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Human Capital and Economic Growth in Tunisia: Macroeconomic Findings

Iyad Dhaoui

Research Unit Money, Development and Infrastructures (MODEVI), Faculty of Economics and Management of Sfax, Airport Road km 4.5, Sfax, 3018, Tunisia

ABSTRACT: *This paper examined the impact of human capital development on economic growth in Tunisia using time series data spanning from 1961 to 2011 which were sourced from the World Bank Indicators. It was set out to explore the relationship between human capital indices (education by level of instruction and health) and economic growth. The study employed a Vector Error Correction Model to estimate short and long run realtionships and Granger causality test to show causality direction between education (by level of instruction) and economic growth. The cointegration test showed that there is a long run relationship between economic growth and different levels of education. Econometric estimates of the long run model showed that only the secondary school enrollment rate has a positive and significant impact on economic growth in Tunisia (3.4%). The impact of higher education is low (0.7%). In the short run, primary and higher levels have no impact on economic growth.*

Keywords: *Human Capital, Education, Economic Growth, VECM., Tunisia*

I. INTRODUCTION

The growth of modern economies seems to be generated by the special relationship between human capital and growth. In this sense, the process of development in industrialized countries as well as the emerging markets, has historically accompanied by a general increase in the average level of education and skills of their people. The simultaneous evolution of stocks of education and growth trajectories sparked a general interest in the analysis of mechanisms and channels of transmission. Governments took a growing awareness of the vital role that education can play in the process of economic and social development. Thus, it is becoming increasingly clear that the level of education attained by individuals is a major determinant of the success of the global economy and hence the standard of living of the citizens. In such context, it is not surprising that accumumation of human capital through education play a crucial role in policy development both at microeconomic and macroeconomic levels. Moreover, economic growth can sustained continue if the total factor productivity (TFP) in the economy continues to improve and grow. TFP represents the evolution of technical change in the economy. This leads to the question of the role of human capital accumulation in improving TFP in general and particularly the labor factor. The questions that we seek to answer here are: Does human capital have a significant effect on economic growth in Tunisia? What are the main features of the process of human capital formation in connection with the economic growth in Tunisia? What are the economic policies which can be suggested to boost economic growth?

The interest of this study is justified by two major facts. First, Tunisia invests heavily in education and it is important to see whether such investment is beneficial for economic growth. Second, given the important role of human capital in the productivity of labor and the economic development of a nation, it is urgent that Tunisia has empirical studies on the contribution of human capital to economic growth.

The main objective of this study is to investigate the impact of human capital on economic growth in Tunisia through an empirical analysis based on the data covering the period 1961-2011, taking into account the characteristics of the series used. The secondary objectives are, first, specify the econometric relationship between human capital and the different variables that determine economic growth. Then analyze the process of human capital formation and its relationship with economic growth. The assumption in this study is that Tunisia like other developing countries is engaged in the process of mass education without having adequate curriculum. In this case, the rapid growth of the school population is detrimental to the quality of education. In addition, the dynamics of the production system is more or less disconnected from the education system. Thus, human capital has a low impact on economic growth.

Following introductory motive, this paper is set out as follow. Next section describes data and methodollogy. Section 3 deas with empirical results. Section 4 tries to estimates a VECM. Section 5 provides some recommendations and the paper is rounded off by section 6 with concluding remarks. The findings in this study provide context for initiating constructive debates concerning the contribution of education by level of instruction to the economic growth.

II. DATA AND METHODOLOGY

The theoretical basis of the model used in our study is the production function obtained by Mankiw and al. (1992) by improving the Solow model through the includsion of human capital accumulation in the basis of the assumptions of growth theories:

$$Y=K^{\alpha}_{t} H_t^{\beta} (L_tA_t)^{1-\alpha-\beta} \quad (1) ;$$

Where Y is output, K the stock of physical capital, L the labor force, H the stock of human capital and A the state of available technology, and α and β are positive parameters such as $\alpha + \beta = 1$.

If s_k and s_h are the fractions of income invested respectively in physical and human capital, the development of the economy is determined by:

$$K'_t=s_k y_t-(n+g+\delta)k_t \quad (2)$$
$$h'=s_h y_t-(n+g+\delta)k_h \quad (3)$$

With y = Y / AL, k = K / AL and H = H / AL, n is the growth rate of L, g is the growth rate of A and δ the depreciation rate.

Then in a state of equilibrium, we have the following relationship:

$$\text{Ln}\frac{y(t)}{L(t)} = \text{LnA0}+gt+\frac{\alpha}{1-\alpha}\text{Ln}\,(s_k)-\frac{\alpha}{1-\alpha}\text{Ln}\,(n+g+\delta)+\frac{\beta}{1-\alpha}\text{Ln}(h^*)+\varepsilon \quad (4)$$

This equation derived many models. Our empirical model which will be tested in the context of Tunisia is written as follows:

$$\text{Ln(PIBH)}_t=C+\beta_1\text{Ln(INV)}_t+\beta_2\text{Ln(OC)}_t+\beta_3\text{Ln(TBS1)}_t+\beta_4\text{Ln(TBS2)}_t+B_5\text{Ln(TBS3)}_t+B_6\text{Ln(EVI)}_t+\beta_7\text{Ln(TCR)}_t+\beta_8\text{Ln(EDCI)}_t+\beta_9\text{Ln(TCD)}_t+U_t \quad \text{(Modèle I)}$$

This equation explains the growth rate of gross domestic product per capita (GDPCt) depending on the variable of interest which is is the enrollment rate from primary to tertiary (TBS) and other determinants of economic growth :

Table 1. Variables used in the study

Variables	Description
GDPC	Level of Gross Domestic Product per capita / year (in logarithm)
Ln(INV)	Investment rate in logarithm
Ln(TOP)	Trade openness rate (ratio of exports plus imports divided by GDP in logarithm)
Ln(GER1)	Gross enrollment rate of primary in logarithm
Ln(GER2)	Gross enrollment rate in secondary in logarithm
Ln(GER3)	Gross enrollment rate of higher in logarithm
Ln(LEAB)	Life expectancy at birth in logarithm
Ln(RER)	Real Exchange rate in logarithm
Ln(CDE)	Carbon dioxide emission in logarithm
Ln(APGR)	Annual Population growth rate in logarithm

The data for these variables come from the World Bank through the World Development Indicators (WDI), the Unesco Institute for Statistics UIS and from the website of the University of Sherbrooke (www.perspective.usherbrooke.ca). The data are collected over a long period from 1961 to 2011, a period of 51 years. This is justified by the need to cover a sufficient number of years to identify trends more or less significant. In our study, we will work with the software EVIEWS.

