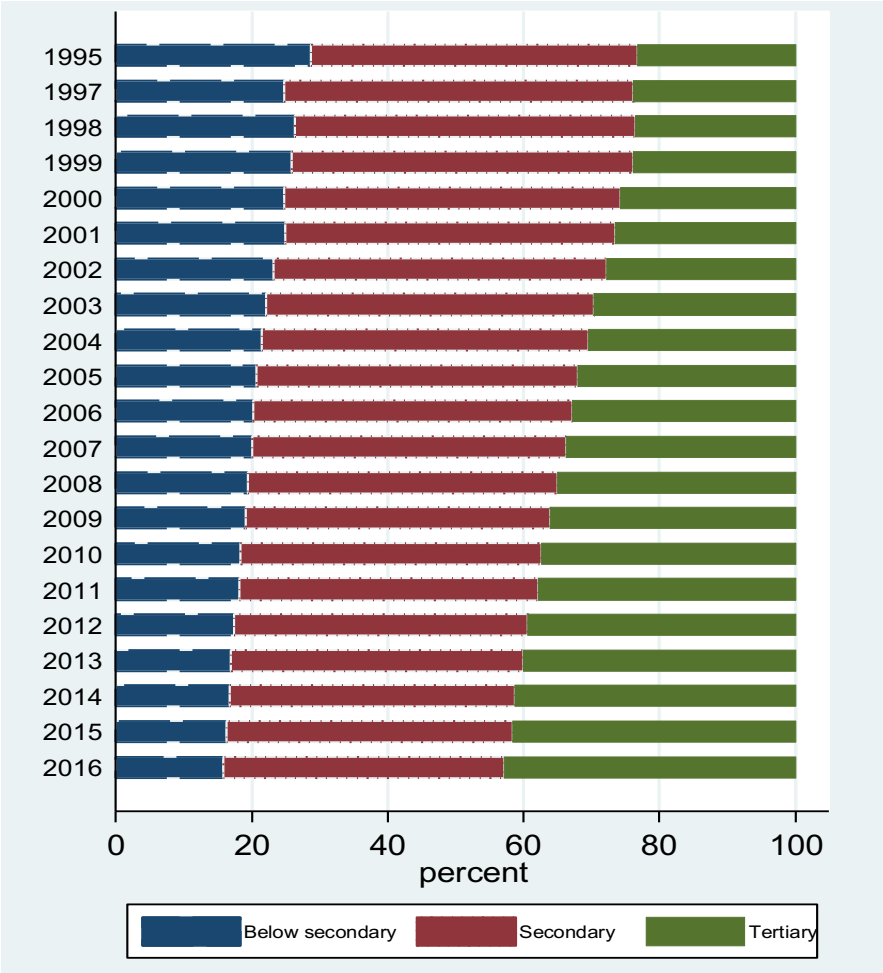
Data source: Barro and Lee (2018)

From 1950 to 2010, average years of schooling jumped by more than 90 percent, shown in Table 1, with a remarkably steady increase. The expansion of education has occurred at all levels that approximately 85 % of young adults have upper secondary and above education (OECD, 2017). In fact, OECD countries' average

years of schooling from 1950 to 2010 is 2.8 years higher than the world average years of schooling and 3.8 years higher than non-OECD countries.[4]

Figure 1 Population with Tertiary Education

(percentage in the same age group, OECD average) , 2016



[4] Appendix Table 16 for detailed summary on average years of schooling across countries

Additionally, Figure 1 illustrates the average OECD countries' changes in composition of population share of different levels of education. As shown, shares of tertiary education steadily increase while the share of below secondary education decreases. Along with the increases in years of schooling and shares of tertiary educated population, expenditure on education also increase by 20 percent within 10 years (2005 to 2015)[5].

These OECD statistics on education clearly indicates a strong and persistent individual and social demand for acquisition of education of all levels. Such phenomenon can be explained with the statistics on relative earnings advantages by education level. According to OECD Education at a Glance (2018), 55% of tertiary-degree have relative-earning advantage than those with upper secondary-degree and more than 80% of tertiary-degree earns more than the OECD median earning. Moreover, upper secondary education-degree is now seen as the minimum level of education in the labor market[6] that pushes younger cohort to extend their degree of education.

With the expansion of education and individual's relative-earning advantages in higher education in mind, one might wonder the aggregate impact of education on overall economic growth. Although existing statistical evidence suggests that educational attainment generally benefits individuals in OECD countries, impacts of education on economic growth of OECD countries are still ambiguous. To clarify both

[5] Appendix Table 11 includes detailed information on changes in expenditure on education, numbers of students, and expenditure per student by countries

[6] 85 % employment rate for tertiary-degree and 76 % employment rate for secondary-degree (Education at a Glance 2018, OECD)

short and long-term impacts of education on growth among OECD, this study runs a growth regression of average years of schooling on the growth rate of GDP per capita. Through this study, it is intended to reflect a macro-understanding of effects of education while suggest policy implication on the future of OECD education.

2.3 Proxy for Education: Quantity vs. Quality Controversy

Aside from the controversy on whether education is an appropriately and sufficiently reflects the measure of human capital, a true controversy lies on the measure of education itself. Many raises concerns for using years of schooling as a measurement for education. There are major drawbacks for using the conventional measure of schooling inputs, average years of schooling.

First and foremost, when performing time-series cross-country analysis, an identical quantity of education varies in its quality depending on a sample country and time period which ultimately leads to inconsistent effects on productivity, hence misleading interpretation on growth effects. Neglecting uncontrolled quality problem and solely rely on quantity of education implicitly assuming that any variations in quality of education are just a trivial factor. This notion leads one to consider a year of school in Israel, one of the most educated country, has the same merits and acquisition of knowledge as a year of school in, say, Niger, a country ranked as the least functional education system[7]. In fact, there is a study held by Hanushek and Kimko (2000), where

[7] Based on Human Development Report- Education Development Index (2013).

the effect of the quality of education, measured by the international mathematics and science test scores during 1960-1990, is statistically positive on economic growth and furthermore has stronger association with growth compared to the quantity of schooling.

Also, it is argued that health variable significantly factors into the source of learning. The simple use of years of schooling without controlling for health factor neglects the impacts of variety of health policies on development of human capital and the quality of education (Hanushek, 2013). Human capital is, indeed, difficult to precisely quantified and to have a sound measure given its multifaceted attributes. It is an undeniable that the measurement of average years of schooling is incomplete and, perhaps, even misleading proxy for human capital in a broad cross-country analysis.

Nonetheless, much of the empirical analysis on the relationship between education and growth has been centered around the use of quantity measure of education. Numbers of human capital proxies, such as enrollment rate, literacy rates, and average years of schooling, exist; yet, the latter is by far gained the most popularity within the work of economic growth and education mainly for its cross-country data availability. Not only average years of schooling has been used by the Human Development Reports of United Nations Development Programme (UNDP) as an indicator for the calculation of the Human Development Index, Barro (1991,2001,2010), Benhabib and Spiegel (1994), Cohen and Soto (2001) and many other influential empirical studies rely on average years of schooling as a education aspect of human capital proxy for growth regression.

Following the previous studies, this paper also uses average years of

schooling as a proxy for education. Given that this paper excludes all developing countries and confined its sample only to advanced countries, it is less likely to have such large education quality gaps among the sample countries[8]. Exclusively using OECD countries themselves partially controls for the quality issues. Moreover, to compensate for health aspect of human capital, a basic measure of health capital- life expectancy- is added to the model.

[8] According to Pearson Education, 27 OECD countries are ranked within top 40 educational system in the world.

III. Methodology

3.1 Framework

The majority of the early macroeconomic literature on schooling and economic growth present a significantly positive association between quantitative measure of schooling and economic growth. Despite of all, it still is questionable when the sample is confined to OECD countries for relatively recent period (1970 – 2010). Thus, in order to investigates the impacts of macroeconomic variables especially focusing on the contribution of education on economic growth among OECD countries, the estimation model is created by the following model:

$$\begin{aligned}\Delta Y_{i,t} = {} & \beta_0 + \beta_1 ln\,(GDP)_{i,t} + \beta_2 ln\,(GDP)sq_{i,t} + \beta_3 Schooling_{i,t} + \beta_4 Gov\_other_{i,t} \\ & + \beta_5 Gov\_edu_{i,t} + \beta_6 Open_{i,t} + \beta_7 Open \cdot GDP_{i,t} + \beta_8 Inf_{i,t} \\ & + \beta_9 Investment_{i,t} + \beta_{10} ln\,(Fer)_{i,t} + \beta_{11} Fem \cdot Fer_{i,t} + \beta_{12} Life_{i,t} \\ & + \beta_{13} Tot_{i,t} + \beta_{14} Rule_{i,t} + \beta_{15} Dem_{i,t} + \varepsilon_{i,t}\end{aligned}$$

where $\Delta Y_{i,t}$ is the growth rate of real GDP per capita, $ln\,(GDP)_{i,t}$is the log of real GDP per capita, $ln\,(GDP)sq_{i,t}$is the log of real GDP per capita squared. For the measurement of education, average years of schooling, $Schooling_{i,t}$[9], from Barro & Lee educational attainment database is used. Following regressors include an array of policy variables- the share of government spending on all sectors except

[9] Average Years of Schooling Index: $s_t^a = \sum_j h_{j,t}^a Dur_{j,t}^a$,

Where $h_{j,t}^a$ = fraction of schooling age group a having attained the education level j=pri, sec, ter. Dur = duration in years (Barro, 2010).

education, $Gov\_other_{i,t}$, the share of the government spending on education exclusively, $Gov\_edu_{i,t}$, a measure of international openness, $Open_{i,t}$, the rate of CPI inflation , $Inf_{i,t}$, the rule of law index, $Rule_{i,t}$[10] and the democracy index, $Dem_{i,t}$. Also included are investment ratio, the total fertility rate, $ln\ (Fer)_{i,t}$, the interaction term of average years of female education and fertility, $Fem \cdot Fer_{i,t}$, and the life expectancy, $Life_{i,t}$. Table 2 below further provides more detailed description of all the variables used in this paper.

