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THE IMPACT OF HUMAN CAPITAL ON ECONOMIC GROWTH: EVIDENCE FROM TUNISIA USING STAR AND STECM MODELS

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ABSTRACT

Human capital is one of the most important drivers for economic growth. This paper aims to outline theoretical and empirical frameworks for thinking about the role of human capital in a model of endogenous growth. Only a small set of recent papers investigated the relationship between different educational levels and economic growth in one country. This first study conducted in Tunisia contributes to the existing literature by using Smooth Transition Autoregressive models (ESTAR, LSTAR) referring to non-linear least squares (NOLS) procedure to underline this non-linear relationship. The advantage of our modeling strategy is that the relationship between human capital and growth is nonlinear. The principal empirical finding conducted in Tunisia over the period 1974-2012 is that human capital exerts a significant influence on economic growth.

Keywords: Human capital, Economic growth, Tunisia, NOLS, ESTAR, LSTAR.

JEL Classification: C23, J24, O47.

1. INTRODUCTION

Lucas (1993) argued that important engine of growth is the accumulation of human capital and the main reason of differences in standards of life among nations is differences in human capital. Human capital is defined by the knowledge, skills, competencies embodied in individuals that facilitate the creation of personal, social and economic well-being. Endogenous growth theories (e.g., the pioneering studies of (Romer, 1986; Lucas, 1988)) interiorized the human capital which is explained by education level of a society. This literature has emphasized the important role of human capital on economic growth. The increase of human capital improves social welfare and economic growth. Human capital has a positive spillover on labour productivity which contributes to a higher trend of economic growth rate and leads to higher wages and higher expected lifetime earnings. In contrast, Freire-Seren and Panades i Martí (2013) conclude that in economies with low nominal tax rates, human capital accumulation could affect economic growth negatively if the taxpayers avoid taxes.

Emerging and developing countries have made considerable progress in closing the gap with developed countries in terms of schooling, because cognitive skills are drivers for growth.

Education is the main component of human capital. Schooling is important for economic growth. Strong knowledge promotes the two further ingredients of growth the invention and innovation. From 1948 to 1986, 61% of economic growth of the USA is provided by human capital (Jorgenson and Fraumeni, 1992). In 1985, 49% of economic growth in 98 countries is explained by human capital (Mankiw *et al.*, 1992). In 1988, 22% of economic growth in 127 countries is deserved by human capital (Hall and Jones, 1999).

This paper is an empirical contribution to the human capital debate outlined above. Concretely, we study the impact of human capital on growth by using the Smooth Transition Autoregressive model to highlight the role of human capital on growth. Our contribution is therefore threefold. In the first place, all existing empirical studies use the classic econometric approaches to underline this relationship. Second, little attention has been paid in developing and emerging countries. Finally, a small set of recent papers investigated the relationship between different educational levels (tertiary, secondary and primary) and growth in one country. For this, our study is conducted on Tunisia. Since 1965, policies introduced are more noteworthy for causing changes in Tunisia's growth performance.

The rest of the article is organized as follows. Section 2 presents a brief review of the literature and discusses the relationship between human capital and economic growth. Section 3 describes the econometric modeling approaches and discusses the empirical results. Section 4 concludes the paper.

2. RELATED LITERATURE

The analysis of the impact of human capital on the economic growth represents an old, but still unsettled topic of research. Human capital would ultimately in the very long-run led to economic growth for all nations. In general, human capital can stimulate growth through two channels (i.e., the level effect and the rate effect). Human capital can directly contribute in production as a productive factor and consequently output growth. Human capital can contribute to raising technical progress and education that positively affects productivity growth (Khalafalla and Suliman, 2013). This literature that links human capital to economic growth provided a conceptual framework that links education and growth and provides conflicting views of the relationship among components of education and growth.

Education mirrors the important role of human capital in growth and development for all economies. Musibau and Rasak (2005) try to investigate the link between education and economic growth in Nigeria by using the factor of production and technology as proxies of human capital. Through the two channels, they find that a well-educated labor force impacts positively the economic growth. For Aghion and Howitt (2009), human capital and technological progress are two key inputs in all endogenous growth models.

Self and Grabowski (2004) conclude in China that primary education had a strong and robust impact and a limited evidence of secondary education on economic growth. Chi (2008) concludes that tertiary education has a positive and larger impact on GDP growth than primary and secondary education. In Portugal, Pereira and Aubyn (2009) found that increasing education at all levels except tertiary had a positive and significant effect on outcome. Li and Huang (2009) and Li and Liu (2011) found a positive relationship between education and growth. For the case of Nigeria, Dauda (2010) employed the three levels of education as measures of human capital and found a positive long-run relationship between education and growth. Zhang and Zhuang (2011) point out in China that human capital structure promotes economic growth. They conclude that tertiary education plays a more crucial effect than primary and secondary education on economic growth.

