International Research Journal of Finance and Economics
ISSN 1450-2887 Issue 159 January, 2017
http://www.internationalresearchjournaloffinanceandeconomics.com

How Education does at all Levels Influence Total Factors Productivity Growth?

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Abstract

The issue of improving productivity growth is well stressed in developing and less developing countries that confront a severe economic and social deterioration owing to the misuse of the available human and physical resources. Education, as a main component of human capital, plays a leading role beyond that of physical capital in prompting Total Factor Productivity growth through its potential spillover effects on the technical change and efficiency improvement. Hence, considering education quality embedded in human capital attributable to the rising educational attainment of the labor force is a priority. On this ground, the aim of the paper is to examine thelong run impact of education quality on TFP growth in Egypt during the period (1980-2014). In a two-step approach, the Gauss-Newton algorithm method is used in estimating the nonlinear Cobb-Douglas production function to calculate TFP series. In the second step, the TFP determinants have been estimated by paying special attention to education indicators besides other control variablesthrough applying the Autoregressive Distributed Lag Bounds test approach of co-integration. Results revealed that TFP growth appears to be significantly slightly enhanced by quality improvements in higher education only. Some reforms must be done on the basis of analysis and research.

Keywords: Human capital, Education quality, ARDL model, Total Factor Productivity Growth.
JEL Classification: J21, J24, O47

1. Introduction

Productivity growth is vital for economic and social development in any countryhence constitutes the prime engine of economic growth (Maurel and Seghir2013); where high productivity levels trigger higher individuals' income and higher producers' profits which are reflected in more savings and additional investments which, in turn, create more jobs and achieve economic progress coupled with social welfare.The issue of improving productivity growth is well stressed in developing and less developing countries that face up to a severe economic and social deterioration owing to the misuse of the available human and physical resources (El Feil, 2006).Since the Second World War, it has been noticed that the average annual growth in output per capita isgetting higher in the developed countries, while it is constant or increasing slowly in the developing ones. This difference in the level of development among countries is due to TFP differences and that pose question "Why some countries are so developedwhile others so poor? There are some factors that contribute to these vast TFP differentials. One important key factor of total productivity growth is human capital.

The important role of human capital in promoting total factor productivity (TFP) growth is widely introduced since the seminal contributions of Schultz (1961), Becker (1964), Welch (1970) and Mincer (1974), and has been strongly supported by many economic theories and economists in our time.

Broadly speaking, human capital is defined in the Oxford English Dictionaryas "the skills the labor force possesses and is regarded as "a resource" or "an asset." It encompasses the notion that there are investments in individuals (e.g., education, training, health) and that these investments increase an individual's productivity. The flow of individuals' skills is forthcoming when the return to investment exceeds the cost. Returns to these skills are private in a sense that an individual's productive capacity increases (Goldin, 2014). Externalities of human capital developmentemerged when the productive capacity of others increasedand enhance TFP components by being an agent of technological innovation, diffusion and catch-up processes (shahzad, 2014, 110).Also, there is a supportiveempirical evidence that links human capital closely to educationas itplays a leading role beyond that of physical capital in prompting TFP growth through its potential spillover effects on the technical change and efficiency improvement and thus allowing developing countries tocatch up with advanced ones(Saquis and Arbache, 2002; Hua, 2005) [1].On this ground, the papernarrows thefocus on examiningthe impact of education quality on TFP growth,which is one of the hot-debated topics in recent studies, in Egypt during the period (1980-2014) [2].Here education is measured from the output – based approach and the education attainment by the workforce is used as a proxy for education quality and labor skills [3].In order to test the argument "upgrading the quality of education will positively affects TFP growth of the economy", the Egyptian employments' educationlevels split them into 3 levels: illiterate labor, labor with intermediates education degree and below, and labor with high education.

After examining the relation between education and TFP growth, the empirical methodology adopted include applying the Bounds Testing Approach to Co-integration constructed by Pesaran et al., (2001), followed by the Autoregressive Distributed Lag (ARDL) bounds test approach of co-integration suggested by Pesaran and Shin (1999). In estimating TFP series [4], the present study used the Gauss-Newton algorithm method in estimating the nonlinear cobb-Douglas production function to calculate TFP series as the residual of the production function. Hence, in the first place, the Cobb-Douglas production function will be estimated (in its nonlinear form) for reaching TFP series. In the second step, the determinants of TFP have been estimated by paying special attention to education because it is our central argument that education affects economic growth via TFP.

The findings confirmed thepositive impact of high education expansion on economic growth via enhancing TFP growth but with lower coefficient. Also the impact of intermediate education expansion on TFP growth is ended to be statistically negative, and the impact of illiterate workforce on TFP growth isnegative and insignificant. Somereforms in the education system must be done on the basis of analysis and research.

Therest of the paper is organized as follows; Section 2 demonstrated the relation between education, as a key component of human capital, and TFP in economic thought. Section 3 summarizes a the quality of education in Egypt. Section 4deals with the literature review, Section 5 begins with Data and Research Methodology, Section 6 describes the Results, and Section 7reports the concluding remarks and policy recommendations.

Human Capital as a Key Source of Total Factor Productivity Growth

Total factor productivity growth, also known as "Solow residual", is the part of output growth not explained by growth in traditional inputs like capital accumulation, labor or land [5]. During much of the twentieth century, the size of the residual relative to economic growth in per capita or per worker terms revealed that physical capital accumulation did not explain much of growth and that something else did; which in fact was the human capital growth; that is knowledge creation and the augmentation of the labor input through education and training and gaining experience. Therefore, one key source of total factor productivity growth is the qualified human capital stock that is embedded in upgrading the quality of the workforce, credited to education and experience accumulation;the learning-by-doing effect(Lee, 2007).

In economic literature, the crucial role of human capital in promoting total factor productivity (TFP) growth is widely introduced since the seminal contributions of Schultz (1961), Becker (1964), Welch (1970) and Mincer (1974), and has been strongly supported by many economic theories. Nelson and Phelps(1966) argued that the role of education is beyond that of physical capital, also human capital development through education promotes total factors productivity through facilitating the technological transfer (Hao and Wei, 2009; Aggrey et al, 2010).