III. PRESENTATION AND ANALYSIS OF RESULTS

Before performing the classical tests, we should check that there is no outliers in our estimation. The presence of outliers can distort the test results.

For T>30, we have the following confidence interval for residues (for a risk of 5%): $-1.96s \leq e_t \leq 1.96$ s (the same as $-2s \leq e_t \leq 2s$)

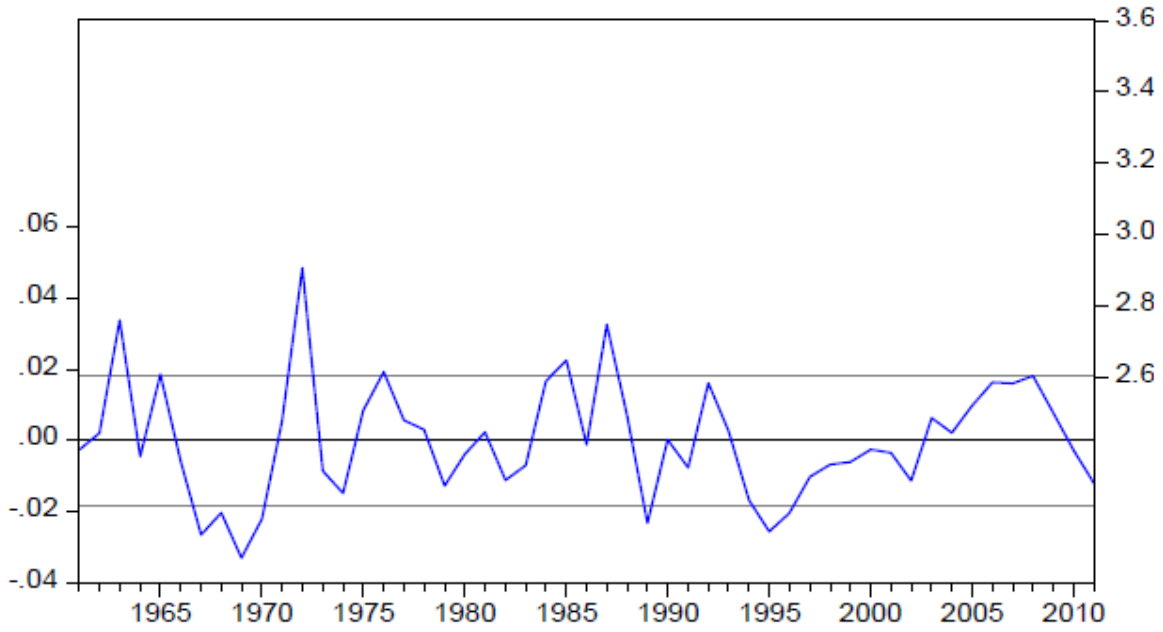

Fig 1. Residues before the introduction of the dummy variable

Here, we have s = 0.018065 (SE of regression), so: -0.03613< e_t <0.03613. we note that there is a significant outlier in 1972 and another in 1987. We cannot remove this outlier if there is an economic explanation for this. Otherwise it should be taken into account in the modeling. Then we add a dummy variable VIND the model as: VIND=1 if t= 1972 or 1987 and equal to zero elsewhere.

We note that R^2 = 0.994998 and s = 0.014904 in the model without VIND ; while R^2 = 0.992469 and s = 0.018065 in the case of the introduction of VIND. Thus, the model with the dummy variable is better than the model without dummy .

In addition, we find that the coefficient of the dummy variable is significantly different from zero (t-statistic in absolute value = 4.497786> 1.96 for a risk of 5%).

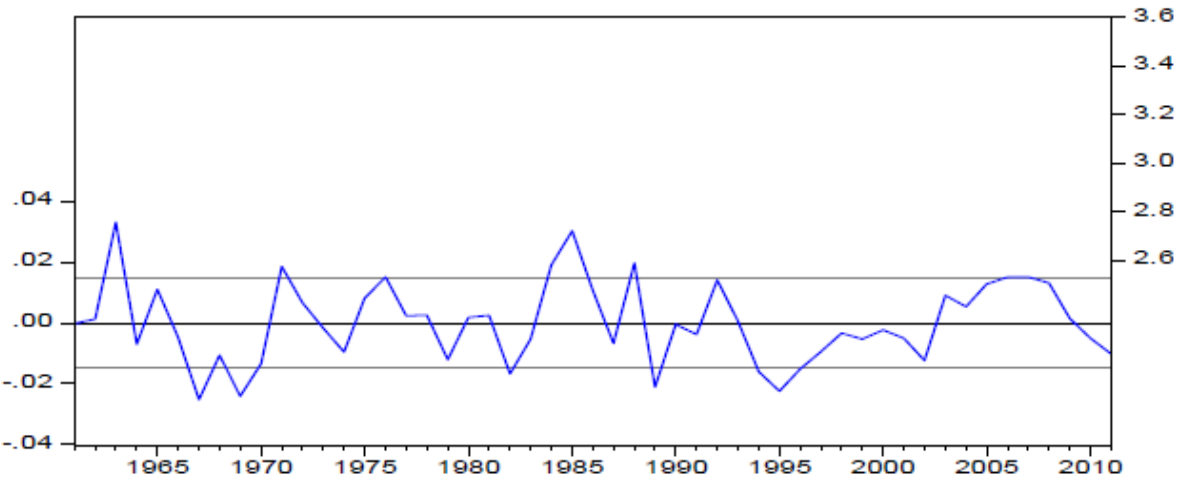

Fig 2. The residue after the introduction of the dummy variable

We see that the outliers in 1972 and 1987 have disappeared. Moreover, EVIEWS offers several techniques to locate the date of the change. All these techniques are based on recursive calculations of the regression coefficients and residuals. Indeed, the Chow test is used to accept or reject the hypothesis of a structural change. The Fischer likelihood statistic is 0.0096 <5%. We must reject the null hypothesis and accept the alternative hypothesis. Thus, it is concluded by a change of regime in 1987, this is true insofar as Tunisia began to adopt a structural adjustment program (SAP) in a process of economic liberalization.

