Analyzing the Impact of Health and Education on Total Factor Productivity: A Panel Data Approach

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Analyzing the Impact of Health and Education on Total Factor Productivity: A Panel Data Approach

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ABSTRACT

This study examines the impact of health and education on total factor productivity (TFP) by using panel data for the period 1990-2010 for thirty-seven developed and developing countries. In a two-step approach, the Cobb-Douglas production function is estimated initially to calculate TFP. In the second step, the determinants of TFP have been estimated by paying special attention to indicators of health and education. The study uses information on life expectancy as indicator of health and average years of schooling as indicator of education. Common, Random and Fixed Effects modeling approach has been applied. The study finds that the indicator of health has positive, robust and significant impact on TFP whereas the impact of education has been found to be positive and significant. These findings reconfirm the need for improving health and education of the general populace to ensure sustainable growth and economic development. In fact, the study recommends that the developing world which is lagging behind developed nations need to prioritize this effort on urgent basis.

Keywords: Cobb Douglas Production Function, Total Factor Productivity, Life Expectancy, Common Effects, Random Effects and Fixed Effects.

JEL Classification: I15, I25

1. INTRODUCTION

Over the past few decades, standards of living in many developed countries have reached levels almost unimaginable to our ancestors. But still in the twenty-first century we live in a world of rich and poor. A simple comparison between the haves and have-nots is quite revealing. In the developing world, 866 million people do not have enough food to eat, one billion people do not have access to safe drinking water, and 2.7 billion have no access to sanitation. Roughly 10,000 children die every day from

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diseases caused by contaminated water. At the other extreme, among the industrialized countries, diseases caused by too much food have become a major health problem (WHO, 2008). Education levels also differ between the two set of countries; whereas 34 percent of adult population in the developing world has no education at all, among the advanced countries, it is only 0.8 percent.[2] One of the reasons for this difference is the relative economic strength measured by per capita income which is significantly higher in the developed countries compared to the developing countries where 2.6 billion people have to sustain their livelihoods on a meager sum of less than two dollars per day.[3]

Since these differences among countries are critical from growth and development perspectives, following the footsteps of Barro and Sala-i-Martin (2004), the present study seeks to investigate why some countries have done so well while others are found struggling with little or no success at all. We believe that the most important factor that has contributed to this gap has been the difference in investment in human beings. Significant and consistent investment in human capital in developed economies has not only resulted into well-educated and healthy population, there is a remarkable improvement in longevity as reflected by improvement in life expectancy. At the same time, mortality rate has declined and morbidity is also quite low.[4] Similarly, the cross-countries evidence also supports that human capital is closely related to education. There is strong evidence to support that the educated and healthier workforce in developed countries is more active and vibrant, both physically and mentally. Because of being more productive these workers receive higher earnings, which in turn improve their living standards. On the other hand, the burden of diseases and poor state of human capital in under-developed countries is a major challenge to economic growth and development. As a result, these economies are found continuously struggling to break the vicious cycle of poverty and social injustice.

There is substantial theoretical support for the argument that the accumulation of knowledge is growth enhancing.[5] In recent years, a number of authors, including Bloom et al., (1999); Knowles and Owen, (1995); Gallup and Sachs, (2000); Mayer, (2001); McCarthy et al., (2000); Bhargava et al., (2001); Arcand, (2001); Webber, (2002), and Cole and Neumayer (2006) have investigated the contribution of better health and education facilities in promoting growth via improvement in total factor productivity. The rationale for inclusion of human capital variables in the growth model is that the quality of human capital is an important input in the production process along with physical capital and labor. Growth is driven forward with the help of quality human capital as growth and

2 United Nation (2002)

3 United Nation (2006)

4 Life expectancy at birth is 78 years in the developed countries that also have high degree of human development, 67 years in emerging economies with medium human development, and 46 years in underdeveloped countries with low level of human development.

5 See for example the seminal contributions of Solow (1956), Romer (1986), and Lucas (1988).

development are influenced via positive external or spillover effects (Mankiw et al., 1992; Benhabib and Spiegel, 1994). Currently this line of research has started to pay further attention on the contribution of research, innovation, and entrepreneurial skills on the growth process [Aghion, and Howitt (1998)].