According to the human capital theory, humancapital contributes to output just like other factors of production, and via technological change by driving both innovationand imitation. likewiseeducation, as a main component of human capital, contributes to productivity improvement through its potential spillover effects on the technical change and efficiency improvement; as it allows workers to use the existing physical capital more efficiently, increase the capacity to upgrade the availabletechnology and imitate the advanced techniques which previously used by developed countries (Saquis,and Arbache,2002).Corvers (1975)explored that human capital is vital for firm productivity and isaccrued in two ways: experience and education. He discussed four effects of human capital on productivity; the worker effect, the allocative effect, the diffusion effect, and the research effect.

The worker effect; refers to the positive marginal labor productivity as a result of education. The allocative effect; relates the ability of educated workers to more efficiently allocate input factors of production to the production process. The diffusion effect and the research effect; stressed that educated workers are better at implementing new ideas and have more ability to adapt to technological change and will introduce new production techniques more quickly, and eventually enhance TFP growth.

Despite the critical role of human capital as a motivating source of economic growth, it wasn't introduced in the growth modelas an independent variable until the end of 80s by the works of Lucas (1988), Romer (1990), stockey (1988), and Mankiw, et al., (1992) [6].

According to new endogenous growth theory, the ability of labor to enhance the overall productivity and achieve a sustainable economic growth depends on human capital accumulation through education, training and experience. Also, the theory assumes a constant return on capital investment; the rate from investing in physical capital diminishes overtime, whereas the investment in human capital through education has its internal effect on labor's productivity, and its external positive effect on total factors productivity. Hence, the increase in productivity of physical capital resulting from these positive spillover effects of human capital accumulation would cancel the effect of "law of diminishing returns", in turn, leaving the rate of return on capital constant overtime, and hence a sustainable economic growth will be achieved.

In Lucas's model (1988), the rate of return on education depends on the time spent on education. Besides, he argues that investment in education is complementary to investment in physical capital, and that explains whyphysical capital doesn't flow from developed to underdeveloped countries with relatively low stock of human capital (Lucas, 1990). All of Romer(1990a, 1990b) and Aghion&Howitt (1998) asserted that education exercises a crucial impact on the speed of technological catch- up and diffusion; as it facilitates the ability of a nation to adopt, assimilate and implement new technologies from other nations and upgrades its ability to innovate domestically.Grosman and Helpman (1991) asserted that the effect of human capital on total factor productivity growth depends on the openness degree of a country; as it promotes the international competition, enhances the advances in production methods and advanced technology imitation, which in turns increases the demand for skilled labor [7].

Foster and Rosenzweig (1995),Wozniak (1984); Bartel and Lichtenberg (1987); Fleisher and Chen, (1997); Vandenbussche et al., (2006); Fleisher et al., (2008),statethat “more educated workers have a comparative advantage in implementing new technologies”, and such a microeconomics proposition has an empirical evidence. Also,Benhabib and Speigel (1994) have argued that the relationship between human capital and income growth is best viewed in the context of the positive effect that human capital has on total factor productivity, rather than its direct effect as an accumulative factor in the production function.AiyerandFeyrer,(2002) resolved the debate over whether factor accumulation or TFP increases are more important for economic growth; they ended to the result that TFP differences explain most of the static variation in GDP across countries and human capital accumulation is a crucial determinant of the dynamic path of TFP. Conversely, some studies, such as Hanushek and Kimko (2000); Pritchett, (2001);Bosworth and Collins (2003) havemarked the negative impact of education on total factor productivityattributable to using unsuitable measures of human capital that neglect the quality of human capital.

To end this, the qualified human capital stock can drive a sustainable economic growth through three main channels; forward as being an important input in the production process along with physical capital and labor (e.g. Lucas, 1988; Mankiw et al., 1992), or implicitlyeither through its spillover effects on technical efficiency and technological change (Nelson & Phelps,1966; Romer, 1986, 1990; Aghion & Howitt, 1998; Mankiw et al., 1992; Benhabib and Spiegel, 1994, Islam, 1995), or by attracting physical capital investment (e.g. Benhabib and Spiegel, 1994; Chi, 2008).And the current paper focuses narrowly on the indirect channel through which education can foster the economic growth; via enhancing TFP growth.