It then remains to be done both regressions, one for the period 1986 and 1961a of the other 1987 to 2011.

Table 2. Coefficients and R ² of Both Models

Coefficients	Modèle 1961-1986	Modèle 1987-2011
LnINV	-0.018404	0.029807
LnOC	-0.102704	0.045671
LnTBS(1)	-1.222632	-1.845416*
LnTBS(2)	0.162269	0.527733*
LnTBS(3)	-0.013433	0.045912
LnEVI	2.183523	-2.379304*
LnTCR	0.002998	0.017675
LnEDCI	0.226025*	0.488810*
LnTCD	-0.065244	0.030932
R^2	0.988409	0.994894

* The coefficients are significant at 1%.

It is clear that, according to this table, the regression coefficients are significantly different from one period to another. In fact, we note that physical capital (physical investment and trade openness) have a positive impact on GDP per capita after the adoption of SAP. However, this impact remains insignificant.

On the contribution of human capital, it is clear that ambiguity concerning the contribution of the primary GER and life expectancy on economic growth (the coefficient is greater than 1). Higher education has a positive contribution after 1987, but it is still not significant and this raises a lot of questions about this level of education. The contribution of secondary education (GER2) is remarkable (it is almost tripled) at 1% level. Indeed, an increase of 10% in this rate has increased GDPC by 16.22% before structural change. After this period, the contribution becomes significant, this time it reached 52.77%.

This finding also relates to the acceleration of industrialization (CDE). Its contribution to growth is almost doubled (22.60% and 48.88%).

On the rate of population growth, its contribution to GNPC became positive (-6.52% and 3.09%).

The appendix (2) gives the matrix of correlation coefficients between the variables in the equation of our study. The comparison of the correlation coefficients between the variables and the variable LnGDPC and suggests an existence of collinearity between variables. Strong collinearity was recorded between GNIPC and EDCI, between the GDPC and GER (3), between the GDPC and GER (2), and also between GDPC and LEAB and to a lesser extent between GDPC and GER (1).

This collinearity is positive, i.e if a value of a variable increases, the value of the other also increases, for all variables except LnTOP and LnAPGR, collinearity is negative, i.e if a value of a variable increases, the value of the other decreases. That said, we can say that there is multicollinearity between variables.

To determine whether a variable is stationary or if it is not, we run the ADF Test. ADF test results are reported inthe appendix in Appendix 3. It is clear from reading this table that the calculated level variables are all insignificant (ADF value satistic> ADF critical value at 5%), while those in first differences are significant at the 5% (value ADF satistic <ADF critical). It is therefore deduced that the series are non-stationary over the period studied, i.e. they admit a unit root, and therefore require a differentiation of the first order to become stationary.

The completion of this test shows that all variables are stationary in first difference, which means that the ten series taken separately are integrated of order 1. So there is a risk of cointegration. So we can use the method of Johansen (1988). Subsequently, we will seek to estimate an ECM. In addition, the ADF test realized on the residue of the long run relationship gave the following results:

Table 3: ADF test on the residuals of the long run

Variable	Level difference	type of model	confidence level	T.Statistique ADF	critical value
Resid lt	1	[1]	5%	-7.240953	-2.923780

Given the non-significance of the trend and constant, the unit root test was performed on the model [1] (without constant or trend). This test revealed no unit root in the series of residues. The residue from the long run relationship is stationary after first difference, which reveals a risk of cointegration between the variables. The cointegration test would be done in terms of verification.

III.1. Result of cointegration test

Johansen (1988) proposed a test of cointegration. The Appendix 4 summarizes the results of the trace of the variables in our study.

Analysis of the results in this Appendix reveal that the statistics of Johansen on the first eigenvalue is above the threshold of 1% critical value (433.1569> 265.5449). Therefore, we reject the null hypothesis that there is no cointegration relationship (R = 0) at the 1% level.

However, we accept the hypothesis (R = 5) that there is at most one cointegrating relationship between the variables in the model (80.64372 <85.33651) from the fifth row of the table. Thus, we consider that there is

indeed a cointegrating relationship between the variables. However, we accept the hypothesis (R = 5) that there is at most one cointegrating relationship between the variables in the model (80.64372 <85.33651) from the fifth row of the table. Thus, we consider that there is a cointegrating relationship between the variables.

The estimate by the Johansen method leads us to retain a single cointegrating long run relationship. In our case, we choose the specification with constant and trend (intercept no trend in CE and test VAR) giving results on the econometric and permissible deviation from economic theory. The equation below shows the estimated cointegrating relationship:

LnPIBH=-8.314+0.373LnINV+0.615LnOC+2.512LnTBS(1) -0.520LnTBS(2) + 0.033LnTBS(3)-0.809LnEVI+0.225LnTCR-0.375LnEDCI+0.104LnTCD

We reveal the existence of a perfect long run relationship between the variables on the one hand, physical capital (investment and trade openness) and human capital (education and health) policy variable (exchange rate), environmental variables; and on the other hand, economic growth in Tunisia.

Results of the relationship between physical capital and growth that we obtained are all positive. This is consistent with the logic of the economy: the stock of physical capital is the main engine that induces full employment and growth. However, the volume of created wealth and growth depends mainly on the sectors targeted by the investment.

With regard to the relationship between human capital and growth, we note low level of the contribution of higher education to growth and ambiguous with respect to primary education. In addition, environment variables, especially the rate of population growth has a positive contribution to GDP per capita. Finally, the negative sign obtained for the constant (-8.314) does not demonstrate the existence of variables other than those that we used, which would be likely to explain economic growth.

III.2. Empirical results

This section is intended to make the interpretation of the empirical results of the determinants of GDP per capita in Tunisia. We will check and to validate the research hypotheses and suggestions to make the economic policies that could lead to effective management of internal balance and externally by the authorities in charge of the country's economic policy. To estimate the error correction model, we specify the long run relationship in the Granger sense and short run dynamics which will be taken into account according to the Hendry sense.