Table 2 Variable Descriptions[11]

	Variables code	Variables	Description	Period
Dependent Variables	Y	Growth rate of real GDP per capita	The growth rate is formulated with three periods: 5 years, 10 years and 20 years	1950-2014
		Investment ratio to GDP	The average investment ratio to GDP for three periods: 5 years, 10 years and 20 years	1950-2014

[10] Missing values are replaced with the average of the forward and backward observations.

[11] Missing years were calculated by using the linear interpolation for the following variables: Schooling, Female*fertility.

Independent Variables [12]	Ln(GDP)	Log (per capita GDP)	Log of real GDP per capita	1950-2014
	Ln(GDP)sq	Log (per capital GDP) squared	Log of real GDP per capital squared	1950-2014
	Schooling	Average years of schooling (age over 25)	Barro & Lee data, missing values are calculated through the linear interpolation	1950-2010
	Gov_other	Govt. consumption_other	Government consumption(expenditure), as a share of GDP, excluding spending on education	1970-2011
	Gov_edu	Govt. consumption_edu	Government consumption(expenditure), as a share of GDP, exclusively of spending on education	1970-2011
	Open	Openness	The ratio of export plus import to GDP	1960-2018
	Open·GDP	Open*log GDP	The openness multiplied by the log (GDP)	1960-2014

[12] Original data sources are listed in the Appendix Table 9.

Independent Variables	Inf	Inflation	The inflation rate based on consumer price index	1950-2018
	Ln(fer)	Log(Fertility)	The log of the fertility rate as a main determinant of population growth	1950-2018
	Fem·fer	Female*Fertility	Average years of total female education multiplied by the fertility rate	1950-2010
	Life	Life Expectancy	Life expectancy at birth in years, which is compiled under UN Population division.	1950-2018
	Tot	Terms of Trade	The growth rate of the terms of trade, which is export price relative to import price	1970-2018
	Rule	Rule of Law	Rule-of-law index from World Governance Indicator (range -2.5 to 2.5)	1996-2014
	Dem	Democracy	Democracy index has four categories: full, flawed, hybrid, and authoritarian regimes (range 0-10)	1970-2010

The variables listed above are the key indicators in this paper to examine the short-, mid-and long-term determinants of the economic growth among OECD

countries. The empirical work considers two independent variables: the average growth rates and average ratio of investment to GDP; and has three education variable specifications varied by gender: total-average years of schooling, male-average years of schooling and female-average years of schooling. These gender-varying specification is to provide a granular examination on whether the contribution of education on economic growth and investment differ by gender. This cross-country growth regression model is estimated by OLS using the calculated average growth rate per capita and investment ratio based on intervals of 5 years-, 10 years- and 20 years- for all 36 OECD countries[13] over the period 1970-2010. The independent variables used in each regression analysis are calculated with the moving average of two years before and after as to avoid results being manipulated by the economic fluctuation of a particular period.

Above set of explanatory variables are mostly selected based on common specification of a cross-country growth regression of previous studies specializing on the role of education in growth. In fact, Barro (2001) presented a similar empirical framework to analyze the determinants of long-term economic growth in a panel for 100 countries from 1960 to 1995. His emphasis on education variable lies on using average years of schooling for male at upper level given his other finding suggests male-primary and female of all level of education are statistically insignificant. Also, Barro (2001) utilizes full-country samples with great heterogeneity of economic

[13] See appendix Table 8 for a full list of OECD members and dates of accession.

development, which inevitably exacerbate measurement error problem in different levels of education.

However, this paper chooses to use average years of all schooling as, first, it is most commonly employed measurement to identify the economic returns to education[14]. And the main focus lies solely on OECD countries where it is less likely to have measurement error for all levels of education; thus, the use of all years of schooling appears to be a more appropriate measure. Second, the use of years of schooling is further justified through the work of Krueger and Lindahl (2001) that the cross-sectional reliability of all years of schooling (0.903) is higher than average years of upper education (0.719). However, similar to Barro (2001), this paper will also include separate growth analysis with gender-specific education indicators.

Furthermore, in attempts to analyze the effects of government spending on education on economic growth, government consumption as a percentage of GDP variable is divided into two separate variables: government consumptions exclusively on education and government consumption on all other sectors. The government consumption on all other sectors includes spending on general public services, defense, public order and safety, economic affairs, environmental protection, housing and community amenities, health, recreation, culture and religion, and social protection. The education variable and the ratio of government consumption to GDP on education are the key components of the regression as it is expected to reflect assessments of

[14] This paper's intention for using the average years of schooling is explained in the previous section 2.3.

continual educational expansion on growth among OECD countries.

International openness measure, ratio of export plus import to GDP, is included since it is often expected to positively contribute to economic growth as trade openness can potentially promotes international competitiveness and allocation efficiency. Another important indicator for growth is inflation. The influence of inflation on growth is well established as substantial, particularly medium or high inflation's adverse impact of impeding efficient resource allocation by changing relative prices.

Aside from education, one of the core components of human capital includes health. Aggregate measure of health variable- life expectancy at birth-is added to the model. However, another common health variable- infant mortality rate- is excluded as it is commonly used as a determinant for growth of less-developed countries and proven to be insignificant in Barro (1996).

3.2 Data

With the exception for rule-of-law indicator and democracy index[15], the panel data constructed for the purpose of this study are derived from four main databases[16]: OECD Statistics, Penn World Table version 9.1, Barro and Lee (2018) and World Development Indicator.

For the selection of the educational attainment dataset, Barro and Lee (2018) is used over OECD statistics because the Barro and Lee (2018) data set on educational attainment includes cross-country panel data on the distribution of population by age, gender and level of educational attainment. Data on investment ratio to GDP is mostly based on PWT 9.0 database; however, some of the missing values are replaced with IMF data observations.

The data provides total of 44 observations per country for each variable, except for countries - Czech Republic, Estonia, Lithuania, Latvia, Slovak Republic, and Slovenia- with limited data availability.

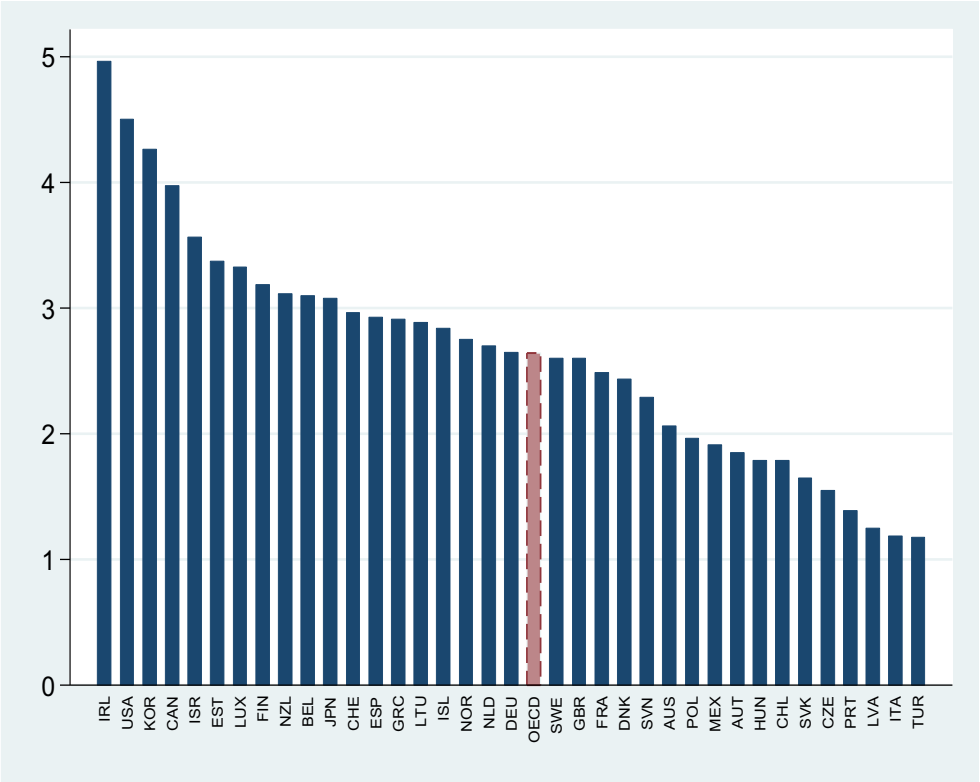
[15] Rule of law index comes from the World Governance Indicator, while the democracy index is taken from the Economist Intelligence Unit (EIU)

[16] Further detailed data descriptions are provided in the Appendix Table 9 and summary statistics of all variables are listed in the Appendix Table 10

IV. Empirical Findings and Discussion

From a theoretical perspective, there is a general consensus on the importance of education in economic development. How the expansion of education drive economic growth has been widely manifested around the world for both developing and advanced countries, and higher education is seen as the source of productivity and catalyst for technological innovation and adaption.