Literature Review

The economic theory claims that education enhances economic growth by working as an input of production and by being an agent of technological innovation, dissemination, and imitation and by attracting physical capital investment.Previous empirical evidence on the effect of education on growth through total factor productivity growth is mixed. Nelson and Phelps (1966) were first to argue that the adoption and the effective use of new technology depend not only on the availability of technology, but also on the capability of countries to adopt and effectively use these technologies. They suggest that education plays a crucial role in determining the abilityof countries to implement new technologies that allows developing countries tocatch up with advanced ones. Millerand Upadhyay (2000) found a negative effect of human capital on TFP in high-incomecountries and a positive effect in middle-income countries. The effect of human capitalon TFP in low-income countries moved from negative to positive as the country movedfrom a low to a higher level of openness and hence export enhances productivity growth. The study made by Pritchett (2001) showeda large and significant negative impact of human capital on TFP growth in Nepal; as it is still an agro-based economy and hi-tech industrial activities are in low level, thereby education is a less influential factor in growth.And similar to the findings of Miller and Upadhyay (2000),trade openness (measured as real export’s share in real GDP) has positive and statistically significant effect on growth (Bonelli, 1992; Haddad, de Melo& Horton, 1996; Weinholdand Rauch, 1999; Yean 1997; Sjoeholm, 1999). (AiyerandFeyrer,2002) analyze the causal links between human capital accumulation and growth in total factor productivity (TFP). In particular, they test the Nelson-Phelps hypothesis that human capital is crucial in enabling the imitation of technologies developed at the frontier. TFP was calculated for a sample of 86 heterogeneous countries over the period (1960-1990), and thus they investigated whether there has been (conditional) convergence in TFP. By using a variety of GMM estimators in a dynamic panel framework with fixed effects, human capital is found to have a positive and significant effect on the long run growth path of TFP. Countries are found to be converging to these growth paths at a rate of about 3% a year.Akinlo (2005) explores the effects of macroeconomic factors on total factor productivity (TFP) in 34 sub-Saharan African countries for the period 1980-2002. The” neo-classical growth accounting” approach is used to estimate TFP .The panel data model results show that human capital (measured by enrollment rates in secondary education) has a positive significant impact on TFP growth and hence confirms that human capital investment via education promotes TFP, besides other control variables such as export–GDP ratio, credit to private sector as percentage of GDP, foreign direct investment as percentage of GDP, manufacturing value-added as a share of GDP, and liquid liabilities as percentage of GDP have significant positive effect on TFP. However, Other factors that have significant negative effect include inflation rate, agricultural value added as a percentage of GDP, lending rate, and local price deviation from purchasing power parity.In China,Hua (2005) investigates the different impacts that primary, secondary and university education exert on total factor productivity growth and its two components. TFP growth is measured as a ratio between the value added and weighting sum of production factors and the TFP components;efficiency growth and technical progress, are calculating using DEA Malmquist indices for twenty nine Chinese provinces over the period (1993-2001).Using panel econometric model for TFP growth, findings revealed a positive significant impact of university education on the two TFP components, such a favorable impact of university education on efficiency change is via the reallocation of university-educated workers into the more efficient non-state sector. On the other side, both primary and secondary education has negative effect on efficiency growth.El Khatib (2008) aims at estimating the main determinants of TFP in the non -Oil Saudi Economic Sector in order to specify its sources of growth depending on annual data in constant prices covers the period (1970-2007). Following “the endogenous growth model” and by applying Johansen co-integration test, both investment return on education and years of education are used as a proxy for human capital. Findings revealed that human capital investment has an insignificant impact on TFP growth in non-oil sectors public expenditure on education. Hao and Wei (2009) study the role of human capital in China’s provincial total factor productivity growth over 1985-2004. They adopt the stochastic frontier approach to measure productivity growth of Chinese provinces in terms of the Malmaquist TFP index, and assess the relationship between productivity growth and human capital. When measuring human capital, they particularly focus on the composition of human capital, represented by enrollment rates at various levels of schooling, as well as education quality. After controlling for endogeneity, they find that human capital has significant and positive effects on total factor productivity growth of Chinese provinces. However, when education quality is incorporated, productivity growth appears to be significantly enhanced by quality improvements in primary education only. They also find that regional impacts of human capital differ at various levels of schooling. In the eastern region of China, productivity growth is significantly attributed to secondary education. TFP growth in the central region is mainly promoted by primary and university education. Yet in the western region, primary education plays the most prominent role. (Sanderson and Striessnig, 2009) presented a new data on total factor productivity for eight world regions over the period 1970 to 2001. The regions are North America, Western Europe, Japan/Oceania, the China Region, South Asia, Other Pacific Asia, Latin America and the Caribbean, and Sub-Saharan Africa and the paper is based on the new IIASA/VID database on education. The study estimated a new model of the determinants of total factor productivity based on the framework of conditional convergence. The model distinguishes between factors that influence the level of the conditional productivity frontier and the speed of catching up to that frontier. They show that productivity stagnation in Latin America, the Caribbean and in Sub-Saharan Africa are not because they are trapped far below their potential, but rather that they are fully utilizing the low potential that they have. Also, they found that education and age structure have independent and joint effects on productivity. The rate of capital formation, the quality of institutions, openness, and corruption also affect total factor productivity. The effects of specific variables on total productivity differ by context. They can be different depending on whether a country is catching up to its conditional productivity frontier or not. This provides the possibility of resolving some of the puzzles with respect to the effects of age structure and education. (Kumer and Chen, 2013) examine the Nelson-Phelps hypothesis and study the dynamics of the total factor productivity (TFP) and the impact of education and health on the growth rate of TFP in a sample of 97 countries for the period (1960-2005). TFP is estimated by using the augmented Solow model in which health capital is a factor of production. The results cleared that both health and education have a positive and significant effect on TFP growth and hence, support the Nelson-Phelps (1966) hypothesis that education plays an important role in technology diffusion. However, results also suggest that in designing policies which facilitate technology diffusion, there is a need to broaden the concept of human capital to include health. Dahal (2013)stated that education contributes to growth through its direct benefits to the individual and positive externality to the society. He empirically examines the effect of higher education on total factor productivity in the aggregate level of the economy of Nepal employing time series data of the period (1975-2011) applying the ARDL method of co-integration. The findings are not encouraging on the issue, as they revealed that the effect of higher education on TFP is almost ambiguous. Quantity of higher education measured by enrollment per capita in higher education in entirety or categorized as general or technical higher education appears with positive andnegative sign as well in the ARDL method of co-integration. The log run (i.e., the levelvalue) estimates showed positive effect of overall higher education (EDUH), generalcategory of higher education (HGEN) and technical type of higher education (HTEC)but in the error correction model (ECM) estimates the coefficient of all measures ofhigher education variable turned to be negative and significant also. This cast seriousdoubt on the effect of higher education in enhancing productivity in Nepal. By using a rich amount of firms' information in the Senegalese database, Maurel and Seghir (2013) examine the role played by low, intermediate skilled and high-skilled labor in explaining differences in total factor productivity (TFP) dynamics for the different sectors of the Senegalese manufacturing sectorduring the period (1998-2013). The results indicate that the contribution to TFP of education is significant and robust, noticeably for technical education. This finding corroborates the conclusion of a recent report (ADB, 2012) suggesting the importance of primary and vocational education. ShahzadAlvi (2013) examines the impact of health and education on total factor productivity by using panel data for the period (1990-2010) of thirty seven developed and developing countries. In a two-step approach, the Cobb-Douglas production function is estimated in the first step for calculating 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 year of schooling as indicator of education. Findings revealed 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 public to ensure sustainable growth and economic development.

To sum up, most of studies that examines either the impact of human capital through education on TFP growth or explore the main determinants of TFP applied "the neo-classical growth accounting" approach in their way to estimate TFP series, and those who are interested in splitting TFP components; efficiency growth and technical progress, use the DEA Malmquist indices for productivity growth. On the other hand, different education levels of workers, enrollment rates, investment return on education and years of education are commonly used as proxies for education. Also, regarding the impact of education quality on TFP growth, using time series data,(ARDL- ECM) model is run on or (VECM) model isapplied alternatively. Most findings revealed that the contribution of education to TFP is significant and robust in countries with high skilled labor; well-trained and good educated workforce.in most cases, the effect tends to be lower and negative for lower education level, also in developing countrieswith extreme dependenceon imported manufactured goods, with highly dependence on unskilled labor in its labor market, and hence with lower opportunity to "catch- up" with developed nations. Moreover the impact depends, even in developed countries, not only on the availability of technology but also on the capability of using, imitating, developing, and improving such a technology.