Dias and Tebaldib (2012), in a panel of 61 countries from 1965 to 2005, provide strong evidence that the growth rates of human capital impact a country's growth rate of output per capita. Khalafalla and Suliman (2013) show in Sudan for the period 1982-2009, by using a simultaneous equation model, that quality of the education has a determinant role in the economic growth. Campbell and Agbiokoro (2013) find in Nigeria over the period 1980-2010 that human capital alongside with technological development has a positive relationship with growth. More recently, using accounting framework and ARDL-based co-integration approaches, Banerjee and Roy (2014) approve the importance of human capital and technological progress in determining India's long run growth.

3. EMPIRICAL ANALYSIS

In the existing literature, the human capital effects on growth are not easy to understand. Since 1956, the role of improved schooling has been a central part of the development strategies of Tunisia. Fundamentally, to highlight this relationship in Tunisia, we use the Smooth Transition Autoregressive models (STAR) to determine the link between human capital and growth over the period 1974-2012. The model, referring to Nerlove (2003), to estimate is as follow:

$$GDP_t = \exp(\beta_1) EFP_t^{\beta_2} EFS_t^{\beta_3} EFSP_t^{\beta_4} TEL_t^{\beta_5} \exp(\varepsilon_t) \quad (1)$$

Where: GDP is real GDP per capita, EFP is primary school enrollement. EFS is secondary school enrollement. EFSP is tertiary school enrollement. TEL is the measure of technological progress. Data is sourced from the World Bank (WDI). The natural log gives the following equation:

$$Log(GDP)_t = \beta_1 + \beta_2 Log(EFP_t) + \beta_3 Log(EFS_t) + \beta_4 Log(EFSP_t) + \beta_5 Log(TEL_t) + \varepsilon_t \quad (2)$$

First, we will test the stationarity of all variables used in the model by the Unit Root Test of Zivot and Andrews (1992)[1] to determine the presence of unit root with break.

[1] Lumsdaine, and Papell, (1997). propose a sequential ADF-type unit-root test that allows for two shifts in the deterministic trend at two distinct unknown dates.

Table-1. Unit Root Test of Zivot and Andrews (1992)

	LGDP	LEFP	LEFS	LEFSP	LTEL
T-Statistics	0.47846	-1.72795	-0.64220	-5.14352	-1.94691
λ	0,87	0,79	0,85	0,72	0,87
Break Dates	2003	2000	2002	1997	2003
The lag length	2	2	2	2	2

We conclude that T-Statistics of Zivot and Andrews (1992) are larger than the critical values -5.34 and -4.80 respectively at levels of 1% and 5%. So, all variables have a unit root with break under the null hypothesis. Now, we determine the optimal lag length and estimation of AR (p).

Table-2. Optimal lag length and estimation of AR (p)

T-Stat of Lags	Δ LGDP	Δ LEFP	Δ EFS	Δ LEFSP	Δ LTEL
Lag (1)	9.70909	6.67281	5.31235	1.29290	7.05813
Lag (2)	2.33894	0.25073	0.24727	0.43942	0.97579
Lag (3)	0.94348	1.48969	1.65525	-0.54393	0.40081
Lag (4)	1.09064	0.03577	-0.17371	-1.84429	-1.07348
Lag (5)	0.52402	0.79955	-1.30327	-0.54886	-2.03633
Lag (6)	-1.14785	0.08513	-1.10745	-1.69252	0.89431
Lag (7)	4.10771	-0.70694	0.57783	0.03288	-0.72559
Lag (8)	1.13760	0.47191	-0.10677	-0.37817	-0.73745
AR (p)	AR (2)	AR (1)	AR (1)	AR (1)	AR (1)
Constante	-0.001613	0.0000856	0.00919	0.073135*	0.0161
φ_1	0.7023122*	0.74939*	0.7591*	0.21480*	0.7959
φ_2	0.453286**				
Variance of AR	0.00274	4.3675×10^{5}	9.721×10^{6}	0.00648	8.744×10^{6}
Ljung-Box Q-Statistics					
Q (6)	19.712(0.003)	4.88 (0.56)	8.44 (0.21)	7.51 (0.28)	9.75 (0.13)
Q (12)	35.75 (0.0003)	8.48 (0.75)	13.67 (0.32)	10.1 (0.61)	23.8 (0.02)
Q (18)	58 (0.000004)	21.28 (0.26)	17.15 (0.51)	22.0 (0.23)	42.61 (0,0)
Q (24)	78(10^{-7}) 0.0004)	41.25 (0.01)	50.5(0.001)	37.8 (0.04)	77.4 (0,00)

* and * indicate statistical significance at the 1% and 5% level.

