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Education and Economic Growth: Is Tertiary Education for all Workers Optimal?

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Abstract *The main objective of this study is to find out if it is optimal to have tertiary level of education for all workers among OECD countries. The findings show that, although higher education level means higher economic growth, it is not optimal for any economy to have all workers with tertiary education. The optimal level, which gives the highest level of output in the sample, is about 49.8 percent in model 1 and 3, and about 46.9 percent in model 2. The highest level of 55.17 percent of workers with tertiary education is found in Canada for the year 2015. Therefore, though higher levels of education leads to higher economic growth, there should be proportions of workers with lower than tertiary levels of education.*

Key words Optimal education, economic growth

JEL Codes: O3, O4

1. Introduction

Education has been termed as a strong determinant of economic growth. Economies with high education levels have high levels of economic growth just the same way individuals with high levels of education earn high income. Even democracy is stronger in economies with higher levels of education because of the positive correlation between education and income levels (Acemoglu *et al.,* 2005). Some have specified student performance in science stream subjects most especially mathematics and physics to be the main determinants of economic growth of a nation (Ramirez *et al*., 2006).

Countries have to reform their education system to become economically competitive. Higher performance target put by USA, for instance, to be the leader in mathematics by 2000s, aimed at making the country economically competitive. The argument set is that attending school has no meaning if there is no learning, because students' performance is a direct measure of the cognitive capacity of people joining the workforce (Hanushek *et al*., 2008).

Students' performance argument directly points out on the importance of high levels of education on economic growth. High performance at a lower level of education enables a student to enter into a higher level of education. Due to this, the current study aims at analyzing the optimal level of the proportion of workers with tertiary education.

2. Literature review

Economic growth that has been given higher priority by economists can arise from factor accumulation or factor productivity growth. However, the two routes of growth differ in their ability to sustain growth, that is, growth due to factor accumulation is not sustainable while growth due to factor productivity growth is said to be sustainable (Easterly and Levine, 2001). Productivity led growth results from improved technology because the same level of factors of production can now produce more output than previously produced. This technology can be labor augmenting, capital augmenting, or neutral technological change (Solow, 1956).

It has been common to think that capital provides one of the highest contributions to economic growth. However, growth accounting with full analysis of factors determining economic growth portrays a full picture of the proportion of capital on the contribution of capital which is important but not as much as pronounced in analyses which are causality based. For instance, the growth accounting study from 1948 to 1973 shows that capital accumulation contributed only 15 percent on growth, while 15 percent was due to increased working hours by labor, and 14 percent resulted from improved labor as a result of education (Denison, 1980).

Education has played an important role on economic growth even in attracting foreign direct investment. Even where education has not emerged as a significant determinant of economic growth or as an attracting feature of foreign direct investment, still foreign direct investments have concentrated in highly developed places. In the provinces of China, for instance, foreign direct investments have concentrated in highly developed provinces which also have a higher level of human capital development in terms of high levels of education (Jiang, 2012).

For countries close to their production frontier, higher levels of education, that is, education that results from research universities provides the only means of growth. Those countries which are far from their production frontier, their low education investment can result into higher growth as a result of imitation from highly technological innovations which emerge from places with high levels of education. High education investments regions are characterized with high income and high development which in return enhances higher investment in education. Ordinarily, for saturated economies, growth can only be enhanced by higher levels of education that enables innovation (Aghion *et al.,* 2009).

Differences in cognitive skills that come from differences in test scores in mathematics and physics for instance, have accounted for differences in economic growth among regions. Regions with higher cognitive skills have portrayed higher economic growth. This has shown the importance of measurement issues in previous findings which were controversial to the anticipated impact of education on economic growth. As a matter of facts, the new findings have uplifted the spirit of promoting education expenditure for economic development by policy makers (Hanushek and Woessmann, 2012).

However, many developing and developed countries have concentrated on increasing the number of school enrolment instead of learning ability. For attainment of higher economic development, education must focus on learning that is knowledge and not just the time spent in school. This is due to the fact that more productivity comes from more skilled and knowledgeable man power. Therefore, if economies are to effect their economic growth from education expenditure, the quality of education has to be given higher priority (Hanushek and WoBmann, 2010).