III.2.1. The model of the long run relationship

The following table summarizes the results of the long run relationship.

Table 4. Results of the estimation of the long run model

Variable	Coefficient	t-statistic	probability
C	3.564*	0.546	0.000
LnINV	0.017	0.722	0.474
LnOC	-0.037	-1.005	0.320
LnGER(1)	-1.211*	-5.059	0.000
LnGER(2)	0.349*	3.156	0.003
LnGER(3)	0.073**	2.280	0.028
LnLEAB	0.758***	1.992	0.053
LnRER	-0.090	-1.055	0.297
LnCDE	0.297*	3.261	0.002
LnAPGR	0.019	0.499	0.620
DUM	0.004	0.586	0.560
R-squared	0.992		
D-W statistic	1.328		
Probabilité	0.000		

*, ** and *** respectively indicate significance of coefficients at 1%, 5% and 10%.

Given the results we can write:

LnGDPC=3.564+0.017LnINV-0.037LnPOP-1.211LnGER(1) +0.349LnGER(2)+0.073LnGER(3) +0.758LnLEAB-0.090LnRER+0.297LnCDE+0.019LnAPGGR+0.004DUM (Modèle I.1)

The correlogram shows that residues of long run model are not autocorrelated. _The Jarque-Bera value is 2.48, so it is less than the critical value is 5.99 (still the probability = 0.288 = 28.8%> 5%). So, we accept the null hypothesis. This means that our distribution of residuals is normal. The results of autocorrelation errors based on Breusch-Goldfrey test showed that the errors are uncorrelated. For illustrative purposes, we have for the long run model, probability = 0.2544 = 25.44%> 5%. Therefore, there is no autocorrelation in our model. For the heteroscedasticity errors test, White test for long run model gives a probability of 0.1455 (14.55%> 5%) Thus,

the errors are homoskedastic, which means that the variance of model residuals is constant, confirming that the coefficients obtained by OLS are not only unbiased but effecient.
We can use these coefficients to forecast and construct confidence intervals.
The stability test of Ramsey Reset shows that there is no omission of an important variable (probability (F-statistic= 0.0887 = 8.85%> 5%). The stability test Cusum shows that the curve is contained in a Cusum corridor at 5%. Thus, the model in this study is stable.
The test results Cusum and Cusum SQ at 5% level show that the series are stables. It should nevertheless be emphasized that the test Cusum SQ has four openwork break periods in 1969, between 1980-1989 and between 2001-2002 and in 2011. This failure was corrected by introducing a dummy varaible (DUM) in the model.

$$DUM = \begin{cases} 0 : \text{Unfavorable economic and political conditions: 1969; 1980-1989; 2001-2002; 2011 (not a well-faire State) ;} \\ 1 : \text{economic and political favorable conditions: the rest (well–faire State).} \end{cases}$$

This analysis is done in two stages: analysis of the overall quality of the adjustment on the one hand, and that of the individual quality of the other estimators, on the other hand.
In the case of this study, the probability (F-statistic) = 0.00000 is less than 5% for long run model, the null hypothesis is rejected and the long run relationship is globally significant. This result is consistent with the value of the statistic R^2 (here $R^2 = 0.992$), which also provides information on the quality of the fit as it is close to unity.
To decide on the significance of individual estimators, we use the probability provided directly by EVIEWS. The results of the estimation of the long run relationship clearly show that at 1% level, only the variables GER (1) GER (2) and CDE are significant because the associated probabilities are below 0.01. GER (3) is significant at the 5% level.
Nevertheless, some variables that are significant in this model do not have the expected signs. The presentation of the results of different estimates being made, it is necessary nowto carry out their economic interpretations that can lead to suggestions of relevant economic policy.

The long run results indicate that five variables explain economic growth, approximated by gross domestic product per capita. Of these five variables, four are related to human capital.
Indeed, primary education significantly influences but negatively economic growth at 1%. The coefficient is equal to -1.211 and it is difficult to interpret, this is due to the fact that the gross enrollment rate at primary level is increased by repetition rate. So, this can skew the results.

Secondary schooling affects growth positively and significantly at 1%. Indeed, when the gross enrollment rate increased by 10%, all else being equal, economic growth increases by 3.497%.
The coefficient on the variable of enrollment level is significantly different from zero at the 5% level. In this context, when the tertiary GER increased by 10, all else being equal, economic growth in Tunisia increases by 0.736%.

The question thus arises: is it logical that higher education has a contribution to the economic growth less than secondary education? The answer is that higher education is not adapted to the changing in economic and social srtructures experienced by the country (the educational sphere is disconnected from the productive sector of the country). Moreover, we note that the largest share of the unemployed in Tunisia came from Higher Education. In addition, the country devoted a large budget to tertiary education. However, we do not expect a high contribution of this sector to the country's economic growth.
The health as measured by the logarithm of life expectancy at birth explains positively the economic growth at 10% level. When life expectancy at birth increased by 10%, economic growth increases by 7.85%. This may explain the importance of health in the contribution to economic growth in Tunisia over the long run.

The last variable that significantly explains the growth is the carbon dioxide emission expressed in logarithm. In fact, this variable positively and significantly influences economic growth at 1%. So we can say that as CO2 emission increases (in other words the acceleration of industrialization), economic growth further increases. Indeed, if the emission of carbon dioxide increased by 10%, the growth increases by 2.97%. We expected a negative sign for this variable given the harmful effects of carbon dioxide on human health and therefore on economic growth. But this is not the case. The explanation is that, firstly, the air pollution in Tunisia is relatively low. Also, the effects of training and imitation generate positive externalities outweigh the negative externalities of accelerated industrialization.

The results reval also that the investment rate has a positive effect but not significantly on growth. In fact, an increase in the rate of 10% corresponds to an increase of only about 0.174% to economic growth in the long run. Trade openness negatively affects economic growth. When the level of trade openness increases by 10%, economic growth goes down by 0.375%. This result can be explained by the fact that some problems still persists on trade liberalization in Tunisia. Trade policies were concentrated on the promotion of exports. Trade reforms which were occurred in the context of the free trade agreement with the European Union have not resulted in economic performance in trade with the outside world. The trade does not lead to greater specialization and thus limits gains in total factor productivity. Domestic firms do not benefit from economies of scale despite the expansion of potential markets.