The objective of present study is to test the role of human capital in the form of health and education on growth and development via total factor productivity (TFP) by using panel data for a set of thirty seven developed and developing countries covering a time span of 21 years ranging between 1990 and 2010. In particular, we are interested to know how far good health and education in the form of human capital increases labor quality, which in turn promotes economic growth and development. A two-step approach is being used in the study where the Cobb-Douglas production function is estimated in the first step for generating the estimates of TFP. In the second step the determinants of TFP have been estimated by paying special attention to health and education variables. The study uses information on life expectancy as an indicator of health and average years of schooling as an indicator of education. Common, Random and Fixed Effects modeling approach has been utilized for estimation purposes. We have found that investment in human capital has positive, robust and significant impact on TFP. While consistent with earlier research, this outcome reconfirms the need for improving health and education of the general populace to ensure sustainable growth and economic development in all countries included in the sample. The study recommends that the developing world which is lagging behind the developed world needs to prioritize this effort on urgent basis.

The paper is organized as follows; Section II begins with details related to data and research methodology, Section III presents the results and analyses, and concluding statements are provided in Section IV.

2. DATA AND RESEARCH METHODOLOGY

Economists and historians have long been intrigued by the economic growth processes and the factors that cause or stimulate production that facilitates economic development. The classical economists and their followers have focused on physical resources (land, labor and capital stock) which are used in the production of goods and services. To make this relationship crisp, Douglas along with Cobb (1927) developed a highly elegant and simplified production function ($Y = AK^{\alpha}L^{\beta}$) to define input and output relationship. Here L is the labor force input, K is the capital stock, A is the total factor productivity (TFP), α is the share of capital and β is the share of labor. The present study follows a two-step procedure. After obtaining the estimates of TFP in the first step, the determinants of TFP have been estimated in the second step by paying special attention to indicators of health and education. This approach is similar to one used by Hall and Jones (1999), Miller and Upadhyay (2000), and Cole and Neumayer (2006).[6]

The central argument of this study is that health and education as measures of human capital affect the economic growth via TFP. We start with the standard Cobb-Douglas production function as specified below:

$$Y = AK^{\alpha}L^{\beta}, \; 0 < \alpha < 1 \qquad ...(1)$$

Where Y is the real GDP, A is the index of TFP, K is the total physical capital stock and L is the total labor force. Where ($\alpha + \beta$) is not necessarily equal to 1 which allows for the possibility of increasing or decreasing returns to scale.

The per capita or the intensive form of the model is obtained as follows:

$$\frac{Y}{L} = \frac{AK^{\alpha}L^{\beta}}{L} \qquad ...(2)$$

$$\frac{Y}{L} = \frac{A}{L}\left(\frac{K}{L}\right)^{\alpha}(L)^{\beta}(L)^{\alpha} \qquad ...(3)$$

$$\frac{Y}{L} = A\left(\frac{K}{L}\right)^{\alpha}(L)^{\alpha+\beta-1} \qquad ...(4)$$

Taking k = $\left(\frac{K}{L}\right)$ capital per worker and y = $\left(\frac{Y}{L}\right)$ output per worker

The production function becomes

$$y = A(k)^{\alpha}(L)^{\alpha + \beta - 1} \qquad ...(5)$$

Rewriting the Equation (5) in natural logarithm form as follows

$$lny = lnA + (\alpha + \beta - 1)lnl + \alpha \, lnk \qquad ...(6)$$

For empirical analysis, we use panel data of 37 countries for the period 1990-2010. Hence Equation (6) for empirical estimation can be written as

$$lny_{it} = \phi_i + \alpha ln k_{it} + (\alpha + \beta - 1)lnL_{it} + \varepsilon_{it} \qquad ...(7)$$

This generates total factor productivity as follows:

$$tfp_{it} = (\phi_i + \varepsilon_{it}) = ln A \qquad ...(8)$$

Where subscript "i" denotes the country and "t" denotes the time (years). The total factor productivity can be defined as $(\phi_i + \varepsilon_{it})$ which is equal to lnA in Equation (6).