Background

While Egypt is a human capital rich country; 91 million people in 2015 half of whom are under the age of 25, it has regularly underinvested in human capital. On education, especially, it has fallen behind other developing countries– both in terms of spending and outcomes.According to (Qutb,2015a, 2016b),there is a reasonable degree of internal inefficiency in allocating the public education spending in Egypt; where for the past 40 years, minor part of it has been devoted to investment expenditures. Also, the share of wages and compensations of workers in the balanced budget is high and constitutes 86% where it doesn't reflect a high wages of education academic stuff rather it reflects the high share of nonacademic ones to the total workers compared to the accepted global rate. Besides, Pupil-teacher ratio is high and reached on average around 28 pupils per teacher in primary education, and 19 pupils per teacher in secondary education. All those factors affect negatively the quality of educational services received by pupils.

Table 1: The enrollment rates and GPI in Egypt over the period(1976-2015)

item	1976	1986	1996	2003	2006	2010	2015
PrimaryEnrollment rate(Gross)	65.4	81.9	102.3	104.9	107.17	112.3	115
PrimaryEnrollment rate(net)	63	68	92	96.1	95.7	97.9	95
GPI (primary)gross%	66	79.8	75.6	94.9	94.2	95.9	98
Secondary Enrollment rate	38.9	58.2	72.16	87.7	--	75.8	89
GPI (secondary)	55.6	69.1	87	93.6	--	96.4	97.4

Source: world development indicators

Also, although Egypt has made a considerable progress in closing a woeful gender gap and increasing the enrollment rates in primary and secondary education, as indicated by table (1), it still suffers from a relatively weak efficient finance devoted to its education sector; where there are high intensity of classrooms, adult illiteracy is high (about 40%), and also the unemployment of educated individuals remains persistently high (13.6%) due to the mismatch between the outcomes of the education system and the needs of the job market.

Concerning the employment in the Egyptian labor market, as indicated by table(2), we notice that:

a) In Egypt, the demand for unskilled labor was dominating the Egyptian labor marketduring the period of study till year1997, then it starts to decline but still the contribution of illiterate workers is higher than that of skilled workers in the labor market till now.
b) The workforce with an intermediate educationhas enjoyed a dominant share in the Egyptian workforce since 1998; where their share has been amplified over the period of study from 30% during the 80s, reached 34.7% throughoutthe 90s, and has gone to 45% during the last three years.
c) Concerning those with university education certificate; their contribution out of workforce has enlarged on averagefrom 8.7% during 80s, reached 21.2% in the 90s, and gone to 24% throughout the last three years.
d) With reference to illiterate workers category; their share out of the Egyptian workforce has declined over the period of study, on average, from 61% duringthe 80s to 44% throughoutthe 90s and to 31% during the last three years. Although these figures reflects upgrading in the construction of workforce, it needs more attention and extra cutback efforts; because illiteracy represents a direct threat to both social and economic stability in any country; as it restrains achieving a sustainable economic growthwhich denotes a hindrance to poverty rates reduction, also it reflects deterioration in the stock of human capital (Qutb, 2016, 169).

Table 2: The evolution of enrollment rates and employment in Egypt Over the period(1980-2015)

item	1980	1986	1990	1996	1997	1998	2003	2006	2010	2015
Employment (million)	8	11.9806	13.5	15.4	15.8	16.2	18.1	20.4	23.8	24.8
Illiterate workers (%)	63.0%	62.1%	59.3%	43.4%	40.8%	37.4%	32.1%	33.3%	29.5%	29%
Workers with secondary e0.d 3ucation (%)	26.8%	32.7%	25.8%	34.7%	37.2%	40.4%	41.7%	43.8%	47.0%	48.4%
Workers with tertiary education (%)	10.2%	5.2%	14.9%	22.0%	22%	22.2%	26.2%	22.9%	23.5%	22.6%

Source: CAMPAS, statistical book year

In Egypt, the planned high quality education system that yields well-trained and qualified labor force that matches labor market requirements is essential to reduce the unemployment rate. Also, education indicators in Egypt call for the need of more concentration on education sector reform through rising the percent of GDP that is devoted to the education sector (Qutb, 2015; Alaraby, 2010) In this regard, Egypt has got a step forward in reforming its education system to increase the quality of the educational services; as the new constitution commits the government to assign 7% of its GDP to the education sector with a promise to increase such a ratio gradually till reach the accepted global rate, hoping that the new spending quotas might help Egypt catch up to other emerging markets. But In fact, quality issues are not addressed by simply throwing more money at the problems; reforms must be done both on the basis of analysis and research.

5. Data and Research Methodology

In this section, after displaying data sources, we focus on the measurement of total factor productivity (TFP), autoregressive distributive lag (ARDL) approach of co-integration and data used in the study.

5.1 Measurement of Total Factor Productivity in Analyzing the Impactof Education on Total Factors Productivity in the Egyptian Economy during the Period (1980-2014), TFP Series has to be Estimated on the First Place

Total factor productivity (TFP) is attributed to a combination of not –so- easy-to- measure factors like technological advances, economic restructuring and upgrading, social and political stability, and upgrading the quality of labor force (Lee, 2011,2). It measures a combination of changes in the efficiency of usingthe production inputs and changes in technology. Solow (1957) proposed a residual component in growth accounting method as a measure of the contribution of productivity change toeconomic growth [8].

In the present study andrelying on previous studies such as (El Naka, 2015), the Gauss-Newton algorithm method is used in estimating the nonlinear production function to approximate the time series of the dependent variable TFP as a residual of the function. We will start by theCobb-Douglas production function in the neoclassical Solow-Swan tradition, where output (Y_t) can be properly estimated overtime by two factors, capital stock (K_t) and labour force (L_t). This function takes the form of:

$$y_t = f(L_t, K_t) = A{L_t}^{\alpha}{\mathrm{K}_t}^{\beta}$$

where $\boldsymbol{y_t}$ is real GDP in the year (t), A is the efficiency index, a measure of TFP (the Solow residual), K_t is the aggregate stock of capital in the year (t), L_t t is the aggregate labor force in the year(t), and α and β, are the output elasticity with respect to labor and capital respectively [9].