We conclude that all explanatory variables have one lag (AR (1)) and the dependant variable has 2 lags (AR (2)). The Ljung-Box test confirms that the error term $\varepsilon_{it} i.i.d\left(0,\sigma_{\varepsilon}^{2}\right)$.

To more underline the cyclical phenomena of the economic growth in Tunisia, we use the Smooth Transition Autoregressive models (STAR). The STAR (p) is as follow:

$$Y_t = \left(\alpha_{10} + \sum_{j=1}^{P} \alpha_{1j} Y_{t-j}\right) + \left(\alpha_{20} + \sum_{j=1}^{P} \alpha_{2j} Y_{t-j}\right) F\left(Y_{t-d}\right) + \varepsilon_t \quad (3)$$

$$Y_t = \alpha_1' Z_t + \alpha_2' Z_t F\left(Y_{t-d}\right) + \varepsilon_t \quad (4)$$

Where: $\alpha_1' = (\alpha_{10},........,\alpha_{1P})$, $\alpha_2' = (\alpha_{20},........,\alpha_{2P})$ et $Z_t = (1, Y_{t-1},........, Y_{t-p})'$

F (Y_{t-d}): is the transition variable bounded between 0 and 1. Terasvirta and Anderson (1992) propose two transition functions:

$$\text{Logistic: } F(Y_{t-d}) = \left(1 + e^{-\gamma(Y_{t-d}-c)}\right)^{-1}; \quad \forall \gamma \succ 0 \tag{5}$$

$$\text{Exponential: } F(Y_{t-d}) = 1 - e^{-\gamma(Y_{t-d}-c)^2}; \quad \forall \gamma \succ 0 \tag{6}$$

$$F(Y_{t-d}) = \begin{cases} 0 & \text{Si } Y_{t\text{-d}} \prec c \\ 1 & \text{Si } Y_{t\text{-d}} \succ c \end{cases} \tag{7}$$

LSTAR (p) is as follow:

$$Y_t = \left(\alpha_{10} + \sum_{j=1}^{P} \alpha_{1j} Y_{t-j}\right) + \left(\alpha_{20} + \sum_{j=1}^{P} \alpha_{2j} Y_{t-j}\right)\left(1 + e^{-\gamma(Y_{t-d}-r)}\right)^{-1} + \varepsilon_t \tag{8}$$

ESTAR (p) is as follow:

$$Y_t = \left(\alpha_{10} + \sum_{j=1}^{P} \alpha_{1j} Y_{t-j}\right) + \left(\alpha_{20} + \sum_{j=1}^{P} \alpha_{2j} Y_{t-j}\right)\left(1 - e^{-\gamma(Y_{t-d}-r)^2}\right) + \varepsilon_t \tag{9}$$

The AR (p) model is a particular case of STAR (p) model if the null hypothesis of linearity is accepted. Lukkonen *et al.* (1988) propose the LM test to test H_0: AR model Vs H_1: STAR model. Terasvirta (1994) proposes a test to determine the optimal lag length of the transition variable (d).

Table-3. LM Fisher linearity test

D	Statistiques	Δ LGDP	Δ LEFP	Δ LEFS	Δ LEFSP	Δ LTEL
d=1	LM	1.08 (0.39)	0.20 (0.89)	**2.78 (0.05)**	**5.88(0.002)**	1.98 (0.13)
d=2	LM	0.59 (0.55)	0.82 (0.49)			0.024(0.99)
d=3	LM	1.55 (0.20)	0.33 (0.80)			0.349(0.78)
d=4	LM	1.71 (0.15)	0.27 (0.84)			0.453(0.71)
d=5	LM	1.12 (0.38)	0.429 (0.73)			2.245(0.10)
d=6	LM	1.14 (0.37)	0.29 (0.83)			0.886(0.46)
d=7	LM	5.49(0.001)	0.95 (0.43)			0.933(0.43)
d=8	LM		0.32 (0.81)			3.603(0.02)

H_0: AR model Vs H_1: STAR model. The numbers in parentheses are p- values

Referring to the LM test, the null hypothesis that the model is linear is rejected at the 5% level for all variables except for school enrollement primary (EFP). We explain the linearity of this variable by the success of Tunisian pupils in their primary studies. We conclude, also, that the delay of transition (the optimal lag length) is different for all variables. After fixing the delay, Terasvirta (1994) proposes a short sequence of ordinary Fisher test to decide between ESTAR and LSTAR family of models.