6 To incorporate the suggestion from anonymous reviewer, we derived the estimates of TFP on the basis of Cobb-Douglas and Translog production functions. Since the two estimates were not too different from each other, the analysis in the paper is based on Cobb Douglas production function. It may be added that the TFP estimates are available with the authors for interested readers.

In the second step we use the TFP from the first step as dependent variable to evaluate the impact of health, education and other factors on TFP. As indicated, life expectancy and average years of schooling are taken as indicators of health and education, respectively. Other independent variables include trade openness and economic activity as suggested by the various growth and productivity related studies.

$$lntfp_{it} = \eta_i + \delta_t + \theta_1 ln\, H_{it} + \theta_2 edu_{it} + \theta_3 open_{it} + \theta_4 lneco_{it} + \varepsilon_{it} \qquad ...(9)$$

Where "*tfp*" is the total factor productivity, "H" is the life expectancy, "*open*" is the trade openness, "*edu*" is the average year of schooling and "*eco*" is economic activity that captures the combined impact of structural reforms in diverse areas such as finance, fiscal affairs, price and regulatory structures that is expected to boost economic activity and encourage competition in markets. We expect that vigorous economic activity is essential for improved productivity. The subscripts "*i*" and "t" are as defined above and "*ln*" in the above equation stands for natural logarithm.

2.1. Description of Variables

The variables included in the model and the rationale for their inclusion is presented below.

1. Real output per worker is the dependent variable which is real GDP (in US dollars) of thirty seven countries at constant prices (2000) taken from the World Bank (2012) data source for the period ranging between1990-2010. To get real output per worker, it is divided by labor force (as defined below) for each of the country for the said period.

2. Real capital stock per worker: Capital includes machines, buildings, infrastructure such as roads and ports, and vehicles etc. used in the production process. Capital stock per worker is an independent variable in the Cobb- Douglas production function. Since the data on capital stock is not available for all the countries, it has been calculated as follows. The data on real gross fixed capital formation (in US dollars) at constant prices (2000) is taken from World Bank (2012) to estimate base period capital stock as:

$$K_0 = \frac{\mathrm{GFK}_0}{\delta + g_{\mathrm{GFK}}} \qquad ...(10)$$

   where K_0 is the capital stock, GFK_0 is level of Gross Fixed Capital Formation, δ is rate of depreciation which we have assumed to be 5 percent per year and g_{GFK} is average growth in gross fixed capital formation. To calculate data for the remaining years we used the procedure given by the following equation.

$$K_t = K_{t-1} - \delta K_{t-1} + GFK_t = (1 - \delta)K_{t-1} + GFK_t \qquad ...(11)$$

where K_t a capital stock is at current year, K_{t-1} is capital stock in previous year, GFK_t is the Real Gross Fixed Capital Formation and δ is rate of depreciation, as indicated above. To get the capital stock per worker, the resulting capital series of each country is divided by its respective labor force.

3. Labor Force: Labor is very important input in the production function. Even though the number of work hours is a better measure of stock of labor, but due to lack of data, labor force data available in World Bank (2012) has been used in the study.

4. Health: Economic theory suggests that human capital in the form of healthy worker contributes to economic growth. Life expectancy is used as a proxy for the health of the work force. We argue that higher life expectancy is generally associated with better health status and lower morbidity. According to WHO (2002) 'life expectancy alone is one of the strongest explanatory variables of economic growth'. The data on life expectancy is obtained from the World Development Indicators for the period 1990-2010.

5. Education: Human capital is often regarded as the accumulation of education. Past studies have confirmed that productivity and economic growth are markedly influenced by educational accomplishments. Sharpe et al.(1998) has argued that with stable macroeconomic environment, public support for training, education, and research and development enhances overall productivity of the economy. Similarly, Nachega and Fontaine (2006) have shown that a well-educated and healthy work force directly or indirectly increases TFP and thus economic growth. They used average number of years of schooling as a proxy for human capital accumulation. The present study uses average years of schooling as a proxy for human capital in the form of education. The data on average years of schooling is taken from Barro and Lee (2010) for the period of 1990-2010 with five year intervals.