By estimating the value of the “α” and “β”coefficients, and by placing the time seriesof y_t, k_t, and L_t, we can get the time series of TFP, where the geometric index version of TFP is calculated as follows:

$$\mathrm{TFP} = Y_t / L_t^{\alpha} . K_t^{\beta}$$

where Y is an index of output; K is an index of capital input; L is an index of labor input; α is labor's share of output, and β is capital's share of output (with α+β=1).Hence, by estimating both α and β, we can get TFP. By applying Gauss-Newton algorithm method, the nonlinear production function of the Egyptian economy will be estimated over the period (1980-2014) as indicated by table (3):

Table 3: Estimating the nonlinear production function of the Egyptian economy using Gauss-Newton algorithm method over the period (1980-2014)

Dependent Variable: Y
Method: Least Squares
Date: 01/08/17 Time: 18:19
Sample: 1980 2014
Included observations: 35
Convergence achieved after 50 iterations
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)
Y= C(1)*L^C(2)*K^C(3)

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	3.459453	1.367783	2.529241	0.0166
C(2)	1.657277	0.170167	9.739144	0
C(3)	0.109544	0.127648	0.858173	0.3972
R-squared	0.960443	Mean dependent var		656.241
Adjusted R-squared	0.957971	S.D. dependent var		315.467
S.E. of regression	64.67399	Akaike info criterion		11.25841
Sum squared resid	133847.2	Schwarz criterion		11.39173
Log likelihood	-194.022	Hannan-Quinn criter.		11.30443
Durbin-Watson stat	0.694714			

Source: computed using E-Views package

The estimated nonlinear production function can be written as follows [10]:

$$y_t = f(L_t, K_t) + \varepsilon = aL_t^{\beta_1} K_t^{\beta_2} + \varepsilon_t = 3.46L^{1.66}K^{0.11} + \varepsilon_t$$

Hence,

$$TFP=A=Y/ (L^{1.7}*K^{0.08}) \quad (1)$$

The LS estimate of production function related to equation (1) using the time series data of the period 1980-2014 produced the share of capital (α) to be 0.11 and labor's share (β) is estimated to be 1.66(i.e. the production function in the Egyptian economy exhibits increasing returns to scale in the long run) Then we inserted these values in equation (1) along with the actual values of Y_t, K_t and L_t to obtain the series of TFP.

5.2 Unit Roots Test

We first test the nature of the time series of the variables to determine whether they are stationary or non-stationary and also specify their order of integration which assist indetermining the subsequent long-run relationship among the variables. The augmented Dickey- Fuller (ADF) unit root test is conducted for unit roots to avoid spurious regression. The general equation for the ADF test is:

$$\Delta Y_t = \alpha + \beta t + \gamma\, \Delta Y_{t-1} + \delta_1\, \Delta Y_{t-1} + \ldots + \delta_p \Delta Y_{t-p} + \varepsilon_t$$

where Y is a time series variable, α is a constant, β the coefficient on a time trend (t), p the lag order of the autoregressive process and ε_t is a pure white noise error term. The ADF test for a unit root tests the null hypothesis (H_0: γ=0;series contains a unit root), against the one-sided alternative (H_1: 1 <γ; series is stationary). If the computed Dickey-Fuller statistic is more negative than the test critical (theoretical) values, the null hypothesis is rejected.

5.3 Co-integration: ARDL Bounds Test

In order to establish a long run-relationship between the variables, the Bounds Testing Approach to Co-integration constructed by Pesaran et al., (2001) is employed, followed by the Autoregressive Distributed Lag (ARDL) bounds test approach of co-integration suggested by Pesaran and Shin (1999). The general form of ARDL model can be written as:

$$\Delta Y_t = \alpha + \delta\, t + \rho\, Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \ldots + \gamma_{\rho-1} \Delta Y_{t-\rho+1} + \theta X_t + \omega_1 \Delta X_t + \ldots + \omega_q \Delta X_{t-q+1} + e_t$$

as a Co-integration method, the ARDL has economic merits over other bivariate co-integration test introduced by Engle and Granger (1987) and multivariate co-integration technique proposed by Stock and Watson (1988), Johansen (1988, 1991) and Johansen and Juselius (1990); unlike bivariate and multivariate co-integration methods which are applicable mostly for large sample size and are not reliable for small sample sizes, the ARDLmodel applicable for small sample size. Another advantage of applying the ARDL co-integration technique is that it allows tests for the existence of relationships between variables in levels irrespective of whether the time series being considered are integrated of order one, I(1), and/or order zero, I(0) or mutually co-integrated.

Referring to the economic literature and the previous studies that estimate the impact of education quality, measured by different education levels, on TFP, the functional form of the proposed model can be written as follow:

TFPg= F (ln H1, HE, Ln PREH, TRADE)

Hence, the form of ARDL model can be expressed as:

$$\Delta\, TFPG_t = \alpha_0 + \alpha_1 TFPG_{t-1} + \alpha_2 \,Ln\, H_{1t-1} + \alpha_3 HE_{t-1} + \alpha_4 Ln\, PREH_{t-1} + \alpha_5 Trade_{t-1}$$
$$+ \beta_0 \Delta TFPG_{t-1} + \beta_1 \Delta\, Ln\, H1_{t-1} + \beta_2 \Delta\, HE_{t-1} + \beta_3 \Delta\, LnPREH_{t-1} + \beta_4 \Delta\, Trade_{t-1}$$
$$+ \beta_5 \Delta\, HE_t + \beta_6 \Delta LNPREH_t + \beta_7 \Delta\, Ln\, H1_t + \beta_8 \Delta TRADE_t + U.$$

Where,the dependent variable,Δ $TFPG_{t,}$ represents total factor productivity growth. While, The independent variables: Ln H1; is the part of labor that is illiterate.$LnPREH_{t;}$ isthenatural logarithm of labor with universityeducation degree and above. $LnHE_{t;}$isthe part of labor with intermediate education degree and before and$TRADE_{t(}$ The trade openness degree); and calculated as the summation of exports and imports as a percent of GDP. Open economies can grow more rapidly through greater access to cheap imported intermediate goods, larger markets, and advanced technologies that can be imitated and then contribute to TFP

Here in our model,we divide the labor force into three groups; those who are illiterates, those with education level up to an intermediate degree, and those with universitiescertificate and above. And then estimate the impact of different education levels on TFP in Egypt during the period (1980-2014).

