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HUMAN CAPITAL EXTERNALITY AND SENSITIVITY OF TFP GROWTH

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ABSTRACT

This paper explains how externality of human capital enhances TFP growth. It measures the sensitivity of TFP growth to human capital quality in different levels of return to scales by using the appropriate method of growth accounting. Applying this method to some transition economies; Egypt, Tunisia, Turkey and Saudi Arabia, we proved an existence of an inverse relationship between returns to scale and TFP growth, and positive relationship between human capital and TFP growth in all countries. In particular, the growth of the TFP is attributed to the growth of GDP that is not adequately explained by the growth of physical capital and human capital. Then, the calculation of TFP growth in different level of returns to scales and adjusting the weighted elements of human capital, we improved strong sensitivity of TFP growth to human capital quality.

INTRODUCTION

Boosting a national economic growth is acrucial target for each societies developed and developing alike. The growth is essential and critical component of the development process differences in living standards and the stages of development between countries is due to the sharp differences in economic growth rates in the long term.It is here became the subject of growth and its associated specific factors represents the main focus of models and policies of macroeconomic theory. Growth of total factor productivity (TFP) provides society an opportunity to increase the welfare of people.So it was the major areas of research in economics has been to identify factors of output growth. Total factor productivity (TFP) measurement enables researchers to determine the contribution of supply-side production factors to economic growth.

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In particular, the growth of the TFP is attributed to the growth of GDP that is not adequately explained by the growth of physical capital and human capital, Solow (1956).TFP growth is usually measured by the Solow residual.Human capital, as a critical engine of economic growth, is present in many empirical and theoretical body of knowledge on growth models and theory. Nelson and Phelps (1966); Lucas (1988); Becker, Murphy, and Tamura (1990); Rebelo (1992); and Mulligan and Sala-i-Martin (1992), have emphasized the role of human capital in the form of educational attainment. Empirical studies of growth for a broad cross-section of countries, such as those by Romer (1990a), Barro (1991), and Benhabib and Spiegel(1992), have used proxies for human capital. These studies have, however, been hampered by the limited educational data that were available on a consistent basis for a large number of countries. Recent research by Barro and Lee (2013) through the World Bank has provided better estimates of educational attainment for a large number of countries over the period from 1960 to 2010.

Hence, these data make it possible to use a broad sample of experience across countries and over time to assess the contribution of human capital externality to total factor productivity as a part of economic growth. Following Barro (1991) and Mankiw, Romer, and Weil (1992), there has been an upsurge of empirical research on the effects of human capital on economic growth. However, the conclusion on its importance as a driver of economic growth remains inconclusive. Measuring human capital remains the main obstacle to assessing the importance of human capital and education in economic growth. In our view, Human capital as a critical engine of economic growth. So in this paper, we investigate the influence of human capital quality and quantity and its enhancing on TFP growth. To achieve the aim of this study we suppose two hypotheses: first TFP is more sensitive to human capital than physical capital, and maximizing human capital quality enhance TFP growth.

This paper is structured as follows: after the introduction part, in Section 2 theoretical and literature review in which we review the technical changes in input factors especially human capital and we argue that it is highly preferable to estimate TFP as efficient instrument to measure economic growth of economies. In the following, Section 3 the authors outline the methodology employed to estimate TFP growth for transition countries (Egypt, Tunisia, Turkey and Saudi Arabia). In Section 4the paper ends with conclusion remarks in which summary of the research results is given and commented.

Theoretical and Literature Review

Many theoretical literature suggests that human capital enhances TFP growth. The role of human capital in promoting total factor productivity (TFP)growth has been strongly supported by many economic theories. By The literature review about economic growth we distinguish three theoretical stages characterizing the evolution of thinking about TFP determinants all basically centered on the human capital as the main determent of TFP growth. From exogenous growth theory developed by Harrod (1939), Domar (1946), Solow and Swan (1956) centered macroeconomists' attention throughout the 1960's and 1970's on tangible (physical) capital formation as the driver of economic growth. Through endogenous growththeory developed by Romer (1986, 1990a, b), Lucas (1988), Barro (1991) and Mankiw, Romer, and Weil (1992), Barro and Lee (1993), (Young, 1994) and many authors were based on empirical studies and centered on human capital externalities (formation, education, schooling, training, "spillsover"). To the new economic theory of growth based on the degree of open economies(integration rate) Coe and Helpman (1995),foreign direct investment (FDI) as a source of spillovers, Grossman and Helpman (1991), capacity of production and use of new technologies (ICT) Goldon (2000), Colechia & Schreyer (2001), Oliner & Sichel (2002). In other side many studies examined the relationship between human capital and TFP growth, Wei & Hao (2011) found some studies which report a significant and positive estimated impact of human capital on the TFP growth. While others find significant and negative effects of human capital. Recently Turner, Tamura & Mulholland (2013)concluded through the Case Study on the US economy that Input per worker growth explains three-fifths of output per worker growth. This disparity in results is due to the difference in the internal aspects of human capital, as well as capital adequacy measure through the negligence of human capital quality. Therefore, in order to avoid the neglect of human capital quality as a determinant of TFP growth. This study tries to measure the sensitivity of the TFP growth towards the quality of human capital through different estimation ways

Sensitivity of TFP growth to production factors: empirical study.