Figure 2 Tertiary Education in OECD: Percentage Changes from 1970 to 2010



Data source: OECD Statistics

Along with a firm belief that education is one of the key sources for growth, it

is clearly apparent that OECD countries have continued to place a strong emphasis on educational expansion that their years and levels of education persistently increased over time. Figure 2 shows the average percentage changes of tertiary schooling from 1970 to 2010. The total OECD average has increased by more than 2.5 percentage point per year during the past 4 decades. This substantial increase gives an overall reflection of a universal understanding that educational advancement is a key to foster higher economic outcomes.

Based on this background, one can only wonder the impacts of education on growth for both short and long-term. Following empirical analysis attempts to portray the contribution of education on economic growth as well as investment among OECD countries.

4.1 Effects of Education on GDP Growth Rate

Table 3 below reports panel growth regressions for samples spanning over 5 year-, 10 year- and 20- year periods. The dependent variable is the average growth rate of GDP per capita. Column 1 indicates that average years of schooling for all population of age 25 and above has a marginally negative effect on the subsequent rate of economic growth under high frequency changes (5 years). However, the negative effect of average years of schooling disappears in its significance for mid- and long-term effects; and becomes insignificant. Figure 3 depicts this partial relationship.

Table 3 Panel Regressions for Growth Rate

Independent variable	Growth rate of GDP		
	(1) 5 Years	(2) 10 Years	(3) 20 Years
Log(per capita GDP)	-0.163**	-0.195***	-0.202***
	(0.0690)	(0.0407)	(0.0141)
Log(per capita GDP)squared	0.00774**	0.00919***	0.00965***
	(0.00346)	(0.00202)	(0.000721)
Schooling	-0.00260*	-0.000505	0.0000774
	(0.00133)	(0.000604)	(0.000394)
Gov_other	-0.000275***	-0.000150***	-0.000106***
	(0.0000765)	(0.0000391)	(0.0000282)
Gov_edu	-0.00107	-0.0000785	-0.000937***
	(0.000700)	(0.000356)	(0.000223)
Openness	0.0749**	0.0520***	0.0571***
	(0.0325)	(0.0188)	(0.00988)
Open*log GDP	-0.00611**	-0.00404**	-0.00505***
	(0.00304)	(0.00174)	(0.000914)
Inflation	-0.000863***	-0.000158***	-0.0000461**
	(0.0000862)	(0.0000260)	(0.0000184)
Investment	0.0305**	0.0279***	0.0453***
	(0.0147)	(0.00879)	(0.00519)
Log(Fertility)	-0.0333***	-0.0127***	-0.0248***
	(0.0114)	(0.00483)	(0.00324)
Female*Fertility	0.00108*	0.000215	0.000251

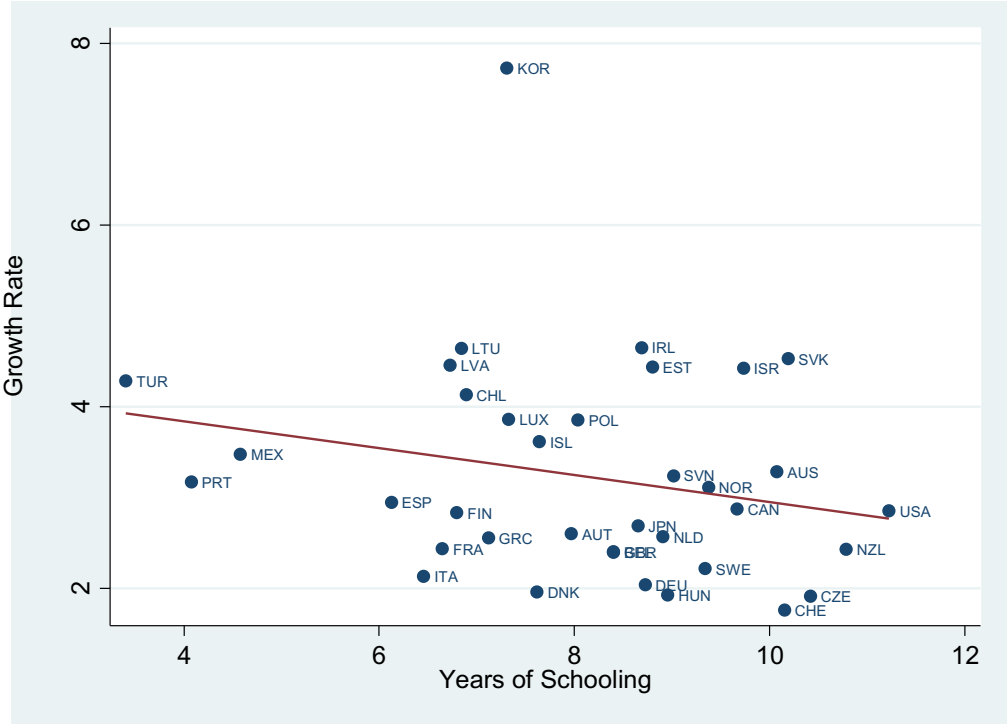
	(0.000596)	(0.000251)	(0.000167)
Life expectancy	-0.00148***	0.0000552	0.000301**
	(0.000355)	(0.000188)	(0.000117)
Terms of trade	0.174***	0.0233	-0.0185**
	(0.0395)	(0.0186)	(0.00909)
Rule of Law	0.0111***	0.0113***	0.00390***
	(0.00273)	(0.00141)	(0.000920)
Democracy	-0.0634***	-0.0517***	-0.0349***
	(0.0131)	(0.00743)	(0.00409)
Constant	1.055***	1.080***	1.072***
	(0.348)	(0.205)	(0.0719)
adj. R-sq	0.304	0.349	0.564
Standard errors	="* p<.1	** p<.05	*** p<.01"

Notes: Column 1 consist of changes for 1970-75, 1975-80, 1980-85, 1985-90,1990-95,1995-00, 2000-05, 2005-10. Column 2 consist of changes for 1970-80, 1980-90, 1990-00, 2000-10. Column 3 consist of changes for 1970-90, 1990-2010.

One possible explanation for this negative effect in the short-term lies in the matter of time span. It is likely that over the short time period, the actual effects and changes in average years of schooling would be close to nil while there exists relatively transitory component of the growth rate. Nonetheless, interpretation regarding short-term average years of schooling may be hampered by the short-run volatility in the data of average years of schooling. de la Fuente and Domenech (2002) find implausibly

abrupt short-run changes in some of OECD countries in Barro and Lee's education data. This implies there is an uninformative noise from measurement error that may give a misleading short-term trend analysis.

Figure 3 Growth rate vs. Schooling from 1970 to 2010



The long-term coefficient for years of schooling is positive yet insignificant. This result is consistent with Barro (2001) where he finds average years of schooling to be insignificant on growth during 1965-1995. Although positive coefficient has been a more common result shown that one-year increase in average years of schooling is positively associated with approximately 0.3 % per year faster growth or per capital

income raise by 3% - 6% for all samples[17], when the sample is restricted to advanced countries it becomes insignificant and small.

There are potentially two possible explanations for the long-term insignificant effects. Unlike developing countries, where added years of schooling leads to better educated workforce that helps to facilitate absorption of technologies from advanced countries, case for advanced countries with high initial level of education is more complicated. First, increasing or decreasing average years of education does not affect growth unless education yields greater achievement, in other words, improved productivity and skill. Average years of schooling, a mere quantitative expansion of education, may not directly convert into human capital due to trivial or no changes in knowledge or skill, productivity and skills; therefore, weak link to economic growth occurs in advanced countries. In case of countries with higher average education levels, more schooling can raise income, but it would not affect growth rate (Krueger and Lindahl ,1999). In fact, skilled human capital rather than larger human capital has a stronger growth-enhancing role for advanced countries that are considered technological frontier (Vandenbussche, Aghion and Meghir, 2006). Another explanation is that average years of schooling is not an appropriate proxy for human capital accumulation for OECD countries. Hanushek and Wobmann (2010) reveals that quality of education has a stronger association with growth than quantity of education. Thus, excluding measure of quality of education may lead to a distortion or underestimation on the effect of education on growth.