The ARDL procedure of co-integration involves two stages. The first stage requires testing the existence of a long-run relationship between the variables under investigation (testing the significance of the lagged levels of the variables) by comparing the “F-statistic” of “Wald - bound test” with Pesaran critical value at α=5% and k = the number of independent variables in the ARDL model.The second stage involves the estimation of the long run and short run relation between the variables.

And the following main hypothesis is established:

Ho: There is no significant long run relationship between educational quality and TFP growth.

H1: There is a significant long run relationship between educational quality and TFP growth.

5.4 Data Sources

The empirical investigation has been carried out in the case on Egyptian economy with a dataset of the period 1980 to 2014. The present study uses data which have been collected from the National Accounts Statistics, ministry of high education, and CAMPAS, (http://www.CAMPAS.gov.eg). The reliability of the data for empirical research can be attributed to the fact that all the data sources used in this study are government sources, and thus data is very much reliable for policy research. The data variables used in the present study are classification f workers by education level (proxies for education) and gross domestic product at fixed prices (y_t), the size of labor force (L_t), and size of physical capital (K_t), openness ($Trade_t$).All data used are expressed in constant prices in order to avoid the inflation effect. Statistical description of the relationship is described in the following sub-section.

6. Empirical Results

6.1 Unit Root Test

The stationary test results presented in Table 4 revealed that some of the variables under study are stationary at level, d(0), such as ($Trade_t$and TFPGt), while other are stationary at the first difference or non-stationary or integrated of order one in its level and stationaryd(1), or integrated of order zero at its first difference at least at 5% level). Once the series are made stationary, they can be used in regression analysis. But the drawback of this method is the possibility of losing long-run information about the variables. This problem can be overcome by applying the cointegration technique, which shows the long-run equilibrium relationship between two or more non-stationary series.

Table 4: The augmented Dickey- Fuller (ADF) unit root test results

variables	ADF (t- statistic)	Critical value (1%)	(5%) level	(10%) level	Probability*	Degree of co-integration (at level)
TFPG	-3.9	-3.67	-2.95	-2.6	0.0045	I(0)
Ln H1	-4.41	-2.6	-1.9	-1.6	0.0001	I(1)
Ln PREH	-1.7	-2.6	-1.9	-1.6	0.07	I(1)
HE	-3.45	-3.6	-2.95	-2.61	0.0159	I(1)
TRADE	-3.7	-2.6	-1.9	-1.6	0.0091	I(0)

*MacKinnon (1996) one-sided p-values

6.2 Co-integration: ARDL Bounds Test

After determine the optimal lag interval according to Schwarz andAkaikecriteria (which is found to be 2 optimal lags).the ARDL co-integration bounds test (Wald test) is conducted to test for the long-run equilibrium relationship between the variables.

Table 5: the ARDL co-integration bounds test: Wald test

Wald Test:			
Equation: Untitled			
Test Statistic	**Value**	**df**	**Probability**
F-statistic	4.412310	(5, 12)	0.0164
Chi-square	22.06155	5	0.0005

Source:computed using E-views packages, k=4 the n≠ of indepvariables in the ARDL model.
*The critical values are extracted fromPesaran et al., 1999: table
(3): Case V with unrestricted Interceptand Unrestricted Trend.

The table(5) aboveshows the results of "Wald bound" test statistics for testing the significance of the lagged values of our variables under investigation. The first stage test result indicates the existence of a co-integrating relation of the dependent variable 'TFPg with its regressors because the computed F-statistic of Wald bound test of value (4.4) is greater than the upper bound test critical value, the Pesaran critical value,(4.01) at α=5% and k=4. The existence of co-integration implies that the variables of the model have a tendency of moving together over the period of time. After finding that there is a co-integration in the model,we run the ARDL model.

6.3 The ARDL Model Results

The results of the ARDL method of co-integration for impact of education quality on TFPgrowth in Egypt are given in Table(6) in which dependent variable is TFPg with 34 observations used for estimation from 1980 to 2014.Test includes intercept(C) and order of the ARDL is set to two.We computed the long run coefficients of the ARDLmodel (in the difference form) [11], which are given in the equationbelow:

$$D\ (TFPG)_t = 0.026 + 0.03\ HE_t - 0.079\ LnPREH_t + e_t$$

(0.045) (0.020)(0.062)

Following (Tang, 2001, 10) and after omitting the most insignificant variables one by one, findings revealed that the estimated long run coefficients of higher education (HE_t) and pre-higher education($PREH_t$) variables are statistically significant with different signs (according to t -statistics test and standard error test).

Similarly the long run coefficients of the openness degree (trade) and illiterate workers (Ln $H1_t$) variables are insignificant statistically. Results indicates that in long run total factor Productivity growth appears to be significantly enhanced by quality improvements in higher education but with a lower coefficient; where an increase of number of workers with higher education by 1 million worker will add to TFP growth by 0.03% which gives a sign of the possibility of promoting the economic growth through its positive spillover effect on TFPgrowth as itdrives both innovation and imitation. Whereas, in long run the intermediate education variable will has a negative effect on TFG growth; where an increase of number of workers with higher education by 10 % worker will lessen TFP growth by 0.79% and that may hinder achieving a sustainable economic growth. That witnesses a problemin the education quality.

The minor positive long run impact of higher education expansion on TFP growthcan be justified in the context of the general weakness of the education sector featured by lacking the educational institutions of qualified staff, equipment, and an appropriate infrastructure needed in the educational process. Besides the negative impact of intermediate education on TFP growth in Egypt is reasonable, but we should notice here that this categorydominates the labor market demand; hence somereforms in the education system must be done on the basis of analysis and research.