Data base and methodology

Measuring TFP is therefore important in assessing countries past and potential economic performance. But it is also difficult, for two reasons. Fairly innocuous differences in assumptions can lead to very different estimates of TFP growth. And the interpretation of measured TFP growth can be problematic when such growth reflects factors other than purely technical change considered as an externalities(ie: increasing returns to scale, markups due to imperfect competition, or gains from sectorial reallocations).

The Sensitivity of TFP growth to production factors explained by two directions: Sensitivity related to the extent of returns to scale (γ) and Sensitivity related to elasticity of factor production (α) which measure the importance of physical capital in output. According to the Sensitivity related to the extent of returns to scale (γ) the results obtained by calculating TFP growth in different levels of scales (γ=0.3; γ=0.4 and γ=0.5) for Egypt, Tunisia, Turkey and KSA show that , improve an inverse relationship between returns to scale and TFP growth, (tables :1b,2b,3b).

According to the Sensitivity of factor production (α) the results obtained by calculating TFP growth in different levels of intention accorded to physical capital (α=0.3; α=0.4 and α=0.5) in output for the same countries, improve an inverse relationship between physical capital and TFP growth. In other side this result appear the positive relationship between human capitaland TFP growth.

Total factor productivity (TFP)

The starting point for estimating TFP is a production function that represents how inputs are combined to produce output. For example, suppose that GDP *(Y)*is produced using two factors, physical capital *(K)* and human-capital-adjusted labor input *(L)*, using a Cobb-Douglas production function:

$$Y = A(K^{\alpha}L^{1-\alpha})^{\gamma} \quad (1)$$

Where A is TFP, γmeasures the extent of returns to scale and measures the importance of physical capital in output. When there are constant returns to scale($\gamma = 1$), increasing returns to scale ($\gamma > 1$) and decreasing returns to scale ($\gamma < 1$).By expressing equation (1) in growth rates using logarithm function and rearranging the variables, TFP growth can be written as growth in output less a weighted average of growth in inputs. Accordingly, the formula is:

$$\frac{d}{dt}\ln A = \frac{d}{dt}\ln Y + \gamma\alpha\frac{d}{dt}\ln K + \gamma(1-\alpha)\frac{d}{dt}\ln L \quad (2)$$

$$g_A = g_Y - \gamma[\alpha g_K + (1-\alpha)g_L] \quad (3)$$

Physical capital stock (K)

As already mentioned, the physical capital stock (K_t) is calculated using the investment data available through the permanent Inventory Method (I_t ; gross fixed capital formation).

$$K_t = I_t + (1-\delta)K_{t-1}$$

Where$\delta$is the annual capital stock depreciation rate. A value of$\delta$for each country is given by the table 1 below as it used in many researches?

Table 1. A value of capital stock depreciation rate by country

Countries	Stock depreciation rate: $\boldsymbol{\delta}$
Egypt	0.5
Saudi Arabia	0.5
Tunisia	0.8
Turkey	0.7

Source: World Bank Database.

The initial capital stock (K_0) for each country is calculated for the first year, for which gross fixed capital formation data is available (I_0). We admitted the hypothesis that capital stock at time zero is positively correlated with investments in the following year and inversely related to the average annual growth rate of GDP and depreciation rate.It calculated in the same way as informula:

$$K_0 = \frac{I_0}{(g+\delta)}$$

Where g is the average annual growth rate of the aggregate product and δ *the depreciation rate.*

It is interesting to note that this formulation coincides with the equation that defines the physical capital stock atthe steady state in Robert Solow's model (1956).

How externality of human capital enhances TFP growth?