Some economists argue that the gain of economic openness depends on several factors, including the initial situation of the country. This determines the nature of the specialization of the country in the long run and therefore its growth rate. In addition, the results provided a negative sign of the real exchange rate of the dinar against the U.S. dollar, which is approved in this model. The coefficient is -0.090, this is consistent with the theory. Thus, an increased depreciation of the national currency can lead to significant cost in terms of economic growth measured in our study by the logarithm of GDP per capita. Finally, in the context of our long-run model, the rate of population growth has a positive effect (coefficient = 0.019) on economic growth, which is consistent with economic theory. Indeed, the increase in population size increases the size of the market. The latter has a positive effect on consumption which increased production and thus per capita GDP is improved.

III.2.2. The short run equation

The following table presents the results of the short-run relationship.

Table 5. Results of the estimation of the short run model

Variable	Coefficient	t-statistic	Probabilité
C	0.0195*	4.4086	0.0001
DLnINV	0.0078	0.3086	0.7592
DLnTOP	-0.0210	-0.6804	0.5002
DLnGER(1)	0.3580	1.1682	0.2498
DLnGER(2)	-0.3350**	-2.0477	0.0474
DLnGER(3)	-0.0001	-0.0038	0.9969
DLnLEAB	-0.7553	-1.2409	0.2220
DLnRER	-0.0039	-0.0601	0.9524
DLnCDE	0.0937	0.2068	0.1741
DLnAPGR	0.0050	0.2068	0.8372
DUM	-0.0003	-0.0615	0.9512
R-squared	0.2103		
DW statistic	2.2404		
Probabilité	0.4303		

* and ** indicate respectively significance of the coefficients at the 1% and 5%level.

The results allow the following short run relationship:

DLnGDPC=0.0195+0.0078 DLnINV-0.0210DLnTOP +0.3580DLnGER(1) -0.3350DLnGER(2) -0.0001DLnGER(3) -0.7553DLnLEAB-0.0039DLnRER+0.0937DLnCDE+0.0050DLnAPGR -0.0003DUM (Modèle I.2)

The correlogram of the short run model shows that the residuals are not autocorrelated. The errors are not normal (JB = 13.460> 5.99). The Durbin-Watson test (DW = 2.24 close to 2) shows that the residuals are not autocorrelated. This result is confirmed by the Breusch Goldfrey (BG = 0.6186 = 61.86%> 5%). The test of heteroscedasticity errors of White shows that the probability is 0.6956 = 69.56%> 5% for the short run model. Then, we accept the null hypothese, which means that there is no heteroscedasticity, so the variance of our residue is constant. The model does not suffer from the omission of important variable according to the Ramsey Reset test (probability (F-statistic = 0.3016 = 30.16%> 5%). The stability test of Cusum SQ indicates that the Cusum squared curve intersects the corridor. Then, the short run model is not stable.

The coefficient of determination (R^2) is 0.210. This indicates that only 21% of real GDP per capita is explained by the variables in the model. This statistic shows that one away from the linear relationship between the explanatory variables is weak. Probability (F-statistic = 0.430 > 5%) indicates that the short run model does not seem to be of good quality.

Moreover, we note that most of the explanatory variables used in the short run dynamics are not significant and the majority of them do not have the expected signs.

One variable significantly explains economic growth in the short run. Indeed, the gross enrollment rate at the secondary level, expressed in logarithm influenced significantly, but negatively, economic growth at 5%.

In addition, other interest variables such as the GER(1), GER(3) and life expectancy at birth do not explain the short run economic growth in Tunisia. This result was already obtained by several authors in the case of developing countries.

To explain this short run result, we see that Tunisia, like other developing countries, is committed to mass education programs to cope with demographic pressures, but without the proper curriculum.

In this case, the increase in gross enrollment ratio (GER), that is to say, the increase in the number of students and pupils, hides a relative stagnation of available human capital, as increased the school population to the detriment of the quality of education given to each individual.

Some studies reported problems inherent in the Tunisian educational system and the weak performance of educational institutions, the predominance of quantitative aspects in the curriculum, the lack of professionalism and the lack a culture of evaluation. Also, we can add some problems that trace target performance under a development plan covering a period educational and quantitative and qualitative results actually achieved during this period. In addition, the situation of the labor market in Tunisia is characterized by a mismatch between job requirements and graduate qualifications. This fact raises the problem of the quality of the workforce which is also one of the causes of the decline in labor productivity. We can conclude that the difficult evidence of a consistency of the contribution of human capital to economic growth in the short run in Tunisia.
This result shows that the impact of human capital on economic growth is not obvious. This is due to the low internal and external efficiency of the education system in Tunisia. Under these conditions, the short run, economic growth is influenced by other factors (as demonstrated also by the vallue of R^2), especially public consumption, the inflation rate, the lagged per capita GDP and so on.

IV. ESTIMATING A VECM

Now, we assume that the GDP per capita is expressed by only two exogenous variables: the first is relative to physical capital (control variable: LnINV) and other relative to human capital (interest variable: GER(3)).
The equation describes this model can be written as follows:

$$LnGDPC= C+ \alpha_1 LnINV + \alpha_2 LnGER(3) \quad \text{(Modèle II)}$$

The results of the estimation indicate that the variables are stationary in first difference. This reveals a shock on the economy which has a temporary effect on GDP per capita in Tunisia.
In addition, the long run model provides estimates of LnINV and LnGER(3) which are positive and significant successively at the threshold of 5% and 1%. The coefficient of determination R^2 equals 0.95, which means that the two variables LnINV LnTBS and (3) explains 95% of the variability in GDP per capita.
However, in the short run these estimates are positive but not significant, R^2 equals 0.006 which is very low. Thus, this model is generally not significant. This is also confirmed by the probability value (F-statistic= 0.8542 85.42%> 5%).