6. Trade Openness: Openness is generally believed to have a favorable impact on economy.[7] The potential gains from trade arise when a country has a comparative advantage in producing some goods relative to others. Trade allows diffusion of technology. As a result country that is more open will have better technologies for producing output using its factor of production. This transfer of technology could take many channels. For example, in the case of foreign direct investment, transfer of technology could be direct as capital machinery produced in one country is exported and used in another country. Similarly, technology transfer could be through backward channel whereby country purchases key inputs that embody new technology from abroad. Finally, interactions among countries allow for the

7 See Lewis (1980), Grossman and Helpman (1994), Miller and Upadhyay (2000), Akinlo (2008) and Khan (2006).

transfer of softer technologies such as innovative organization and management techniques. Traditionally, openness is defined as export plus import as percent of GDP (Miller and Upadhyay, 2002; Akinlo, 2008; Khan, 2006; Nachega and Fontaine, 2006; Njikman *et al.*, 2006) and the same has been adopted for the present study. The data on these variables is obtained from the WDI (2012) for the period of 1990-2010.

7. Economic Activity and Income: Income is used to capture direct and indirect effects of economic well being on productivity. It is argued that improvement in economic status would have positive impact on savings, which in turn, would lead to accumulation of physical capital. Increase in economic activity also encourages competition in markets and there is an incentive to improve productivity also. In the present case, Real GDP is used as a proxy for economic activity and the data is obtained from WDI (2012).

3. RESULTS AND DISCUSSION

The central idea of growth is that countries can differ in their standards of living for two reasons; because they differ in their accumulation of inputs used in producing output or they differ in the productivity with which those inputs are used. The first aspect is captured through production process, while the second concern is captured through estimation of Total Factor Productivity. We have pushed forward this idea for a group of thirty seven countries. As mentioned earlier, a two-step approach has been adopted to achieve these objectives.

The results of the first step, where Random and Fixed Effects models are used, are reported in Table-1. The estimated results of Fixed Effects model as per equation (7) indicate that the coefficients of lnK and lnL are 0.50 and 0.11, respectively. As the coefficient of lnL represents ($\alpha+\beta-1=0.11$) which gives the elasticity of output with respect to labor force (β) that is equal to 0.61. The production function represents increasing return to scale[8]. The positive sign of the elasticity of capital indicates that workers with more capital can produce more output; differences among the quantity of capital are a natural explanation for the differences we observe in output, income and economic growth among countries. It is also identified that one percent increase in capital stock of a country causes 0.50 percent increase in output. If we turn towards coefficient of labor, it indicates that increase in the number of workers increases the output per worker. The Hausman's test confirms that the Fixed Effects model is more appropriate as p-value is less than 0.5. The estimated results of Random Effects are reported in appendix Table 2A.

8 $\alpha+\beta = 0.50+0.61= 1.11$ which is greater than one which is indicating that the production function is increasing return to scale.

TABLE 1
ESTIMATES OF COBB- DOUGLAS PRODUCTION FUNCTION

Fixed Effect		
Variable (Dependent: LnY)		
LnK		0.50***
		(6.38)
lnL		0.11**
		(2.17)
N		185
R-Square		0.97
F- statistic		320.91
P-value F. Stat.		(0.00)
Hausman's Test(FE v. RE)	p-value (0.001)	

Note: ***, ** and * shows significance at 1%, 5% and 10%

On the basis of the results from the Fixed Effects specification, the TFP for the 37 countries is calculated with the help of following equation:

$$\phi_i + \varepsilon_{it} = ln\, A = tfp_{it}$$

The countries are ranked according to their total factor productivity and the outcome is shown in Table 2. The ranking indicates that the developed countries have high TFP while developing countries have low TFP. If USA is considered as benchmark, then the productivity in most of the developing countries is quite low as compared to the US. There are also some countries, like Luxemburg, which have higher TFP than the US showing the highest level of productivity. On the other hand, Bangladesh has the lowest level of productivity whereas Pakistan has the highest TFP among the group of South Asian countries.