Table 6: Autoregressive Distributed Lag Estimates

Model: TFPg=f (LnH1, LnPREH , HE, Trade,C)

Dependent Variable: D(TFPG) Method: Least Squares Date: 01/10/17 Time: 18:10 Sample (adjusted): 1983 2014 Included observations: 32 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.069328	0.045166	1.534984	0.1384
TFPG(-1)	-2.67027	0.28608	-9.33398	0
HE(-1)	0.090915	0.020464	4.44264	0.0002
LNPREH(-1)	-0.21149	0.062369	-3.39091	0.0025
D(TRADE)	-0.00682	0.001182	-5.76471	0
D(TFPG(-1))	0.845581	0.173469	4.874523	0.0001
D(TRADE(-1))	-0.00351	0.001347	-2.60508	0.0158
D(LNH1(-1))	-0.32631	0.117761	-2.77092	0.0109
D(TRADE(-2))	-0.00532	0.00124	-4.29303	0.0003
R-squared	0.892902	Mean dependent var		-0.00504
Adjusted R-squared	0.855651	S.D. dependent var		0.091075
S.E. of regression	0.034602	Akaike info criterion		-3.65753
Sum squared resid	0.027539	Schwarz criterion		-3.24529
Log likelihood	67.52046	Hannan-Quinn criter.		-3.52088
F-statistic	23.96958	Durbin-Watson stat		2.335304
Prob(F-statistic)	0			

Source:computed using E-views packages

While the lagged TFP growth variable has a positive effect on TFP growth and statistically significant at α=5%,the short run coefficients of both openness degree ($trade_t$) and illiterate workers ($LN\ H1_t$) variables are negative and statistically significant at α=5% up to 2 lags andone lag period respectively. Such a negative association of openness of trade withTFP growth reflects the deficiency of economy inadopting or imitating the technology that trickles through trade. There could alsobe the reason of maximum dependence of domestic economy on foreignmanufactured goods. The short run dynamic model is good as indicated by the significant F-statistic and R^2 (goodness of fit).

6.4 Diagnostic Tests of the ARDL Model

The diagnostic test indicates that the model adequately passes the econometric pathology for residual serial correlation (Lagrange Multiplier test), functional form (Ramsey's RESET test), normality of residuals (Histogram: normality test Jarque-Bera) and heteroscedasticity. This is indicated by the *p*-value given within the square brackets. The result of the diagnostic test of the ARDL model is given in Table 7below:

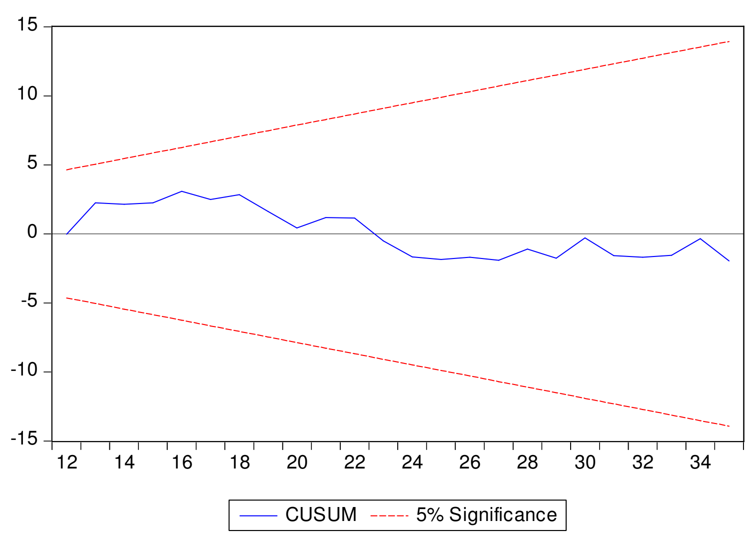
Table 7: Diagnostic Test of the ARDL Model :TFPg =*TFPg=f (LnH1, LnPREH , HE, Trade,C)*

Breush-Godfrey serial correlation Lagrange Multiplier test	f-statistics (1.22) prob (0.31) Chi-square prob (0.18)
Heteroscedasticity test : Breush- pagan-Godfrey	Chi-square prob (0.66) f-stat. prob (0.32)
Ramsey (RESET) test	f-statistics prob (0.46)
Histogram: normality test Jarque-Bera	Prob (0.512)

Source: computed using E-views packages

We further searched the stability of the ARDL model by plotting the cumulative sum of recursive residuals (CUSUM) as given in the figure (1) below.For stability of the short run dynamics and the long run equilibrium parameter of the TFP growth model, it is important that the recursive residuals and CUSUM of squares stay within the 5 % critical bound (represented by two straight lines) as shown in figure (1),the CUSUM of squares plots cross the 5 percent critical lines, therefore, the paper concludes that the estimated parameters for the short run dynamics and long run equilibrium of the model are relatively stable. In order words, a stable TFP growth model exists over the entire sample period.

Figure 1: plot of the Cumulative Sum of Recursive Residual (CUSUM)



Other stability tests such as the Jarque-Bera normality in table(7) also supports the stability of the parameters in theTFP growth model. The results of the various tests suggest that the model is fairly well specified and robust for policy analysis.

8. Concluding Remarks and Policy Implications

A country that only pays attention to the physical capital and not human capital investment could be subjected to a serious distortion in its development(Michaelowa,2000 ;Messbah,2006). As Heckman (2005) argues, the trend in investing more in physical capital then in human capital by the Chinese government could retard the economic development of that country in the future (Rao, and Jani,2009)

As being a key element of human capital formation, education considers one device for fostering economic growth and speeding up social development (Lee, (1989), pp 71-94); as it improves labor skills, efficiency, and enhances productivity which, in turn, put a stop to poverty and reduce the social and financial differentials among individuals within a nation (Saleh El Omr,2012,79-80). In addition, education stimulates economic development and improves people's lives quality through many channels, namely: by increasing the efficiency of the labor force and thus increasing an individual's earning potential, by fostering democracy and thus creating better conditions for good governance, by improving health, reducing fertility, boosting life expectancy, and enhancing equality ((Barro ,1998; Aghion et al. 1999). But we should be noticed that the positive spillover effects of education depends actually on the quality of education and on the extent of its matching with society needs (mussabeh,2006،;Michaelowa, 2000). The issue of improving productivity growth is well stressed in developing and less developing countries that confront a severe economic and social deterioration owing to the misuse of the available human and physical resources. Supported by many economic theories,educationplays a role beyond that of physical capital in promoting TFP growth through facilitatingthe technological transfer;educated workers are better at implementing new ideas and have more ability to adapt to technological change and will introduce new production techniques more quickly (Nelson and Phelps, 1966; covers, 1975; Hao and Wei, 2009; Aggrey et al, 2010).