IV.1. The cointégration equation

We have three variables, therefore the VECM has three equations.vThe equation below provides the estimated cointegrating relationship:

$$LnGDPC=-3.26+0.09\ LnINV-0.37LnGER(3)$$

According to this equation, the stock of physical capital have a positive impact on economic growth. However, the human capital as measured here by the variable enrollment in tertiary education has a negative impact on the logarithm of GDP per capita, this is due to the high rate of the unemployment of university graduates and the structural problems that hinder the development of human capital in Tunisia.
Moreover, the coefficient of the error correction, which is used to measure the speed of adjustment of GDP per capita relative to its equilibrium level was - 0.175932. This coefficient is negative and significant at 5%. Therefore, the formulation of the model form error correction is acceptable.
Indeed, we can see that in the long run, there is a mechanism for error correction which restores imbalance of 17.5% of real GDP per capita. This low level of the speed of adjustment indicates that the return to equilibrium is relatively slow. Thus, the variables used in this equation have little impact on economic growth.
The short run analysis shows that the variation of GDP per capita does not depend on its past values. This is explained by the non statistically significance of the coefficients. In addition, the results reveal that human capital and physical investment affect positively but not significantly the growth in the short run (respectively the probabilities associated are 0.5766 and 0.9482). Thus, this result remains ambiguous in the short run. However, in long run we note that these two variables contribute significantly and positively to economic growth (associated probabilities are 0.0275 and 0.0000 respectively).

IV.2. The Granger causality test

Now we will look for the causal relationship between the variables of the study. Thus, we will illustrate the Granger causality test. The results obtained for a delay p = 2, are given in the appendix (5)

The probability associated with the first null hypothesis that LnGER(3) does not cause LnGDPC, is 0.0023 = 0.23% <5%. Therefore, we reject this hypothesis: the level of human capital as measured by the gross enrollment rate in higher education causes in the Granger sense the logarithm of GDP per capita. Instead, we note that the second null hypothesis LnGDPC not cause LnGER(3), is accepted at the 5% (probability = 0.3495 for = 34.95%> 5%).

Thus, we have: LnGER(3) causes LnGDPC, which is consistent with the literature; and LnGDPC doesn't cause LnGER(3) at the 5% level. Therefore, it is clearly that there is unidirectional causality goes from human capital to economic growth. We can say that the development of human capital through education would be an additional guarantee for a certain level of growth.

V. POLICY RECOMMENDATIONS

In this study of the impact of education on economic growth, the cointegration test showed that there is a long run relationship between economic growth and different levels of education. Econometric estimates of the long run model showed that only the secondary school enrollment rate has a positive and significant impact on economic growth in Tunisia. The impact of higher education is low, while primary school enrollment has a negative effect. In the short run, primary and higher levels have no impact on economic growth.

According to our study, it appears that secondary education is not only a source of human capital accumulation but also a crucial factor of the Tunisian economy growth. In addition, the expansion of primary schooling despite the great number of enrolled pupils, it is unable to provide the economy of human capital capable of capturing knowledge spillovers. Our results show that higher education weakly influences the economic growth. The main reasons are the difficulties faced by this level of education.

Thus, Tunisia cannot become an emerging country if the crisis in higher education persists. The results found in this study can inspire educational policy in Tunisia for sustained growth. First, if Tunisia wants to change the structure of its economy, added efforts must be involved in the financing of secondary and higher education, especially in the area of training and research. Otherwise, the educational system is disconnected from its environment. Secondly, as the stock of skilled workers is very low, investment in higher education should be a priority to drive the other two levels of education. Similarly, as we have checked, the economic growth doesn't cause the development of higher education. Thus, a comprehensive reform of the higher teaching becomes a necessity. Finally, we can say that, according to our estimates provided by the various econometric models, education in Tunisia is not a choice, but rather it is an imperative for growth and development.

VI. CONCLUSION

Tunisia invests heavily in human capital formation. The country achieve some objective such as high enrollment rates, equity ensured and success rate in constant evolution. However, some constraints and difficulties related to the Tunisian educational system and the poor performance of this sector reduce the contribution of the investment in human capital to the economic growth.

Moreover, the cointegration method allowed us to analyze the relationship between economic growth and human capital in the short and long run. Our estimates lead to the identification of a positive and significant effect of the gross enrollment rate in secondary and tertiary education to the GDP per capita in Tunisia over the long run. This result is also valid for the health variable.

Through this study, we were concluded that Tunisia, if it wants to change the structure of its economy, efforts must be engaged in the financing of education and training. Here, investment in higher education should be a priority to drive the other two levels of training. Thus, a comprehensive reform of the higher teaching becomes a necessity. We also demonstrated that education in Tunisia is not a choice but an imperative for growth and development. This study leads us to ask questions about the new direction of education systems in Tunisia.