Previously we pointed to the sensitivity of TFP growth to both the extent of returns to scale (γ) and elasticity of factor production (α), and now we study the contribution of human capital to TFP and its sensitivity to it. The role of human capital in promoting total factor productivity (TFP) growth has been strongly supported by many economic theories. Nelson and Phelps (1966) argued that human capital can promote TFP growth by facilitating technology spillover. Romer (1990a, 1990b) and Aghion and Howitt (1998) contended that human capital can enhance productivity growth through accelerating domestic technological innovations. In the empirical literature, however, the impact of human capital on TFP growth is rather mixed and complex. Because many theories of economic growth stress the role of human capital in the form of education, but empirical studies have been hampered by inadequate data. Following Barro and Lee (1993) which used Years of schooling, and the return on education and participation rate as in the following formula $H_{1t} = L_t P_t e^{r*s}$ as a proxy for human capital growth. We use an alternative measure of human capital based on education index and health indexas in the following formula; $H_{2t} = L_t P_t e^{lifex*edu}$ as a proxy for human capital growth. In order to improve the contribution of human capital to the TFP, we used three methods measuring human capital, as bellow:

First method

In this first method, we adopt the traditional method to calculate Human Capital stock as used by Solow (1956), it given as:

$$L_t = POP_t \ (age\ 15-65)$$

Where L_t*: labor force, it is the number of population (POPt) aged between 15 and 65 years.*

$$g_{TFP} = g_Y - \gamma[\alpha g_K + (1-\alpha)g_L]$$

Table 1a. Input and output growthAverage annual growth in Egypt, Tunisia, Turkey and KSA, 1990–2013

	GDP	K	L
EGYPT	0.079748	0.050107	0.023372
TUNISIA	0.057475	0.084602	0.019727
TURKEY	0.073318	0.461833	0.014094
KSA	0.080232	0.087700	0.035227

Table 1b. Sensitivity of TFP growth estimates by using L and K Average annual TFP growth 1990–2013

		α=0.3	α=0.4	α=0.5
EGYPT	γ= 0.8	0.055	0.052	0.050
	γ= 1	0.048	0.046	0.043
	γ= 1.2	0.042	0.039	0.036
TUNISIA	γ= 0.8	0.026	0.021	0.016
	γ= 1	0.018	0.012	0.005
	γ= 1.2	0.010	0.003	-0.005
TURKEY	γ= 0.8	-0.045	-0.081	-0.117
	γ= 1	-0.075	-0.120	-0.165
	γ= 1.2	-0.105	-0.159	-0.212
KSA	γ= 0.8	0.039	0.035	0.031
	γ= 1	0.0329	0.024	0.019
	γ= 1.2	0.019	0.013	0.006

Source: Authors calculations

Second method

The Human capital stock summarize the contribution of "brawn" and "brains" to labor input as always used by researchers. Brawn is the size of the labor force measured by the number of workers which is the product of the working-age population (L) and the participation rate (P). Which Labor force participation rate is the proportion of the population ages 15-64 that is economically active: all people who supply labor for the production of goods and services during a specified period, while Brains is the some skills provide by education. The index H_t was constructed following Barro and Lee's (1994) methodology based on educational attainment, then

used by Senhadji (1999) to estimate Sources of Economic Growth. According these researches, H_t is written as follows:

$$H_{1t} = L_t P_t e^{r*s}$$

Where;

H_{1t}: human stock,
L_t: labor force as mentioned in the first method,
P_t: participation rate,
r: average years of scolarisation , and
s: scolaisation rate

$$g_{TFP} = g_Y - \gamma[\alpha g_K + (1-\alpha) g_{H1}]$$

Table 2a. Input and output growth Average annual growth in Egypt, Tunisia, Turkey and KSA , 1990–2013

	GDP	K	H1
EGYPT	0.079748	0.050107	0.036059
TUNISIA	0.057475	0.084602	0.033322
TURKEY	0.073318	0.461833	0.022595
KSA	0.080232	0.087700	0.049746

Table 2b: Sensitivity of TFP growth estimates by using H1 and K Average annual TFP growth 1990–2013

		α=0.3	α=0.4	α=0.5
EGYPT	γ= 0.8	0.048	0.046	0.045
	γ= 1	0.039	0.038	0.037
	γ= 1.2	0.031	0.030	0.028
TUNISIA	γ= 0.8	0.019	0.014	0.010
	γ= 1	0.009	0.004	-0.001
	γ= 1.2	-0.001	-0.007	-0.013
TURKEY	γ= 0.8	-0.050	-0.085	-0. 120
	γ= 1	-0. 081	-0.125	-0.169
	γ= 1.2	-0.112	-0.165	-0. 217
KSA	γ= 0.8	0.031	0.028	0.025
	γ= 1	0.019	0.015	0.012
	γ= 1.2	0.007	0.002	-0.002