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[17] Bils and Klenow (2000) and Bassanini and Scarpetta (2001).

Another interesting result is shown in column 3 for government expenditure on education. Previous studies show that government expenditure has negative effects on growth with an exception for education. Nonetheless, OECD government expenditure on education has a negative long-term effect and statistically insignificant short-term effect. This coefficient estimate indicates a 0.01 percent per year decline in growth rate when there is an increase in Gov_edu of 10 percentage points in the long term. It is widely known that the returns to education are higher in less-developed countries. The growth impact of government expenditure on education weakens the higher the initial per capital income of a country. In other words, there exist a higher growth benefit of education in initially poorer countries. The relationship between government expenditure on education and growth has a "hump-shaped" pattern. (Benos, 2004) The results depend on the level of the countries' economic standings.

There are two arguments that can support this negative impact. First, given that in case of advanced countries where relatively high level of average educational attainment have already reached, more government spending on education often focus on the further "higher level of education that … implies an increase of inequality…led to a reversal of the previous pattern [inverted- U shape, educational Kutznet curve]" and drag long-run growth (Meschi and Scervini, 2013). In other words, when a country reaches a certain level of economic advancement, spending on education becomes inefficient as it no longer directly converts into a creation of "skilled" human capital stock and thus into economic and productivity growth. So, education expenditure is beneficial for growth at the initial stage of development then inhibit growth.

Second, Government expenditure on education can be largely divided into two parts: capital and current expenditure. According to OECD statistics, current expenditure accounts for approximately 90% of expenditure on education; and within those current expenditure, nearly 40 % is dedicated to the compensation of teachers. This could imply that the expenditure is oriented towards unproductive destination, which ultimately leads to create a negative impact on growth.

Government spending for all other sectors shows small coefficient but negative and significant as well. The estimated coefficients are (–0.000275), (-0.00015), (-0.000106) for 5,10 and 20 years respectively.

Additionally, when other independent variables are held constant, the estimated coefficient of the level of per capital GDP (log(GDP)) is strongly negative for all time intervals; while it is significantly positive for the log(GDP) squared. Also, the international openness displays a significantly positive effects; however, the interaction term with log of GDP shows significantly negative effect which implies the benefits of openness on growth diminishes as a country get wealthier. Furthermore, fertility has a negative effect on growth (-0.0248 for long-term), which is quite intuitive results. Given that high fertility rate, namely population growth rate, diverts economy's investment and resources away from production to capital for new population, per capital GDP has a tendency to decline with an increase of fertility rate.

Table 4 Pooled OLS with a Country Dummy

Independent variable	Growth rate of GDP

	(1) 20 Years	(2) 40 Years
Log(per capita GDP)	-0.163***	-0.199**
	(0.0416)	(0.0848)
Log(per capita GDP)squared	0.00777***	0.00979**
	(0.00207)	(0.00429)
Schooling	-0.000758	-0.00349*
	(0.000650)	(0.00200)
Govt. Consumption_other	-0.0000207	-0.000244*
	(0.0000406)	(0.000133)
Govt.Consumption_edu	-0.00113***	-0.00202
	(0.000405)	(0.00126)
Openness	0.0390**	0.0861
	(0.0197)	(0.0651)
Open*log GDP	-0.00322*	-0.00735
	(0.00184)	(0.00612)
Inflation	-0.000172***	-0.000810***
	(0.0000280)	(0.000117)
Log(Fertility)	-0.0107**	-0.0433**
	(0.00527)	(0.0178)
Female*Fertility	-0.0000436	0.00151
	(0.000276)	(0.000955)
Investment	0.0235***	0.0425*
	(0.00877)	(0.0252)
Rule of Law	0.0125***	0.0109**

	(0.00170)	(0.00471)
Terms of trade	0.00690	0.269***
	(0.0180)	(0.0582)
Life expectancy	-0.000250	-0.00225***
	(0.000196)	(0.000587)
Democracy	-0.0444***	-0.0562***
	(0.00748)	(0.0208)
Country_dummy	0.00897***	0.00506
	(0.00191)	(0.00568)
Constant	0.922***	1.274***
	(0.209)	(0.422)
adj. R-sq	0.342	0.157
Standard errors in parentheses		
="* p<.1	** p<.05	*** p<.01"

Although the empirical results suggest that the effect of education is rather insignificant, one must carefully consider diminishing effect of education in order to verify the true effect of education on growth. It is plausible that the variation within 36 OECD countries in terms of their economic status and education level could manipulate the overall effects on growth. Thus, to control for the potential diminishing effect of education in certain countries, a country dummy variable is added. Among 36 OECD countries, 12 countries joined OECD after 1994 and these countries can be seen as late-bloomers within advanced countries. By distinguishing the effect from the

initial OECD members from the late-bloomer members for 20 years- and 40 years-span, this paper attempts to perform a robustness check and to rule out diminishing effect of education, shown in Table 4.

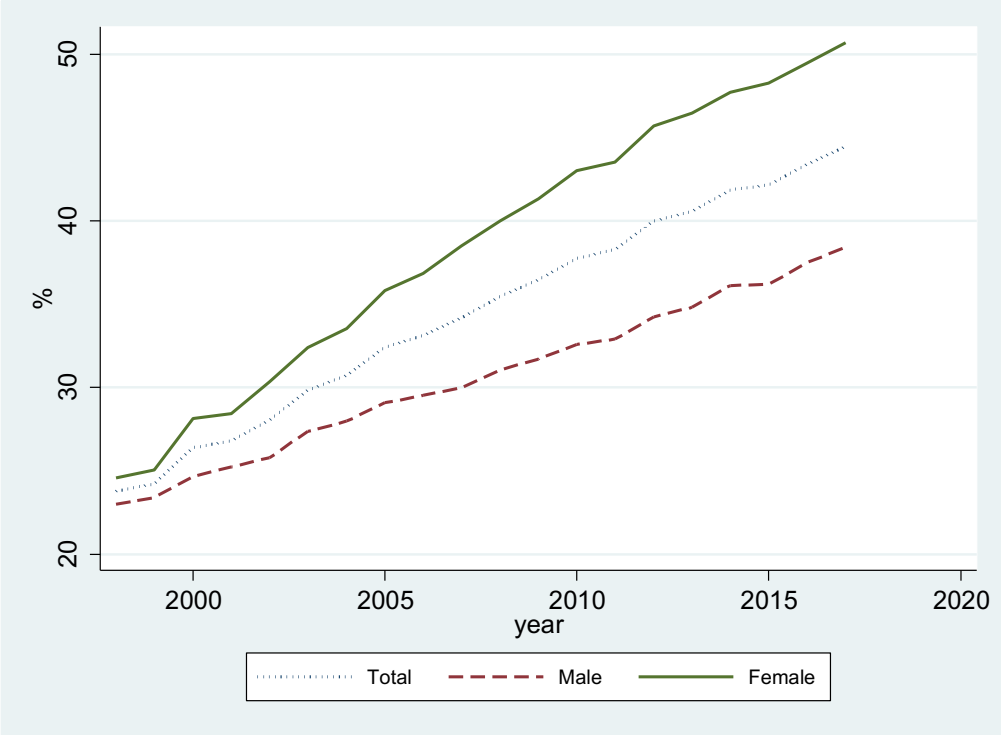
In Table 4, it shows consistent results with Table 3. The coefficient of years of schooling remains insignificantly negative; and government expenditure on education also remains significantly negative for 20 years-span while its significance disappears for 40 years-span. These consistent results imply Table 3 regressions yield robust results.

Table 5 Growth: Coefficients for average years of Schooling by Gender[18]

Average Years of Schooling		
	Male	Female
5 years	-0.00163	**-0.00286****
10 years	0.000484	**-0.00173*****
20 years	**0.000784****	**-0.000757***

[18] Full regression tables are listed in the Appendix, Table 11 and 12.

Figure 4 Share of Tertiary Education from 1998 to 2017 (25-34 cohort)



Data: OECD Statistics

This paper takes a further step to perform additional cross-country growth regressions using gender-specific schooling and to distinguish individual effects of education and to test gender discrimination hypothesis, which refers to discriminatory practices against women in the labor market that curtails the contribution of female education on growth. The coefficients for average years of schooling by gender are listed in Table 5 above. Women have outperformed men in higher educational attainment over the last two decades (Figure 4); however, it appears that results yield

support for the discrimination hypothesis[19] as the female-average years of schooling has strong negative effects on growth for all intervals; while male-education becomes significantly positive in the long-term.