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APPENDIX

Appendix 1: The data

obs	LnGDPC	LNINV	LnTOP	LnGER1	LnGER2	LnGER3	LnLEAB	LnRER	LnCDE	LnAPGR
1961	2.795592	2.931826	2.048494	1.973128	1.255273	-0.096910	1.698970	-0.397940	-0.384050	0.125156
1962	2.808605	3.034533	2.034761	1.975432	1.267172	-0.070581	1.699838	-0.397940	-0.384050	0.230960
1963	2.849434	3.084320	1.980375	1.982271	1.267172	-0.070581	1.707570	-0.397940	-0.357535	0.290925
1964	2.861108	3.268883	2.026119	1.982271	1.271842	-0.045757	1.711807	-0.397940	-0.216096	0.322426
1965	2.862865	3.326809	2.054452	1.985427	1.278754	0.033424	1.712650	-0.301030	-0.274088	0.335458
1966	2.868207	3.175305	2.055895	1.986772	1.290035	0.176091	1.716003	-0.301030	-0.215383	0.335659
1967	2.859689	3.162584	2.057610	1.986772	1.292256	0.204120	1.720986	-0.301030	-0.195179	0.326950
1968	2.893784	3.067283	1.988631	1.991226	1.311754	0.301030	1.724276	-0.301030	-0.137272	0.312177
1969	2.905379	3.074229	1.976060	1.993436	1.342423	0.342423	1.732394	-0.301030	-0.115771	0.294246
1970	2.917009	3.021083	1.983419	1.995635	1.352183	0.380211	1.737987	-0.301030	-0.136677	0.275542
1971	2.953787	2.989814	1.985171	2.001790	1.355854	0.419460	1.740363	-0.301030	-0.092589	0.195900
1972	3.017594	2.983954	1.951054	2.001115	1.353628	0.422918	1.748963	-0.301030	-0.048662	0.215109
1973	3.007068	3.020355	1.842610	1.973908	1.339928	0.390759	1.755875	-0.397940	-0.048177	0.247237
1974	3.032410	3.032022	1.800016	1.963344	1.330779	0.419956	1.763428	-0.397940	-0.007889	0.285557
1975	3.053254	3.247519	1.737634	1.977014	1.321640	0.450557	1.773348	-0.397940	-0.005243	0.324694
1976	3.076133	3.371621	1.776122	1.984410	1.323335	0.592732	1.778875	-0.397940	0.007748	0.364363
1977	3.079696	3.422905	1.769472	1.996205	1.335799	0.623249	1.788875	-0.397940	0.059563	0.403807
1978	3.095174	3.435273	1.735535	2.000976	1.362972	0.666143	1.788875	-0.397940	0.092370	0.427811
1979	3.111032	3.418613	1.725709	1.999744	1.382845	0.672098	1.796436	-0.397940	0.149219	0.432809
1980	3.130508	3.342900	1.651755	2.005223	1.396374	0.676694	1.802637	-0.397940	0.171727	0.426837
1981	3.142326	3.433817	1.705076	2.006372	1.432456	0.690196	1.805501	-0.301030	0.175222	0.422590
1982	3.128800	3.527281	1.710786	2.012964	1.478076	0.698970	1.811575	-0.221849	0.150756	0.418301
1983	3.137461	3.460988	1.694847	2.029181	1.501361	0.699057	1.818885	-0.154902	0.213783	0.411788
1984	3.153179	3.469643	1.719071	2.038938	1.533289	0.700444	1.820202	-0.096910	0.214314	0.294466
1985	3.163814	3.337116	1.732394	2.047458	1.561888	0.730863	1.822299	-0.096910	0.215638	0.483730
1986	3.143808	3.218429	1.720986	2.055046	1.593762	0.751818	1.827369	-0.096910	0.206556	0.498173
1987	3.160983	3.073831	1.728354	2.058384	1.588619	0.735359	1.829304	-0.096910	0.184123	0.403464
1988	3.151635	3.022662	1.778875	2.056516	1.601495	0.757700	1.844477	-0.045757	0.200029	0.347330
1989	3.153604	3.113178	1.859739	2.044736	1.637310	0.680426	1.856124	-0.045757	0.220631	0.106531
1990	3.176276	3.192979	1.864511	2.051546	1.643749	0.681241	1.857935	-0.045757	0.211121	0.385428
1991	3.184273	3.179918	1.833784	2.054697	1.650103	0.689398	1.859138	-0.045757	0.269746	0.298635
1992	3.208042	3.303384	1.828660	2.056184	1.661548	0.689486	1.860937	-0.045757	0.247482	0.310268
1993	3.208965	3.336254	1.830589	2.056992	1.689193	0.693903	1.861534	0.000000	0.279667	0.290925
1994	3.214699	3.297936	1.855519	2.065124	1.731532	1.067183	1.862728	0.000000	0.256958	0.257439
1995	3.217849	3.184938	1.869818	2.065662	1.762363	1.090963	1.865104	-0.045757	0.244277	0.203849
1996	3.241482	3.143908	1.829304	2.062274	1.790377	1.124211	1.866287	0.000000	0.265290	0.164650
1997	3.258526	3.205047	1.854306	2.058612	1.800119	1.149096	1.868644	0.041393	0.264109	0.137671
1998	3.273280	3.213547	1.851258	2.069812	1.843096	1.189575	1.869818	0.041393	0.284882	0.105851
1999	3.293140	3.236505	1.838849	2.064046	1.866677	1.238573	1.872739	0.079181	0.287130	0.115611
2000	3.308153	3.257168	1.869232	2.061954	1.880167	1.285737	1.873321	0.146128	0.318481	0.053463
2001	3.324059	3.266739	1.907411	2.058513	1.892072	1.337379	1.875061	0.146128	0.332439	0.058806
2002	3.326347	3.235598	1.890980	2.054441	1.900285	1.366628	1.875640	0.146128	0.331832	0.046495
2003	3.347285	3.152831	1.879669	2.051889	1.892306	1.426023	1.875640	0.113943	0.337060	-0.229148
2004	3.368681	3.117431	1.901458	2.050059	1.916570	1.464698	1.876795	0.079181	0.353724	-0.028260
2005	3.381416	3.098889	1.916454	2.049420	1.930730	1.488029	1.877947	0.113943	0.356408	-0.014125
2006	3.401059	3.156534	1.936011	2.044963	1.939414	1.502277	1.880814	0.113943	0.358316	-0.007446
2007	3.423573	3.054630	1.943495	2.031853	1.955235	1.499357	1.881955	0.113943	0.367729	-0.019542
2008	3.438937	3.124555	1.988559	2.029660	1.962980	1.527630	1.882525	0.079181	0.372175	-0.001741
2009	3.447958	3.157205	1.887054	2.019901	1.975528	1.534863	1.883661	0.113943	0.377670	0.003891
2010	3.468154	3.255466	1.485167	2.011862	1.986530	1.546802	1.884416	0.113943	0.383277	0.017033
2011	3.478196	3.120468	1.501439	2.003672	1.997260	1.558433	1.885265	0.146128	0.418633	0.027757

Appendix 2: Matrix of coefficients correlation between the variables

	lnGDPC	lnINV	lnPOP	lnGER1	lnGER2	lnGER3	lnLEAB	lnRER	lnCDE	lnAPGR
lnGDPC	1.000	0.1502	-0.4629	0.6786	0.9457	0.9757	0.9585	0.8710	0.9614	-0.5914
lnINV	0.1502	1.000	-0.4933	0.1383	-0.0233	0.0842	0.1860	-0.0398	0.2621	0.4183
lnPOP	-0.4629	-0.4933	1.000	-0.1853	-0.2431	-0.3635	-0.4458	-0.1624	-0.5338	-0.2050
lnGER1	0.6786	0.1383	-0.1853	1.000	0.7549	0.6696	0.8316	0.8197	0.7731	-0.2977
lnGER2	0.9457	-0.0233	-0.2431	0.7549	1.000	0.9524	0.9322	0.9680	0.8870	-0.7206
lnGER3	0.9757	0.0842	-0.3335	0.6696	0.9524	1.000	0.9236	0.8782	0.9256	-0.6630
lnLEAB	0.9585	0.1860	-0.4458	0.8316	0.9322	0.9236	1.000	0.8954	0.9766	-0.4982
lnRER	0.8710	-0.0398	-0.1624	0.8197	0.9680	0.8782	0.8954	1.000	0.8392	-0.6764
lnCDE	0.9614	0.2621	-0.5338	0.7731	0.8870	0.9256	0.9766	0.8392	1.000	-0.4261
lnAPGR	-0.5914	0.4183	-0.2050	-0.2977	-0.7206	-0.6630	-0.4982	-0.6764	-0.4261	1.000