Source: Authors calculations

Third method

We thought that there is an importance effects of health and education on the human capital productivity. It can be considered as an externality growth explaining the grate part of TFP. The education level of population affects how a country supports itself and the degree to which it can participate in the global field, Romer (1991), Barro and Lee (1993). So, In order to examine the effect of education and health on TFP growth we added there as a part of human capital, as written:

$$H_{2t} = L_t P_t e^{lifex*edu}$$

Where;
H_{2t} : human stock,
L_t: labor force as mentioned in the first method,
P_t : participation rate,
lifex: health index , and
edu: education index

$$g_{TFP} = g_Y - \gamma[\alpha g_K + (1-\alpha) g_{H2}]$$

Table 3a. Input and output growth Average annual growth in Egypt, Tunisia, Turkey and KSA, 1990–2013

	GDP	K	H2
EGYPT	0.079748	0.050107	0.032236
TUNISIA	0.057475	0.084602	0.033532
TURKEY	0.073318	0.461833	0.029489
KSA	0.080232	0.087700	0.053782

Table 3b. Sensitivity of TFP growth estimates by using H_2 and K Average annual TFP growth 1990–2013

		α=0.3	α=0.4	α=0.5
EGYPT	γ= 0.8	0.050	0.048	0.047
	γ= 1	0.042	0.040	0.039
	γ= 1.2	0.035	0.032	0.030
TUNISIA	γ= 0.8	0.018	0.014	0.010
	γ= 1	0.009	0.004	-0.002
	γ= 1.2	-0.001	-0.007	-0.013
TURKEY	γ= 0.8	-0.054	-0.089	-0.123
	γ= 1	-0.086	-0.129	-0.172
	γ= 1.2	-0.118	-0.170	-0.221
KSA	γ= 0.8	0.029	0.026	0.024
	γ= 1	0.016	0.013	0.009
	γ= 1.2	0.003	-0.001	-0.005

Source: Authors calculations

Considering the previous Tables 1, 2 and 3, concerning the relationship between TPF growth and its sensitivity to human capital quality in four transition economies; Egypt, Tunisia, Turkey and Saudi Arabia, we proved two fundamental results; an existence of an inverse relationship between returns to scale and TFP growth, and positive relationship between human capital and TFP growth in all countries. According this result we can draw several conclusions and interpretations: Concerning the first result, an inverse relationship between returns to scale and TFP growth. In all countries of this study, moving from the level of return to scale to another in the direction of increasing return to scales, TFP growth rate is heading toward decreasing.

This difference in the degree of decrease in the growth rate of TFP from one country to another, as shown by the results of the study can be interpreted depending on the degree of adoption of each country on its own specificity in mixing factors of production (physical capital or human capital). Then, we notice slowly decline in TFP growth rate in both Tunisia and Egypt (0.6% and 0.7%) and which depend on the human capital as abundant element in the production process, whereas this decline is relatively high in both Turkey and Saudi Arabia (1.2% and 3.5%) which have an abundance in physical capital factor. this result shows that the country, which rely on physical capital has the largest decrease in productivity when we moving from case of diminishing returns to scale toward case of increasing returns to scale. The second result is about positive relationship between human capital in various formula (L, H1, and H2) and the rate of TFP growth in all study countries. This result emphasis on the sensitivity of TFP towards human capital as opposed to physical capital. In more details, we find that the sensitivity of TFP to human capital vary from one country to another. The TFP growth in Turkey case has more sensitivity to human

capital, his TFP growth rate is increasing on average by 4% while increased contribution of human capital by 10%. While in Egypt, Tunisia and Saudi Arabia, TFP growth rate on average amounted to 0.13% and 0.07% and 0 0.36%, respectively. These results explain the efficiency of the human capital factor in Turkey compared to other countries in this study which explains the high growth achieved in Turkey compared to other countries growth rates.

Conclusion

From this paper, we give the necessity that the endogeneity of production factors should be considered when assessing the importance of TFP growth. Most economic studies focus on the role played by investment in formal education as a main factors enhancing the economic growth in modern economies. By examining the sources of TFP growth in Egypt, Tunisia, Turkey and Saudi Arabia economy during the period 1990-2013, with particular focus on the sensitivity of TFP to human capital compounds we conclude same important points:

- To study TFP growth it is necessary to properly define physical capital and human capital.
- TFP is more sensitive to human capital than physical capital. This relationship was clearly proved by the result calculated in this paper. And confirmed in all sample of economies studied.
- The interpretation of TFP growth measure ment, can be problematic if economic growth was due to some other factors non-Technical progress, such as increasing returns to scale, markups due to imperfect competition, or gains from sectorial reallocations.

The study recommended to focus on human capital by investment in education, health, research and development effectively. Because these factors have a significant role in boosting the increase of TFP, therefore economic growth.

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