Such results imply that even within so called advanced countries, gender discriminatory practices may exist to prevent educated female labor force to be efficiently utilized and to have explanatory power for growth. According to the statistics of Education at a Glance (OECD, 2017), under-utilization of educated female is reflected through differences in private internal rate of return to higher education between gender. In case of male's benefits for attaining tertiary education, private return is 13% while for female it is 11%[20]. Also, public internal rate of return for male is 10 % while female with tertiary education results in 8 %. Inefficient use of educated female is further proved by OECD countries' gender-earning and labor-force participation gaps that highly educated full-time women earns approximately 26% less than men with similar education background and female labor participation rate is 19% lower than male. These gender-gaps indicate a labor market distortion that created artificial barriers to educated female, which results in lowering the average productivity in overall human capital and, therefore, a sizable negative impact on economic growth (Klasen, 1999).

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[19] The results are consistent with Barro (2001) and Krueger (1999).

[20] Internal rate of return is calculated as follows:

Percentage changes of Total benefit (Income tax effect + Social contribution effect + Transfers effect + Unemployment benefits effect) - Total cost (Direct cost + Foregone taxes on earning), from upper secondary education to tertiary education

4.2 Effects of Education on Investment

In addition to the analysis on the determination of the growth rate of per capita GDP, this part will see whether education along with other determinants has any effects on investment ratio across OECD countries. Table 6 present parallel estimation for the cross-country growth regression on the ratio of investment to GDP. The key finding of Table 6 is that the stimulants of growth in the previous analysis also appear to be significant for investment. One major difference from the regression Table 3 is that overall coefficient significance declines, especially in the long-term effects.

The long-term effect of average years of schooling remains insignificant. However, short- and mid-term effects are significantly negative. The government consumption ratio also has significantly negative effects for short- and mid-term while the long-term coefficient is negative yet insignificant. These negative effects of government spending roughly suggest that high government spending, perhaps more on non-productive sectors, discourage economic growth by depressing investment.

Another important indicator is the rule of law. Among statistically significant and positive indicators, the rule of law index has the most explanatory power for investment. The rule of law index serves as a guide for reviewing a condition for a country's investment climate and, therefore, positively relates to investment. In other words, if the rule of law index shows positive standing, it signals better practices in property rights, contract enforcement, court regulation and basically overall more effective maintenance of the rule of law that creates attractive environment for investment.

Table 6 Panel Regressions for Growth Rate

Independent variable	Investment Ratio to GDP		
	(1) 5 Years	(2) 10 Years	(3) 20 Years
Log(per capita GDP)	0.330***	0.0976	-0.331***
	(0.0862)	(0.0944)	(0.0558)
Log(per capita GDP)squared	-0.0171***	-0.00522	0.0183***
	(0.00439)	(0.00474)	(0.00289)
Schooling	-0.0106***	-0.0122***	-0.00286
	(0.00222)	(0.00204)	(0.00176)
Gov_other	-0.00116***	-0.000958***	-0.0000820
	(0.000161)	(0.000138)	(0.000112)
Gov_edu	-0.00106	-0.00223	0.000538
	(0.00159)	(0.00144)	(0.00107)
Openness	-0.286***	-0.228***	0.0832*
	(0.0579)	(0.0602)	(0.0443)
Open*log GDP	0.0295***	0.0234***	-0.00876**
	(0.00542)	(0.00567)	(0.00413)
Inflation	-0.000626***	-0.000211**	0.0000282

	(0.000127)	(0.000101)	(0.0000767)
Log(Fertility)	-0.0441**	-0.0671***	0.00544
	(0.0198)	(0.0173)	(0.0136)
Female*Fertility	0.00152	0.00243**	-0.000841
	(0.00106)	(0.000986)	(0.000845)
Life expectancy	-0.000693	-0.000190	0.00131**
	(0.000693)	(0.000617)	(0.000553)
Terms of trade	-0.381***	-0.408***	-0.291***
	(0.0597)	(0.0611)	(0.0431)
Rule of Law	0.0545***	0.0514***	0.0274***
	(0.00508)	(0.00449)	(0.00344)
Democracy	-0.138***	-0.116***	-0.0226
	(0.0269)	(0.0245)	(0.0192)
Constant	-1.092**	0.00492	1.665***
	(0.436)	(0.473)	(0.279)
adj. R-sq	0.315	0.315	0.328
Standard errors in parentheses	="* p<.1	** p<.05	*** p<.01"

Same gender-specific regressions are performed for investment ratio as a dependent variable. Similar to the regression shown in Table 5, the estimated coefficients of female-average years of schooling appear to have significantly negative for all time intervals on investment (Table 7).

Table 7 Investment: Coefficients for average years of Schooling by Gender[21]

Average Years of Schooling		
	Male	Female
5 years	0.000428	**-0.0194*** **
10 years	-0.000742	**-0.0212*** **
20 years	**0.00401*** **	**-0.00973*** **

[21] Full regression tables are listed in the Appendix, Table 14 and 15

V. Conclusion

OECD countries, on average, spend about 5.3 % of their GDP on education and a total cumulative expenditure per student is approximately 93,561 USD for primary to upper secondary education. These statistics reflect a major commitment of a country's resources as a response to a steadily rising demand for higher education. Given such substantial commitment to education for several decades, it is important to examine the role of education on growth. Thus, this study provides a cross-country panel analysis for the determinants of short- and long-term economic growth, stressing on education indicator, within OECD countries observed from 1970 to 2010.

Using evidence from the previous literature and educational attainment data from Barro and Lee (2018), this paper calibrates a cross-country growth model to determine the actual contributions of education on growth. One striking findings of this study is the statistically robust, insignificant long-term effects of education among OECD countries. This result indicates a country with high level of education benefits less or has no impacts from a simple change or increase in the quantity measure of education without considering for quality that links to productivity and skill formation. Despite of continuous increase in years of schooling and maintaining world-leading level of education, such evidently insignificant effect of education within OECD countries points to a fundamental problem in education that lies in its quality rather than quantity. It can be suggested that unlike transitioning countries, OECD countries appears to reach a stage that human capital-driven growth is no longer achieved by mere expansion of education. Additionally, the government consumption on education is also revealed to

be significantly negative on growth, which further alerts for a re-evaluation of the conventional belief on positive effect of education and leads to an open-ended question for a new paradigm for educational policies.

Another interesting result relates to gender-specific growth regressions. It is shown that both growth and investment are negatively related to the female years of schooling in spite of larger shares of female in higher education. This implies under-utilization of educated female in the labor market, which also calls for a reassessment of labor market policies regards to discriminatory practices or systematic distortion that creates inefficiency.

The estimated coefficients of other growth determinants yield consistent results with previous literatures. For instance, rule of law index and the investment ratio in the growth panel are significantly positive. This can be interpreted as an effect from an effective and open investment environment, which indicates that the better maintenance of rule of law encourages more investment and, therefore, enhances growth. On the other hand, democracy, inflation and government consumption on sectors excluding education are shown to have significantly negative effects.

The aforementioned empirical results may help to provide general insight on the short-, mid- and long-term effects of quantitative measure of education on growth; however, bear a limitation stemming from an incomplete proxy for education and limited implications on individual OECD country's education policies. First, to fully capture the true measure of growth enhancing effects of education among OECD countries, it is crucial to consider qualitative aspect of education as well. Second, to draw proper policy

implications for OECD countries, it is necessary to take account of country-specific features of education and characteristics. In fact, policy suggestion should not fall into a hasty judgement based only on empirical results. Education can have crucial welfare benefits, such as effects on parenting, community engagement and public health, that data and empirical models often fail to capture the effect (Tempel, 2002). Thus, only standard recommendations, such as controlling for quality of education to secure the efficiency and eliminating gender discriminatory practice in labor market for better inputs of educated female, can be suggested with the results of this study. Further developed research is required to explore a way to appropriately derive policy suggestions for all and individual OECD countries.