Appendix 3: Summary results of the ADF test on the variables

	Difference level	Model type	Retards delays	Confidence level	ADF-test statistics	Critical value	Observations
LnGDPC	**0**	**[1]**	**1**	**5%**	**-0.684965**	**-2.922449**	**Non stationary**
		[2]			**-1.817675**	**-3.504330**	
		[3]			**4.928293**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-5.101483**	**-2.923780**	**Stationary**
LnINV	**0**	**[1]**	**1**	**5%**	**-2.928988**	**-2.922449**	**Non stationary**
		[2]			**-2.869447**	**-3.504330**	
		[3]			**-0.115634**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-3.958231**	**-2.923780**	**Stationary**
LnPOP	**0**	**[1]**	**1**	**5%**	**-1.874293**	**-2.922449**	**Non stationary**
		[2]			**-2.071414**	**-3.504330**	
		[3]			**-1.027435**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-4.741310**	**-2.923780**	**Stationary**
LnGER(1)	**0**	**[1]**	**1**	**5%**	**-1.545281**	**-2.922449**	**Non stationary**
		[2]			**-0.285807**	**-3.504330**	
		[3]			**0.242683**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-4.057021**	**-2.923780**	**Stationary**
LnGER(2)	**0**	**[1]**	**1**	**5%**	**0.264980**	**-2.922449**	**Non stationary**
		[2]			**-2.351226**	**-3.504330**	
		[3]			**2.930585**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-3.385885**	**-2.923780**	**Stationary**
LnGER(3)	**0**	**[1]**		**5%**	**-0.939958**	**-2.922449**	**Non stationary**
		[2]			**-2.198944**	**-3.504330**	
		[3]			**1.959101**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-4.396928**	**-2.923780**	**Stationary**
LnEVI	**0**	**[1]**	**1**	**5%**	**-2.959411**	**-2.92244**	**Non stationary**
		[2]			**0.1447228**	**-3.504330**	
		[3]			**3.371459**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-3.214291**	**-2.923780**	**Stationary**
LnRER	**0**	**[1]**	**1**	**5%**	**-0.683643**	**-2.922449**	**Non stationary**
		[2]			**-2.091307**	**-3.504330**	
		[3]			**-1.530626**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-4.206278**	**-2.923780**	**Stationary**
LnCDE	**0**	**[1]**	**1**	**5%**	**-3.803150**	**-2.922449**	**Non stationary**
		[2]			**-2.567237**	**-3.504330**	
		[3]			**-0.249345**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-5.187731**	**-2.923780**	**Stationary**
LnAPGR	**0**	**[1]**	**1**	**5%**	**-0.989538**	**-2.922449**	**Non stationary**
		[2]			**-2.330802**	**-3.504330**	
		[3]			**-0.900882**	**-1.947665**	
	1	**[1]**	**1**	**5%**	**-6.145527**	**-2.923780**	**Stationary**

Appendix 4 : Results of cointegration tests for Model I

Date 05/12/12 time 21 :14				
Sample adjusted : 1963 2011				
Inclided observation : 49 after adjustement				
Trend assumption : No deterministic trend (restricted constant)				
Series : LnGDPC LnINV LnPOP LnGER(1) LnGER(2) LnGER(3) LnEVI LnRER LnCDE LnAPGR				
Lags in first difference : 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.01	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.873395	433.1569	265.5449	0.0000
Atmost 1 *	0.799953	331.8894	221.4442	0.0000
Atmost 2 *	0.728426	253.0385	181.5219	0.0000
Atmost 3 *	0.679601	189.1660	145.3981	0.0000
Atmost 4 *	0.659232	133.3948	113.4194	0.0001
Atmost 5	0.403265	80.64372	85.33651	0.0255
Atmost 6	0.321052	55.34593	61.26692	0.0383
Atmost 7	0.294420	36.37260	41.19504	0.0371
Atmost 8	0.240973	19.28461	25.07811	0.0677
Atmost 9	0.111167	5.774447	12.76076	0.2089
Unrestricted cointegration rank test (maximum eigenvalue)				
Hypothesized		Trace	0.01	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.873395	101.2675	72.09392	0.0000
Atmost 1 *	0.799953	78.85091	65.78362	0.0002
Atmost 2 *	0.728426	63.87256	59.50898	0.0029
Atmost 3 *	0.679601	55.77118	53.12290	0.0047
Atmost 4 *	0.659232	52.75106	46.74582	0.0016
Atmost 5	0.403265	25.29780	40.29526	0.4264
Atmost 6	0.321052	18.97333	33.73292	0.4940
Atmost 7	0.294420	17.08799	27.06783	0.2278
Atmost 8	0.240973	13.51016	20.16121	0.1142
Atmost 9	0.111167	5.774447	12.76076	0.2089
Max-eigenvalue test indicates 5 cointegratingeqn(s) at the 0.01 level				
* denotes rejection of the hypothesis at the 0.01 level				

Appendix 5: Result of Granger causality test

Lags: 2			
NullHypothesis:	Obs	F-Statistic	Prob.
LN_INV_ does not Granger Cause LNGDC	49	4.07183	0.0239
LNGDPC does not Granger Cause LN_INV_		1.36817	0.2652
LNGER_3_ does not Granger Cause LNGDP	49	6.97841	0.0023
LNGDPC does not Granger Cause LNGER_3_		1.07674	0.3495
LNGER_3_ does not Granger Cause LN_INV_	49	0.75686	0.4751
LN_INV_ does not Granger Cause LNGER_3_		1.32247	0.2769