Egypt is a human capital rich country hence; paying attention to its education sector will enhance growth rates. But the impact of channels through which education promotes productivity growth is not restricted to the amount of resources devoted to the education sector, but includes the quality of education system as a matter of fact; as it transforms this money investment into qualified human capital stock capable of promoting productivity growth and hence economic growth rates. Hence, it's an important to give an attention to the output of education process. And since TFP growth issue is one of the hot-debated topics in recent studies, the focus in this paper on analyzing the impact of education quality, measured by different levels of education, on TFP growth during the period (1980-2014) of theEgyptian economy. The empirical study will be run by applying the Bounds Testing Approach to Co-integration constructed by Pesaran et al., (2001), followed by the Autoregressive Distributed Lag (ARDL) bounds test approach of co-integration suggested by Pesaran and Shin (1999). Also, theGauss-Newton algorithm method is used in estimating the nonlinear production function to get the time series of the dependent variable TFP. In our study, the labor force is split into three groups; those who are illiterate, those with education level up to an intermediate degree, and those with university degree and above. And in estimating the impact of different education levels on TFP in Egypt during the period (1980-2014), the results turn out to reflect the prevailing status of the Egyptian educational system.

With reference toilliterate workers category; their share out of the Egyptian workforce has declined over the period of study, on average, from 61% during 80s to 44% during 90s and to 31% during the last three years.Findings show the negative and statistical insignificant impact of that sort of workforce on TFP growth and, in turn, slow down the long run economic growth rate. Actually, such a result is soundness; as illiterate workers lack neither the ability to recognize and apply the standing technology nor duplicating the more radical techniques.

Vis-à-vis the workforce with intermediate education category; their share out of the Egyptian workforce has amplified over the period of study from 30% during 80s, reached 34.7% during 90s, and gone to 45% during the last three years. Despite having adominant share in the Egyptian workforce, this education sort of workers has witnessed a negative meager impact on TFP growth and may impede the economic growth in long run owing to facing the difficulty of getting use of current know-how and imitating the advanced technology which requires high level of training with giving more attention to scientific research. Concerning those with university education degree; the contribution out of workforce has enlarged on average from8.7% during 80s, reached 21.2% during 90s, and gone to 24% during the last three years. Suchan improvement in workforce construction showed a modest positive impact on TFPgrowth in Egypt and consequently on economic growth in long run. The paper also concludes that the estimated parameters for the short run dynamics and long run equilibrium of the model are relatively stable. In order words, a stable TFP growth model exists over the entire sample period. The results of the other Diagnostic tests suggest that the model is fairly well specified and robust for policy analysis.

To sum up, in the long run TFP gains in Egypt is driven only by high education, but with lower positiveimpact, whereasthe intermediate education expansion has a negative impact on TFP growth and this could be owed to a weak external and internal efficiency of public subsidization of education which is cleared in lacking the educational institutions of qualified staff, equipment, and an appropriate infrastructure needed in the educational process. In addition to high intensity of classrooms, a high youth's illiteracy rate, high dropout rates from the secondary education, the increased unemployed educated people as a percent of total unemployed individuals, and the lower education years of adult on average. All of these are reflected negatively on the quality of labor force, and eventually weak the impact of education as a leading factors to promote the economic growth despite over the past 3 decades Egypt has got a considerable progress in raising the net enrollment rate in all education stages. we should notice here that semi-skilled labor dominates the labor market demand; hence there should be more attention be given to this category and some reforms in the Egyptian education system must be done on the basis of analysis and research; as the real wealth for any society is its ability to make a better use of and develop its available human resources, with a notice that the reform outcomes will be appeared in the future not in the current time.To this end and based on our findings, the study recommends some reforms in the education system:

1. Egypt over the past forty years has underinvested in education and has few resources other than its abundant human capital. Hence, government should increase its budgetary productive public allocation to the education sector in order to meet up with the recommended UNDP requirement. also, government should be careful in managing the public spending on education in a way to increase the labor skills, and by guiding against mismanagement, misappropriation and diversion.
2. A rating performance indicator should be established for the educational sector to help to monitor progress in the sector. Also, vocational and technical education should be given more attention.
3. Distortion in wages should be handled in a way to reduce the current brain drain and that will help improve productivity of the national economy as a whole.
4. Government should create programs to train potential labor in gaining work based on learning experience andcurrent workers and thus improve the quality of the workforce supply
5. There should be a link between firms requirements and academic educational programs in order for the skills required in the labor market to be matched with those developed in the education system.

Endnotes

[1] In his study,(Dension,1962) through applying "growth accounting approach", found that the contribution of human capital to economic growth in USA is beyond that of natural resources, physical capital and labor. Besides education as a main component of human capital, is responsible for around 10% 15% of the economic growth rate in U.S.A.

[2] In this paper I extend my work (Qutb, 2016) that examined the direct impact of education on the economic growth as being an input in the production function and focus on indirect channel through which human capital enhances economic growth.

[3] Education attainment level is thought to be effective in enhancing the skills and knowledge and earnings potential of workers.

[4] There are different methods applied by empirical works, look: Isaksson, (2008, 2009); Del Gatto, Di Liberto&Petraglia, (2011).

[5] Islam (1995), Hall and Jones (1999), Kumar and Kober (2012) suggest in their studies that cross-country per-capita income differentials are largely accounted for by the differences in the total factor productivity (TFP) rather than by the differences in the use of factors of production.

[6] The rationale for including human capital as an independent variable in the growth model is that the quality of human capital is a vital input along with physical capital and labor.

[7] On the other hand, some economists such as Miller and Upadhyay (2000) viewed the trade policies that aim at protecting the domestic industries work as an obstacle for improving the level of human capital stock.

[8] The regression residual method of estimating TFP is used in empirical works by several researchers (Thomas &Wang, 1993; Coe, Helpman&Hoffmaister, 1997; Miller &Upadhyay, 2000; Senhadji, 2000; Khatiwada& Sharma,2002; Vandenbussche, Aghion&Meghir, 2006, Dahal ,M., (2013 ; ShahzadAlvi,2013, Maurel and Seghir,2013; Saha,2013) including others.

[9] We have not included any measure of the education-centered human capital variable in the production function to estimate TFP because empirical results have shown both positive and negative effect of the education variable in growth regressions.

[10] The insignificance of K variable may be due to the multicolinearity between the variabkes.

[11] The long run coefficients of the ARDL model in the difference form for any explanatory variable is calculated by dividing the coefficient of lagged value of explanatory variable (multiplied by a negative sign) by the coefficient of lagged value of dependent variable, while the short run coefficient is expressed by the coefficient of the first difference of the variables.

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