Human capital influenced by education has turned to be an important variable influencing economic growth that economists have concentrated on. This has been a response to a large residual remaining unexplained under ordinary physical capital and labor analysis of production function. As a result human capital most especially the narrowed concept of education effect on human capital has been so important in explaining a large portion that remained in the residual. Human capital is wide for there must be good health, for labor to be effective but by assuming health component as given, education plays a significant role on the quality of human capital. The important aspect of human capital development lies on the fact that it improves the productivity of other factors of production due to increased skills and knowledge of labor thereby creating externality effects (Boarini *et al*., 2012).

Human capital not only improves productivity, but also technical efficiency. That is to say, human capital accumulation has both a level effect and a rate effect. Consequently, countries' differences in human capital have worked in reverse way with labor productivity convergence (Maudos *et al.,* 2003). Central to human capital accumulation is the knowledge accumulation which is the driving force of innovation. With innovations differing from city to city, cities have experienced differences in their levels of growth. Ordinarily, since cities are more innovative and attract the most skilled work force, they have been the main source of economic growth for their economies. Provided that knowledge creation is becoming more profitable, incentives on research and development by private sector continues to be highly fueled (Zoltan, 2015). And countries with higher levels of technological innovation will continue to lead in long term economic growth (Rosenberg, 2004).

Increasing productivity has influenced most people in the developed world to prefer to have less number of children with better education. This is in line with higher income level embodied in higher productivity. As a matter of fact, all European countries except Turkey have their total fertility rate less than the replaceable rate. The United State has its total fertility rate closer to the replacement level. The higher level is attributed by the Hispanic and non-white population, but if this part of the population is removed, the white population has its total fertility rate same as their European forefathers (Strulik *et al.,* 2013). As a result, developed countries are increasingly becoming knowledge-based economies whereby employment is based on highly-skilled labor (Pascal, 1996). From the reviewed literature, it is clear that education plays a substantial role in influencing economic growth. And if so, then tertiary education should play a great role especially in highly developed economies due to high knowledge quality embodied in the education system. However, what is yet to be known is the optimal level of working population that should have tertiary education. This study aims to uncover the optimal proportional level of working population with tertiary education level.

3. Methodology of research

3.1. Data

This study uses OECD available data from 1997 to 2015 for 13 countries. Some of the countries with missing observations have been removed from the analysis resulting into a total number of 247 observations. The education information, in this analysis, is for the working population. This is due to the fact that output or GDP is produced by the working population. The rationale for choosing OECD countries lies on the fact that developed countries have high data storage capability and a large number of workers with high education levels. Therefore, using OECD sample fits the analysis and provides more reliable results. Besides, more previous studies have used OECD countries in their analysis on growth effect of education.

3.2. Model

In growth analysis, it is convenient to start with the conventional Solow (1957) growth model which is simple and easy to understand, but also provides a foundation in understanding other complicated models. And for simplicity, the special case of neutral technical change is used in this study.

$$Y = A(t)f(K, L) \quad (1)$$

Where *Y* is output, *K* is capital, *L* is labor, and *A(t)* is knowledge or technology factor. In a Cobb-Douglas formulation equation (1) takes the form:

$$Y = A(H)K^{\alpha}L^{\beta} \quad (2)$$

In expression (2), technology is assumed to be a function of human capital (H). This factor is also a function of education and in this study it can take the following form.

$$A(H) = \exp\left[a + \emptyset(E_{it}) + u_{it}\right] \quad (3)$$

Where, $\emptyset(E_{it})$ is the education factor which takes the percentage of the working population with tertiary education in Model 1, and adds the proportion with below upper secondary education in model 2. In model 3, the percentage of working population with upper secondary education is added thereby replacing below secondary education. Model 2 and 3 aim at checking if the optimal level of tertiary education is affected by lower levels of education.
Taking (3) into (2) results into the following expression

$$Y = K^{\alpha}L^{\beta}\exp\left[a + \emptyset(E_{it}) + u_{it}\right] \quad (4)$$

Introducing natural logarithm into expression (4) make the model linear in parameter which allows econometric analysis

$$\log(Y_{it}) = a + \alpha\log(K_{it}) + \beta\log(L_{it}) + \emptyset(E_{it}) + u_{it} \quad (5)$$

Where,

$$u_{it} = \delta_i v_i + \rho_t \omega_t + \varepsilon_t \quad (6)$$

The first term in the right hand of equation (6) is the error term due to cross sectional differences. The second term in equation (6) is the effect on economic growth that is due to time, alternatively, time period error. And the last term in equation (6) stands for the error term which is independently and identically distributed.