Appendix

Table 8 List of OECD Member Countries (Last updated: 2018)

Country	ISO-3	Dates of Ratification
Australia	AUS	07-Jun-71
Austria	AUT	29-Sep-61
Belgium	BEL	13-Sep-61
Canada	CAN	10-Apr-61
Chile	CHL	07-May-10
Czech Republic	CZE	21-Dec-95
Denmark	DNK	30-May-61
Estonia	EST	09-Dec-10
Finland	FIN	28-Jan-69
France	FRA	07-Aug-61
Germany	DEU	27-Sep-61
Greece	GRC	27-Sep-61
Hungary	HUN	07-May-96
Iceland	ISL	05-Jun-61
Ireland	IRL	17-Aug-61
Israel	ISR	07-Sep-10
Italy	ITA	29-Mar-62
Japan	JPN	28-Apr-64
Latvia	LVA	01-Jul-16
Lithuania	LTU	05-Jul-18
Luxembourg	LUX	07-Dec-61
Mexico	MEX	18-May-94
Netherlands	NLD	13-Nov-61
New Zealand	NZL	29-May-73
Norway	NOR	04-Jul-61
Poland	POL	22-Nov-96
Portugal	PRT	04-Aug-61
Slovak Republic	SVK	14-Dec-00
Slovenia	SVN	21-Jul-10
South Korea	KOR	12-Dec-96
Spain	ESP	03-Aug-61
Sweden	SWE	28-Sep-61
Switzerland	CHE	28-Sep-61
Turkey	TUR	02-Aug-61
United Kingdom	GBR	02-May-61
United States of America	USA	12-Apr-61

Table 9 Sources of Data

Variables	Source
Growth rate of real GDP per capita	Penn World Table 9.1, available for download at "https://www.rug.nl/ggdc/productivity/pwt/"
Investment ratio to GDP	Penn World Table 9.1, available for download at "https://www.rug.nl/ggdc/productivity/pwt/"
Average years of schooling (age 25+)	Barro-Lee Educational Attainment Dataset, available for download at "http://www.barrolee.com/"
Govt. consumption_other	OECD Statistics, OECD, available for download at "https://data.oecd.org/"
Govt. consumption_edu	OECD Statistics, OECD, available for download at "https://data.oecd.org/"
Openness	World Development Indicator, the World Bank, available for download at "https://data.worldbank.org/"
Inflation	World Development Indicator, the World Bank, available for download at "https://data.worldbank.org/"
Log(Fertility)	Penn World Table 9.1, available for download at "https://www.rug.nl/ggdc/productivity/pwt/"
Female*Fertility	Penn World Table 9.1, available for download at "https://www.rug.nl/ggdc/productivity/pwt/"
Life Expectancy	World Development Indicator, the World Bank, available for download at "https://data.worldbank.org/"
Terms of Trade	OECD Statistics, OECD, available for download at "https://data.oecd.org/"
Rule of Law	Worldwide Governance Indicator, available for download at "https://databank.worldbank.org/data/reports.aspx?source=worldwide-governance-indicators"
Democracy	The Economist Intelligence Unit, World Democracy Report, available at "https://www.eiu.com/topic/democracy-index"

Table 10 Summary Statistics

Independent Variables	Obs	Mean	Std. Dev.	Min	Max
Growth rate of real GDP per capita (5-year interval)	1320	0.025875	0.027285	-0.12419	0.139158
Growth rate of real GDP per capita (10-year interval)	1140	0.025875	0.013944	-0.02779	0.093029
Growth rate of real GDP per capita (20-year interval)	780	0.021704	0.010747	0.004274	0.060127
Investment ratio to GDP (5-year interval)	1320	0.263694	0.057472	0.102201	0.461124
Investment ratio to GDP (10-year interval)	1140	0.261553	0.051455	0.14139	0.438709
Investment ratio to GDP (20-year interval)	780	0.261804	0.041159	0.161801	0.340453
Dependent Variables	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Log(GDP)	1512	9.990148	0.541888	7.675791	11.43626
Log(GDP)sq	1512	100.0999	10.67402	58.94032	130.7885
Average years of schooling (total)	1620	9.266314	2.278307	2.0356	14.968
Average years of schooling (male)	1620	9.646132	2.140294	2.854	15.348
Average years of schooling (female)	1620	8.924355	2.429987	1.216	14.59
Gov_other (Govt. consumption_other)	1286	38.35483	11.66635	2.28419	64.17774
Gov_edu (Govt. consumption_education)	1323	4.973076	1.263063	1.303005	7.99
Openness	1444	0.732829	0.446097	0.105682	3.577985
Openness*log GDP	1444	7.434275	4.842403	0.984436	40.92223
Inflation	1503	14.90376	48.63426	-0.58759	951.6962
Log(Fertility)	1620	0.61623	0.284187	0.130316	1.915808
Female education*Fertility	1620	16.50668	5.166516	5.983372	40.01226
Life expectancy	1620	74.91656	4.448705	52.2792	83.33862
Terms of trade	1437	0.000683	0.0232	-0.22335	0.128385
Rule of Law	1620	1.239069	0.618786	-0.72665	1.996155
Democracy	1620	0.761757	0.119828	0.428313	0.917889

Table 11 Changes in Total Expenditure Per Student

(Index of change - GDP deflator 2010=100, constant price)

	Change in total expenditure (2010=100)			Change in number of students (2010=100)			Change in expenditure per student (2010=100)		
	2005	2011	2015	2005	2011	2015	2005	2011	2015
Australia	77	99	114	95	102	107	80	97	107
Austria	m	m	m	m	m	m	m	m	m
Belgium	87	101	107	102	101	105	85	100	102
Canada	83	97	104	m	m	m	m	m	m
Chile	81	107	111	99	101	101	82	106	110
Czech Republic	85	107	107	104	99	95	82	109	112
Denmark	92	95	m	95	103	m	97	92	m
Estonia	87	99	105	113	99	90	77	100	117
Finland	89	102	99	100	99	99	88	103	99
France	92	99	101	100	100	103	92	99	98
Germany	90	101	101	104	99	99	86	101	103
Greece	m	m	m	m	m	m	m	m	m
Hungary	m	m	m	108	100	91	m	m	m
Iceland	105	102	115	96	100	99	109	102	117
Ireland	71	99	83	94	101	110	75	99	76
Israel	78	111	129	90	102	m	86	109	m
Italy	100	97	97	99	101	98	101	97	100
Japan	95	101	100	104	99	97	91	102	104
Korea	72	103	99	105	98	89	68	105	111
Latvia	102	102	122	126	95	89	80	107	137
Luxembourg	m	m	m	m	m	m	m	m	m
Mexico	88	102	116	94	101	107	94	100	108

Netherlands	87	101	103	96	100	100	91	100	103
New Zealand	m	m	m	m	m	m	m	m	m
Norway	m	95	112	98	101	104	m	94	108
Poland	83	97	106	117	97	91	71	99	117
Portugal	92	94	98	m	m	m	m	m	m
Slovak Republic	75	97	129	112	97	90	67	100	143
Slovenia	96	99	87	107	99	97	89	100	90
Spain	82	98	96	94	102	107	88	96	89
Sweden	94	101	108	107	100	105	88	101	103
Switzerland	m	m	m	m	m	m	m	m	m
Turkey	m	m	m	m	m	m	m	m	m
United Kingdom	m	m	m	99	102	107	m	m	
United States	89	101	103	97	102	102	92	99	100
OECD average	**87**	**100**	**106**	**102**	**100**	**99**	**86**	**101**	**107**

Table 12 Panel Regressions for Growth Rate (Male Only)

Independent variable	Growth rate of GDP		
	(1) 5 Years	(2) 10 Years	(3) 20 Years
Log(per capita GDP)	-0.161**	-0.185***	-0.193***
	(0.0698)	(0.0409)	(0.0146)
Log(per capita GDP)squared	0.00760**	0.00861***	0.00915***
	(0.00349)	(0.00203)	(0.000743)
Schooling_Male	-0.00163	0.000484	0.000784**
	(0.00113)	(0.000528)	(0.000333)
Gov_other	-0.000253***	-0.000137***	-0.0000992***
	(0.0000740)	(0.0000373)	(0.0000270)
Gov_edu	-0.00104	0.0000976	-0.000782***
	(0.000706)	(0.000364)	(0.000225)
Openness	0.0666**	0.0470**	0.0543***
	(0.0316)	(0.0184)	(0.00984)
Open*log GDP	-0.00534*	-0.00357**	-0.00478***
	(0.00295)	(0.00171)	(0.000910)
Inflation	-0.000862***	-0.000158***	-0.0000460***
	(0.0000862)	(0.0000267)	(0.0000176)
Investment	0.0345**	0.0285***	0.0451***
	(0.0140)	(0.00850)	(0.00495)
Log(Fertility)	-0.0267***	-0.00560	-0.0197***
	(0.0102)	(0.00435)	(0.00281)
Female*Fertility	0.000643	-0.000180	-0.0000211
	(0.000490)	(0.000213)	(0.000139)
Life expectancy	-0.00141***	0.000195	0.000415***
	(0.000363)	(0.000187)	(0.000120)
Terms of trade	0.176***	0.0256	-0.0167*
	(0.0397)	(0.0186)	(0.00877)
Rule of Law	0.0111***	0.0114***	0.00398***
	(0.00274)	(0.00142)	(0.000913)
Democracy	-0.0635***	-0.0514***	-0.0346***
	(0.0131)	(0.00746)	(0.00406)
Constant	1.045***	1.019***	1.018***
	(0.353)	(0.206)	(0.0745)
adj. R-sq	0.303	0.349	0.566
Standard errors in parentheses	="* p<.1	** p<.05	*** p<.01"

Table 13 Panel Regressions for Growth Rate (Female Only)