Table-4. Teräsvirta Tests: Choice between ESTAR and LSTAR

Variables	Δ LGDP	Δ LEFS	Δ LEFSP	Δ LTEL
d=1		H_{01} : 0.5211 H_{02} : 0.3315 H_{03} : 0.0117	H_{01} : 0.4715 H_{02} : 0.0233 H_{03} : 0.0029	
d=7	H_{01} : 0.1053 H_{02} : 0.3544 H_{03} : 0.0003			
d=8				H_{01} : 0.2015 H_{02} : 0.0096 H_{03} : 0.4434

Table 5 presents results of estimation of STAR models using the non-linear least squares (NLS) method. The value of $\hat{\gamma}$ are non-significant for all variables. The estimated values of the threshold are respectively -0.000278, -0.1327, -1.0272 and 0.0068 for LEFS, LEFSP, LGDP/T and LTEL. Except for GDP, all threshold values are in the interval (Min-Max) in table 6.

Table-5. STAR Estimation Results

	Δ LGDP	Δ LEFS	Δ LEFPS	Δ LTEL
Parameters	**LSTAR**	**LSTAR**	**LSTAR**	**ESTAR**
α_{10}	-0.0063	0.217344	0.0203	23.2772
α_{11}	3.0112	1.003485	0.2080	-239.7945
α_{12}	-0.0012			
α_{20}	0.0053	-0.200451	0.0608	-0.0023
α_{21}	-2.3357	-0.368452	0.0530	1.0276
α_{22}	0.0014			
γ	0.0982	0.503176	1.3376	0.2292
C	-0.9454	-0.000278	-0.1327	0.0068

Table-6. Summary statistics of threshold values (C)

Variables	Δ LGDP	Δ LEFS	Δ LEFSP	LTEL
Mean	0.125909	0.044486	0.093204	0.079648
Std.Dev.	0.104052	0.041194	0.080129	0.046646
Minimum	-0.007352	-0.077078	-0.172977	-0.027273
Maximum	0.483449	0.122219	0.294491	0.139498

Table 7 presents the results of the long-run relationship for the impact of human capital on growth

Table-7. Long-run relationship of the impact of human capital on growth: Nonlinear cointegration

Estimation NOLS	Coefficients	T	P-value
Constant	15.75333610	4.36120	0.00010850
LEFS	-4.928502	-7.69417	0.00000000
LEFSP	0.20585554	0.79925	0.42953419
LTEL	3.85875179	7.45917	0.00000001

We find that secondary school enrollement has a negative and significant impact on growth. For school enrollement tertiary and technology, we find a positive impact on growth in Tunisia. Finally, to study the convergence of the error term to the equilibrium value, we use the error term of the long run relationship in table 7. This error term, modeled by ESTAR model, using the short sequence of ordinary Fisher, fluctuates in a nonlinear way towards its fundamental value where the delay of non-linearity is three years. Results of estimation of the error term using the NOLS are presented in table 8.

Table-8. Non-linearity Adjustments Results

Error term	
Parameters	**ESTAR**
α_{10}	118.489855
α_{11}	2456.678696
α_{20}	0.004604
α_{22}	0.409991
γ	0.000865
C	0.048104

We conclude that the estimated value of $\hat{\gamma}$ is non-significant. This confirms the slowness of the shift between phases of expansion and contraction of economic growth. The transition variable validates the symmetric of the two phases following the accumulation of human capital.

4. FINAL REMARKS

Much of the motivation for human capital policies in Tunisia is the possibility of providing economic growth; this paper contributes to the literature on the long-run behavior of the human capital on economic growth by addressing the issue of non stationarity using an empirical approach not previously considered in the literature. We address this issue by applying Zivot and Andrews (1992) nonlinear unit-root test. Using the non-linear least squares method, we find that human capital exerts a significant influence on economic growth in Tunisia. All results presented in this paper must be interpreted with caution because the estimation results appear to be sensitive, particularly the parameter measuring the smoothness of transition. We conclude that the target of economic growth fluctuates in a non-linear way around its fundamental value when using ESTAR model. The transition function underlines the slowness between regimes of growth in Tunisia.

To enhance academic understanding of this subject, this research can be extended by introducing other determinants of human capital (i.e., the best percentage of each educational level in Tunisia) and tax avoidance because individuals can change their willingness to avoid taxes by investing in human capital.

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