4. Findings and discussions

4.1. Country specific Growth Rate Analysis

This section provides variables' growth rate analysis for 13 countries used in the analysis. The average growth rates of each variable used in the analysis are given in Table 1 to show by how much on average the variables have been growing for a period of 19 years, that is from 1997 to 2015.
In Table 1 below, output, capital, and labor have been positively growing, except labor in Greece which has grown negatively. Greece's condition has not been favorable because even output has been ill growing compared to other countries. It has the lowest output growth rate of 2.496 percent, and even capital growth rate is 0.334 percent which is again the lowest in the group. Greece has been badly hit by the financial crisis in the Euro zone, a scenario portraying decreasing labor force as people quit for green pasture elsewhere in Europe. Conversely, Estonia has the highest average growth rate of output and capital in the group which is an indication that as capital accumulates, output keeps growing.
It is not surprising to see the share of working force with education level below upper secondary education (BE) decreasing in each country. For a period of 19 years, the average growth rate is negative which means this category of labor force is decreasing from time to time. This is contrary to the growth rate of the share of labor force with tertiary education (TE) which is positive. The positive average growth rate of tertiary education (TE) is an indication that higher education is given high priority and is increasing from time to time. That is also one of the reasons as to why the growth rate of the percentage of working force with upper secondary education (UE), is decreasing in more than 50 percent of the countries in the sample. Because out of 13 countries included in the analysis, 7 experience, on average, a negative growth rate in upper secondary education level.

Table 1. Average Variable Growth Rate from 1997 to 2015

Country	Output (%)	Capital (%)	Labor (%)	TE (%)	BE (%)	UE (%)
Australia	4.995	5.164	1.808	3.076	-4.082	1.199
Canada	4.034	4.939	1.433	2.070	-4.315	-0.706
Czech	4.651	3.663	0.174	4.002	-3.874	-0.238
Germany	3.577	3.002	0.662	1.082	-1.142	-0.116
Greece	2.496	0.334	-0.281	3.348	-3.111	1.703
Hungary	5.162	4.848	0.893	3.704	-4.029	0.805

Country	Output (%)	Capital (%)	Labor (%)	TE (%)	BE (%)	UE (%)
Korea	4.962	3.922	1.083	4.540	-5.010	-0.245
Slovak	6.023	4.130	0.515	3.821	-4.502	0.166
Spain	4.440	4.124	1.636	3.267	-2.349	2.548
Sweden	4.208	5.324	1.118	2.041	-0.930	-0.540
UK	3.898	3.742	0.937	3.563	-3.413	-0.130
US	3.993	3.679	0.742	1.435	-1.535	-0.752
Estonia	6.958	7.097	0.279	1.289	-3.356	0.065

Source: OECD data calculated by author. The growth rate is calculated as: $g = (X_{t+1} - X_t)/X_t$.

4.2. Panel estimation of the Production Function

In this section, a two way random effect is applied to capture the effect of time and country specific differences on economic growth. This approach is superior to other approaches for each model. For model 2 and 3, the approach provides coefficients which are statistically very significant while other approaches like fixed effect makes some of the variables statistically insignificant. In model 1, other approaches, specifically fixed effect, provide suspiciously large coefficient of determination, even though all other variables are statistically very significant. Therefore, a two way random effect is preferred in this particular study.

The results are given in Table 2, and as it has been noted, all the variables are statistically significant. Nevertheless, each model explains more than 90 percent of the variation in economic growth. However, the idiosyncratic error term is statistically insignificant in all the models. The time used, that is 19 years, is very short to have a significant effect on economic growth. Conversely, the variation on economic growth that comes from country differences is statistically very significant.

Table 2. Two Way Random Effect Estimation Results

Variable	Model 1	Model 2	Model 3
Constant	3.28*** [6.73]	3.59*** [6.73]	3.63*** [6.92]
log (k)	0.61*** [17.2]	0.55*** [14.6]	0.59*** [16.3]
log (L)	0.17** [2.27]	0.25*** [2.96]	0.20** [2.50]
TE	6.39*** [14.7]	6.03*** [10.9]	6.92*** [14.2]
$(TE)^2$	-6.41*** [-9.9]	-6.43*** [-9.70]	-6.95***[-9.86]
BE		-1.59*** [-3.71]	
$(BE)^2$		1.78*** [4.08]	
UE			-2.26*** [-2.88]
$(UE)^2$			2.49*** [3.09]
v_i	0.93*** [5.73]	0.94*** [5.16]	0.94*** [5.31]
ω_t	0.07 [1.55]	0.06 [1.26]	0.06 [1.33]
R^2	0.929	0.934	0.932
Adj. R^2	0.928	0.932	0.930
Observations	247	247	247

Note: ***, **, and * indicate significant at 1, 5, and 10 percent levels of significance. The t-values are in the brackets.