Independent variable	Growth rate of GDP		
	(1) 5 Years	(2) 10 Years	(3) 20 Years
Log(per capita GDP)	-0.156**	-0.200***	-0.206***
	(0.0681)	(0.0403)	(0.0134)
Log(per capita GDP)squared	0.00743**	0.00952***	0.00995***
	(0.00341)	(0.00200)	(0.000680)
Schooling_Female	-0.00286**	-0.00173***	-0.000757*
	(0.00127)	(0.000587)	(0.000398)
Gov_other	-0.000292***	-0.000175***	-0.000122***
	(0.0000777)	(0.0000407)	(0.0000303)
Gov_edu	-0.000929	-0.000146	-0.00101***
	(0.000685)	(0.000350)	(0.000224)
Openness	0.0807**	0.0617***	0.0631***
	(0.0332)	(0.0191)	(0.0101)
Open*log GDP	-0.00663**	-0.00494***	-0.00561***
	(0.00310)	(0.00177)	(0.000936)
Inflation	-0.000866***	-0.000160***	-0.0000471**
	(0.0000859)	(0.0000255)	(0.0000190)
Investment	0.0264*	0.0239***	0.0432***
	(0.0149)	(0.00876)	(0.00523)
Log(Fertility)	-0.0350***	-0.0213***	-0.0307***
	(0.0110)	(0.00480)	(0.00340)
Female*Fertility	0.00124**	0.000752***	0.000610***
	(0.000607)	(0.000257)	(0.000178)
Life expectancy	-0.00145***	-0.0000604	0.000213*
	(0.000345)	(0.000181)	(0.000110)
Terms of trade	0.174***	0.0211	-0.0201**
	(0.0392)	(0.0186)	(0.00936)
Rule of Law	0.0110***	0.0112***	0.00380***
	(0.00273)	(0.00140)	(0.000927)
Democracy	-0.0624***	-0.0514***	-0.0349***
	(0.0131)	(0.00738)	(0.00410)
Constant	1.016***	1.109***	1.099***
	(0.342)	(0.202)	(0.0675)
adj. R-sq	0.305	0.352	0.566
Standard errors in parentheses	="* p<.1	** p<.05	*** p<.01"

Table 14 Panel Regressions for Investment (Male Only)

Independent variable	Investment Ratio to GDP		
	(1) 5 Years	(2) 10 Years	(3) 20 Years
Log(per capita GDP)	0.427***	0.194**	-0.258***
	(0.0853)	(0.0940)	(0.0538)
Log(per capita GDP)squared	-0.0229***	-0.0111**	0.0140***
	(0.00435)	(0.00473)	(0.00280)
Schooling_Male	0.000428	-0.000742	0.00401***
	(0.00205)	(0.00183)	(0.00154)
Gov_other	-0.00101***	-0.000803***	-0.00000247
	(0.000164)	(0.000141)	(0.000113)
Gov_edu	0.000577	-0.000608	0.00180*
	(0.00160)	(0.00146)	(0.00106)
Openness	-0.356***	-0.302***	0.0483
	(0.0576)	(0.0591)	(0.0440)
Open*log GDP	0.0360***	0.0304***	-0.00547
	(0.00539)	(0.00556)	(0.00410)
Inflation	-0.000632***	-0.000218*	0.0000278
	(0.000148)	(0.000113)	(0.0000733)
Log(Fertility)	0.0352*	0.0148	0.0551***
	(0.0180)	(0.0153)	(0.0123)
Female*Fertility	-0.00305***	-0.00233***	-0.00358***
	(0.000892)	(0.000823)	(0.000705)
Life expectancy	0.000714	0.00123**	0.00230***
	(0.000700)	(0.000621)	(0.000565)
Terms of trade	-0.364***	-0.391***	-0.277***
	(0.0573)	(0.0570)	(0.0426)
Rule of Law	0.0565***	0.0535***	0.0283***
	(0.00512)	(0.00449)	(0.00336)
Democracy	-0.137***	-0.116***	-0.0206
	(0.0272)	(0.0245)	(0.0190)
Constant	-1.673***	-0.571	1.226***
	(0.431)	(0.473)	(0.271)
adj. R-sq	0.304	0.297	0.331
Standard errors in parentheses	="* p<.1	** p<.05	*** p<.01"

Table 15 Panel Regressions for Investment (Female Only)

Independent variable	Investment Ratio to GDP		
	(1) 5 Years	(2) 10 Years	(3) 20 Years
Log(per capita GDP)	0.304***	0.0743	-0.365***
	(0.0825)	(0.0910)	(0.0564)
Log(per capita GDP)squared	-0.0149***	-0.00318	0.0206***
	(0.00421)	(0.00457)	(0.00294)
Schooling_Female	-0.0194***	-0.0212***	-0.00973***
	(0.00228)	(0.00210)	(0.00173)
Gov_other	-0.00134***	-0.00114***	-0.000203*
	(0.000159)	(0.000136)	(0.000111)
Gov_edu	-0.00112	-0.00220	0.000152
	(0.00157)	(0.00139)	(0.00106)
Openness	-0.192***	-0.129**	0.146***
	(0.0584)	(0.0611)	(0.0449)
Open*log GDP	0.0207***	0.0141**	-0.0146***
	(0.00548)	(0.00577)	(0.00419)
Inflation	-0.000618***	-0.000203**	0.0000335
	(0.000120)	(0.000101)	(0.0000818)
Log(Fertility)	-0.107***	-0.132***	-0.0438***
	(0.0206)	(0.0188)	(0.0137)
Female*Fertility	0.00565***	0.00669***	0.00225***
	(0.00116)	(0.00108)	(0.000848)
Life expectancy	-0.00139**	-0.000873	0.000650
	(0.000675)	(0.000609)	(0.000539)
Terms of trade	-0.380***	-0.406***	-0.294***
	(0.0608)	(0.0628)	(0.0432)
Rule of Law	0.0510***	0.0477***	0.0252***
	(0.00493)	(0.00435)	(0.00341)
Democracy	-0.128***	-0.105***	-0.0177
	(0.0261)	(0.0238)	(0.0187)
Constant	-0.948**	0.130	1.865***
	(0.415)	(0.454)	(0.281)
adj. R-sq	0.342	0.353	0.343
Standard errors in parentheses	="* p<.1	** p<.05	*** p<.01"

Table 16 Cross-Country Comparison: Average Years of Schooling (1950-2010)

	Country	Total	Primary	Secondary	Tertiary
	World	5.5	3.6	1.7	0.2
	OECD	8.3	5.3	2.6	0.4
OECD	Australia	10.2	5.7	3.9	0.6
	Austria	7.7	4.6	3.0	0.2
	Belgium	8.7	5.6	2.6	0.5
	Canada	9.8	5.6	3.6	0.7
	Chile	7.2	4.7	2.2	0.3
	Czech Republic	10.4	8.2	1.9	0.2
	Denmark	8.0	4.4	3.2	0.4
	Estonia	8.7	5.7	2.7	0.4
	Finland	6.8	4.2	2.3	0.4
	France	6.8	4.1	2.3	0.3
	Germany	8.4	5.7	2.4	0.3
	Greece	7.5	4.9	2.3	0.4
	Hungary	9.1	7.4	1.4	0.3
	Iceland	8.0	5.4	2.3	0.3
	Ireland	9.0	5.8	2.7	0.5
	Israel	9.7	5.5	3.6	0.6
	Italy	6.8	4.3	2.3	0.2
	Japan	9.1	5.6	3.0	0.5
	Latvia	6.9	3.9	2.7	0.3
	Lithuania	7.3	3.8	3.1	0.3
	Luxembourg	7.5	4.7	2.5	0.3
	Mexico	5.1	3.3	1.6	0.2
	Netherlands	8.9	5.8	2.8	0.4
	New Zealand	10.9	6.5	3.7	0.7
	Norway	9.3	6.7	2.2	0.4
	Poland	8.2	6.4	1.7	0.2
	Portugal	4.6	3.2	1.3	0.1
	Republic of Korea	8.0	4.9	2.6	0.5
	Slovakia	10.1	8.1	1.8	0.2
	Slovenia	9.1	6.5	2.3	0.2

OECD	Spain	6.6	4.5	1.8	0.3
	Sweden	9.5	5.5	3.6	0.4
	Switzerland	10.1	6.4	3.2	0.4
	USA	11.2	5.7	4.6	1.0
	United Kingdom	8.6	5.4	2.8	0.4
Non-OECD	Afghanistan	1.5	1.0	0.4	0.1
	Albania	6.3	4.2	2.0	0.1
	Algeria	3.2	2.2	1.0	0.1
	Argentina	7.3	5.6	1.5	0.2
	Armenia	9.2	4.4	4.4	0.5
	Bahrain	4.5	2.7	1.5	0.2
	Bangladesh	2.7	1.7	0.9	0.1
	Barbados	7.5	5.2	2.2	0.1
	Belize	8.6	7.0	1.4	0.2
	Benin	1.8	1.2	0.6	0.0
	Bolivia	5.6	3.7	1.6	0.2
	Botswana	4.8	3.5	1.3	0.1
	Brazil	4.2	3.1	1.0	0.1
	Brunei Darussalam	5.8	3.5	2.1	0.2
	Bulgaria	7.4	4.4	2.6	0.4
	Burundi	1.6	1.4	0.2	0.0
	Cambodia	2.4	2.0	0.4	0.0
	Cameroon	3.2	2.4	0.8	0.0
	Central African Republic	1.8	1.3	0.5	0.0
	China	5.0	3.5	1.4	0.1
	China, Hong Kong	7.7	4.4	3.0	0.3
	China, Macao	5.2	3.8	1.2	0.2
	Colombia	5.0	3.3	1.5	0.2
	Congo	3.6	2.4	1.2	0.0
	Costa Rica	5.8	4.3	1.2	0.3
	Cote dIvoire	2.3	1.6	0.7	0.1
	Croatia	8.1	6.3	1.6	0.2
	Cuba	6.9	4.6	2.1	0.2
	Cyprus	7.4	4.7	2.3	0.4