TABLE 2
FIXED EFFECTS MODEL RESULTS
(COUNTRIES RANKED BY AVERAGE TFP)

Rank	Country	TFP	Rank	Country	TFP
1	Luxemburg	5.70	20	Mexico	4.73
2	Japan	5.53	21	South Africa	4.54
3	Norway	5.51	22	Malaysia	4.54
4	USA	5.49	23	Hungry	4.38
5	Switzerland	5.46	24	Tunisia	4.38
6	Sweden	5.38	25	Philippine	4.31
7	UK	5.33	26	Iran	4.29
8	Netherland	5.32	27	Peru	4.21
9	Italy	5.30	28	Brazil	4.15
10	Singapore	5.29	29	Thailand	4.06
11	Spain	5.11	30	Paraguay	4.00
12	New Zealand	5.03	31	Pakistan	4.00
13	France	4.98	32	Egypt	3.85
14	Korea	4.97	33	Sri-Lanka	3.79
15	Canada	4.93	34	Indonesia	3.72
16	Finland	4.92	35	China	3.52
17	Portugal	4.92	36	India	3.29
18	Germany	4.87	37	Bangladesh	3.09
19	Australia	4.83			

The determinants of TFP have focused on health and education as two important factors that influence the effectiveness of labor force or its productivity. Three different panel data econometric models, i.e., the Common Effects, Fixed Effects and Random Effects have been applied. In this study we have adopted general to specific approach starting with a number of relevant variables and then excluding the insignificant variables. In order to check for the appropriateness of the model, two model specification tests, i.e., the Restricted F-test and the Hausman model specification test have been used. The estimated results are reported in Table 3.

TABLE 3
THE DETERMINANTS OF TFP

	Common effects	**Fixed effects**
Dependent :TFP		
Health	0.618***	0.281***
	(5.024)	(2.267)
Education	0.198***	0.151***
	(6.059)	(4.914)
Openness	0.031**	0.028**
	(2.265)	(2.186)
GDP	0.016***	0.0100*
	(2.750)	(1.755)
Constant	-2.118***	-0.321
	(-4.569)	(-0.629)
Dummy (Developing Countries)		-0.125***
		(-6.236)
N	185	185
Adj. R-square	0.61	0.68
F-Statistic	71.90	77.41
P- Value. F. Stat.	(0.00)	(0.00)

Note: ***, ** and * shows significance at 1%, 5% and 10% level.

The results of Common Effects model reveal that health has a positive and significant impact on TFP with coefficient value of 0.61 percent. This implies that, on average, an addition of one year in life expectancy causes TFP to increase by 0.61 percent. The coefficient of health from common effect model is close to the findings of Hamoudi and Sachs (1999). As expected, education has positive and significant impact on TFP. Since, average years of schooling is used as a proxy of education, the results indicate that an additional year of schooling increases TFP by 0.198 percent. This outcome is not too different from the one found by Cole and Neumayer (2006). Trade openness and economic activity have a robust, positive and significant impact on TFP in the Common Effects model. The coefficient of trade openness is 0.031, which indicates that one percent increase in trade openness help to increase TFP by 0.031 percent. The sign of economic activity is positive and significant indicating that as income increases in a country it helps in promoting TFP. Finally, the R^2 of the model is statistically valid. It highlights that 61 percent model of variations in the dependent variable are explained by the chosen regressors.

The third column of Table 3 reports the results of equation (9) estimated by the Fixed Effects model. Here we have introduced dummy, which is equal to one for developing countries and zero otherwise. The dummy variable has turned out to be significant negative, which indicates that the average TFP of developing countries, is significantly lower compared to developed countries. The intercept of developing countries is obtained by adding constant and dummy (-0.321 + (-0.125) = -0.446). In this model life expectancy has the significant positive impact (0.281) on total factor productivity and the coefficient is close to most of the previous cross sectional studies (see Barro, 1996; Bloom and Sachs, 1998; Bloom and Williamson, 1998). The proxy for education, i.e., average years of schooling also has a significant positive impact on TFP which is in conformity with the findings of Bloom et al (2003). Trade openness and GDP have positive and significant impact on TFP. The coefficient of trade openness indicates that openness to competition enhances factor productivity. In the same way increase in economic activity also helps in improving productivity. In the Fixed Effects model, the values of F-statistic and R^2 have improved. The result of Random Effects model is given in the appendix Table 3A. Here the coefficient of life expectancy is significant and carry expected sign. However, the coefficient for education has turned insignificant even though it continues to display the expected positive sign. Similarly, the other two determinants, i.e., trade openness and GDP have positive and significant impact on TFP.