Starting with our basic model, Model 1, all the variables have their effect statistically significant with expected signs. For instance, an increase in capital by 10 percent leads into an increase in output by about 6.1 percent other things being equal and the effect is statistically very significant at all levels of significance. For labor, the effect is economically not very significant because a 10 percent increase in labor increases output only by about 1.7 percent. But still the effect is statistically significant at 5 percent levels of significance.

The introduction of below upper secondary education in model 2 and upper secondary education in model 3 has reduced the impact of capital on economic growth indicating a positive correlation between capital and the levels of education. Conversely, it has increased a bit the effect of labor on economic growth indicating a negative correlation between the variables. Even though, the levels of significance have not changed in all these alternatives.

The optimal level is obtained from the following illustration:

$$y = ax - bx^2 \qquad (7a)$$

$$y = -ax + bx^2 \quad (7b)$$

Equation (7a) stands for a diminishing effect, while (7b) is for an increasing return. Taking the derivative of the dependent variable with respect to independent variable in either of the two equations and equating to zero gives the optimal value of the independent variable which is positive as in equation (8).

$$\frac{dy}{dx} = a - 2bx = 0 \rightarrow x^* = \frac{a}{2b} \quad (8)$$

From equation (8) we can find the optimal values of tertiary education in Model 1, 2 and 3 as well as the optimal levels of below upper secondary education and upper secondary education in Model 2 and 3 respectively.

For model 1, the optimal level of tertiary education is about 49.8 percent of all workers. This is the level which gives the maximum level of output, away from which lower levels of output will be experienced. The introduction of below upper secondary level in Model 2 reduces the optimal level of tertiary education to about 46.9 percent. In Model 3, the introduction of upper secondary education has approximately changed nothing on the optimal level of tertiary education because it has remained to be about 49.8 percent.

The findings show that increasing tertiary education increases output and reached a point where further increase in tertiary education reduces output. The effect is statistically very significant at all levels of significance with expected sign. This conforms to the results in Table 1 where all the countries have an average positive growth in tertiary education. Consequently, the first order condition gives a positive coefficient and a negative coefficient for the second order condition.

For the below upper secondary education, in Model 2, the optimal level is about 44.7 percent. However, from Table 2, it is clear that an increase in the percentage of workers with below upper secondary education level reduces output. However, when it reaches 44.7 percent, further increase influences economic growth positively. This can also be seen in Table 1 where for all countries, the average growth of below secondary education level is negative. Every country is experiencing a declining trend in this proportion of workers. So increasing this proportion of workers is like taking these countries back in the previous period which is near to impossible.

For the upper secondary education which has been introduced in Model 3 replacing below secondary education, the optimal level is about 45.4 percent. Again as upper secondary education increases, economic growth is decreasing until it reaches 45.4 percent where it starts affecting economic growth positively. As shown in Table 1, more than 50 percent of countries used in this analysis have their upper secondary education proportion growing negatively on average. Therefore it is obvious that workers with this level of education are advancing to higher education levels as time goes on and the proportion of workers with upper secondary education will continue to decrease year after year.

5. Conclusions

Tertiary education has been growing positively from time to time for all the countries in this study. This implies that as time goes the number of workers with tertiary education keeps increasing and the job market continue to seek for highly skilled labor. However, it is not optimal to have all the working population with tertiary level of education. Because, the highest level is about 55 percent found in Canada in 2015. On the other hand, the proportion of working population with levels of education below upper secondary education is decreasing year after year in each of the countries analyzed. This also applies to upper education, though in some countries upper education, on average, is still growing positively. This implies that the proportion of workers with below secondary education level is moving toward upper secondary education and tertiary education.

Developing countries should continue promoting education thereby encouraging their workers to earn higher levels of education, particularly tertiary education, in order to fuel economic growth. This is due to knowledge embodied in tertiary level of education through research and as a matter of facts its promotion spurs economic growth through innovation. However, it is not optimal for an economy to have all workers with tertiary education.

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