Non-OECD	Congo	2.1	1.6	0.5	0.0
	Dominican Rep.	4.9	3.4	1.3	0.2
	Ecuador	5.4	3.9	1.4	0.2
	Egypt	3.2	1.9	1.2	0.1
	El Salvador	4.1	3.3	0.7	0.1
	Fiji	7.1	5.5	1.4	0.2
	Gabon	3.9	2.4	1.3	0.2
	Gambia	1.5	0.9	0.6	0.0
	Ghana	4.1	2.5	1.5	0.0
	Guatemala	2.7	2.2	0.5	0.0
	Guyana	6.5	4.7	1.8	0.0
	Haiti	2.5	1.7	0.8	0.0
	Honduras	3.7	2.9	0.7	0.1
	India	2.9	1.8	1.0	0.1
	Indonesia	3.7	2.9	0.8	0.1
	Iran (Islamic Republic of)	4.0	2.3	1.5	0.2
	Iraq	3.1	2.0	1.0	0.2
	Jamaica	6.3	4.6	1.6	0.1
	Jordan	5.2	3.2	1.8	0.2
	Kazakhstan	6.9	3.0	3.5	0.3
	Kenya	3.6	2.8	0.6	0.1
	Kuwait	4.3	1.9	2.2	0.2
	Kyrgyzstan	7.2	3.3	3.5	0.3
	Lao	2.9	2.3	0.6	0.1
	Lesotho	4.4	3.8	0.6	0.0
	Liberia	2.2	1.5	0.6	0.1
	Libyan Arab Jamahiriya	3.6	2.4	1.1	0.2
	Malawi	2.4	2.2	0.2	0.0
	Malaysia	5.9	3.7	2.0	0.2
	Maldives	4.2	2.6	1.6	0.0
	Mali	0.7	0.6	0.1	0.0
	Malta	7.1	4.2	2.7	0.2
	Mauritania	2.4	2.1	0.3	0.0

Non-OECD	Mauritius	5.5	3.6	1.8	0.1
	Mongolia	5.6	2.5	2.8	0.3
	Morocco	2.1	1.2	0.8	0.1
	Mozambique	1.0	0.9	0.1	0.0
	Myanmar	2.4	1.6	0.7	0.1
	Namibia	4.7	3.6	1.0	0.1
	Nepal	1.6	1.0	0.5	0.1
	Nicaragua	3.8	2.7	0.9	0.2
	Niger	0.8	0.7	0.2	0.0
	Pakistan	2.5	1.4	1.0	0.1
	Panama	6.6	4.4	1.9	0.3
	Papua New Guinea	2.2	1.8	0.4	0.0
	Paraguay	5.1	3.9	1.1	0.1
	Peru	6.0	3.6	1.9	0.4
	Philippines	5.8	3.7	1.7	0.4
	Qatar	4.7	2.6	1.8	0.3
	Republic of Moldova	6.9	2.9	3.7	0.3
	Reunion	5.0	3.3	1.7	0.1
	Romania	7.8	5.8	1.8	0.2
	Russian Federation	7.7	3.9	3.1	0.6
	Rwanda	1.9	1.7	0.2	0.0
	Saudi Arabia	4.8	3.1	1.5	0.2
	Senegal	2.2	1.8	0.3	0.0
	Serbia	7.1	5.5	1.4	0.2
	Sierra Leone	1.7	1.2	0.5	0.0
	Singapore	6.1	3.7	2.1	0.3
	South Africa	6.0	4.4	1.5	0.1
	Sri Lanka	7.0	4.8	2.1	0.2
	Sudan	1.6	1.2	0.3	0.0
	Swaziland	3.5	2.8	0.7	0.0
	Syrian Arab Republic	3.3	2.4	0.8	0.1
	Taiwan	6.7	3.8	2.5	0.4
	Tajikistan	8.0	3.2	4.5	0.2
	Thailand	4.1	3.1	0.8	0.2

Non-OECD	Togo	2.6	1.8	0.8	0.0
	Tonga	8.0	5.1	2.7	0.1
	Trinidad and Tobago	7.6	5.9	1.6	0.1
	Tunisia	3.4	2.2	1.1	0.1
	Uganda	2.7	2.3	0.4	0.0
	Ukraine	7.9	4.0	3.3	0.5
	United Arab Emirates	4.6	2.5	1.8	0.3
	United Republic of Tanzania	3.2	3.0	0.2	0.0
	Uruguay	6.5	4.7	1.6	0.2
	Venezuela	4.6	3.1	1.4	0.2
	Viet Nam	4.4	3.1	1.3	0.1
	Yemen	1.0	0.7	0.3	0.0
	Zambia	4.2	3.7	0.5	0.0
	Zimbabwe	4.4	3.2	1.2	0.1

국문 초록

OECD 국가들의 경제성장에 대한 교육의 영향

서울대학교 국제대학원

국제통상학과

강유진

1980년대 초 이후 등장한 신성장이론을 바탕으로 교육을 통한 인적자본 형성에 초점을 맞춘 다양한 연구가 이루어졌다. 대표적인 예로 폴 로머 (Paul Romer)와 로버트 루카스 (Robert Lucas) 등의 많은 경제 학자들은 인적자본이 경제 성장의 원동력으로서, 국가의 인적자본 축적은 노동생산성을 높이며, 기술혁신 및 습득 능력을 향상 시켜 직접적으로 경제 성장에 기여하는 효과를 갖는다고 주장 했다. 이러한 인적자본 이론에 따라 인적자본 축적이 경제성장에 미치는 영향을 실증적으로 분석하기 위해 교육, 경력, 임금 등 노동력의 특성들을 이용한 측정 방법들이 개발 되어 왔다.

인적자본 추정 지표 중 핵심요소로 꼽히는 '교육지표-평균 교육년수'는 국가 간 비교 분석을 위한 전통적인 대리(proxy) 변수로 사용 된다. 교육지표는 경제성장과 통계적으로 유의한 양의 관계를 나타내고 성장동력으로서의 역할을 한다고 평가된다. 그러나, 대다수의 선행연구는 개발도상국에 초점이 맞춰져 있고 실제 세계의 교육정책 및 개발의 흐름을 주도하고 있는 선진국의 교육과 경제성장 간의 관계는 비교적 소홀하게 다루어져 왔기에 결론이 도출되지 못한 채로 남아있다.

이에 본 연구는 OECD국가들의 교육 동향을 분석하고 평균 교육년수를 이용해 OECD국가들의 교육과 GDP 성장률 간의 관계를 실증적으로 규명하는데 주목적이 있다. 1970년부터 2010년까지 총 40년간의 패널데이터를 구축한 후, 36개의 OECD 국가들을 중심으로 5년, 10년 및 20년 단위로 구분하여 교육이 중장기 성장에 미치는 영향을 패널 회귀분석을 통해 살펴보았다. 또한 성별에 따른 교육수준의 효과 및 교육분야의 정부지출의 영향도 분석하였다.

분석결과에 따르면 평균 교육년수의 증가는 통계적으로 경제성장에 미치는 영향이 유의미하지 않는 것으로 드러났으며, 이는 선진국의 교육의 양적 팽창이 효율적인 인적자본 축적으로 이어지지 않는다고 볼 수 있다. 또한, 일반적으로 교육의 양정 팽창과 대중화는 경제성장을 가속화 시킨다고 알려져 있지만, 이미 높은 교육수준에 도달한 OECD국가들의 경우, 교육의 효과가 장기적 경제성장으로 이어지기 위해선 교육의 양적 증가보다 내적 발전 즉 교육의 질적인 측면에서의 성장이 이루어져야 한다고 해석될 수 있다. 덧붙여 OECD국가들의 여성 교육 수준은 꾸준히 증가하는 반면, 여성의 교육 효과는 경제성장과 음의 상관관계를 갖는 것으로 나타났고, 이는 선진국에서 고학력 여성 인력 활용이 대단히 비효율적임을 의미한다.

마지막으로, 본 논문은 OECD국가들의 교육의 성장기여도를 성장모형으로 밝혀내고자 하였으며, 교육의 양적 확대보다는 질적 개선의 필요함을 주장한다.

주제어: 교육, 교육분야 정부지출, 경제성장, OECD, 성장회귀분석

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