Finally, to determine which of the three models is more appropriate, we have used the model specification test. Firstly, the Restricted F-test was used to investigate the choice between the Common Effect versus the Fixed Effects models. The value of F-test has been found to be highly significant which indicates that the restricted Common Effects is invalid and Fixed Effects or Unrestricted model is a valid choice. Secondly, the Hausman model specific test is used to examine the choice between Random versus Fixed Effects and the test favored the Fixed Effects model over the Random effects model. It rejected the Random Effects at 99% confidence interval and chi-square statistic was also in the acceptance range. Incidentally, the appropriateness of the Fixed Effects econometric technique has also been supported by most of the previous panel data studies including those of Cole and Neaumayer (2006) and Miller and Upadhyay (2000).

4. CONCLUSION

In this study we examined the impact of health and education on total factor productivity (TFP) by using panel data for the period 1990-2010 for thirty seven developed and developing countries. A two-step approach was adopted to first derive the estimates of TFP and then the determinants of TFP. Besides trade openness and an indicator of economic activity, special attention was laid on indicators of health and education as most important factors influencing TFP. We found that besides factor accumulation, improvement in factor productivity through investment in human capital were the major contributing factors in explaining the differences in levels of development among countries. These findings reconfirm the need for improving health and education of the general populace to ensure sustainable growth and economic development across the globe. In fact, the study recommends that the developing world which is lagging behind the developed nations need to prioritize this effort on urgent basis.

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APPENDIX A

TABLE 1 A
LIST OF COUNTRIES

ID	Country	ID	Country		
1	Australia	Developed	20	Netherland	Developed
2	Bangladesh	Developing	21	Newzeland	Developed
3	Brazil	Developing	22	Norway	Developed
4	Canada	Developed	23	Pakistan	Developing
5	China	Developing	24	Paraguay	Developing
6	Egypt	Developing	25	Peru	Developing
7	Finland	Developed	26	Philippine	Developing
8	France	Developed	27	Portugal	Developed
9	Germany	Developed	28	Singapore	Developed
10	Hungry	Developed	29	South Africa	Developing
11	India	Developing	30	Spain	Developed
12	Indonesia	Developing	31	Srilanka	Developing
13	Iran	Developing	32	Sweden	Developed
14	Italy	Developed	33	Switzerland	Developed
15	Japan	Developed	34	Thailand	Developing
16	Korea(Rep.)	Developed	35	Tunisia	Developing
17	Luxemburg	Developed	36	UK	Developed
18	Malaysia	Developing	37	USA	Developed
19	Mexico	Developing			

TABLE 2A
COBB- DOUGLAS PRODUCTION FUNCTION

Random Effects	
Variable (dependent: lny)	
Lnk	0.853***
	(27.623)
lnL	-0.073***
	(-2.397)
N	185
R-Square	0.80
F- statistic	383. 22
Hausman Test(FE v. RE) p-value (0.0001)	

Note: ***, ** and * shows significance at 1%, 5% and 10%

TABLE 3A
DETERMINANTS OF TFP

Random Effects		
Dependent :TFP		
Health		0.142*
		(1.716)
Education		0.019
		(0.67)
Openness		0.018*
		(1.608
GDP		0.037***
		(4.289)
Constant		-0.179
		(-0.482)
Dummy		
N		185
Adj. R-square		0.23
Hausman Test (RE vs. FE)	p-Value	(0.000)

Note: ***, ** and * shows significance at 1%, 5% and 10%