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Correlation ICT-Education and Economic Growth Case of the Arab Economies

[1]Mohamed Neffati & [2]Lobna Besbes
[1]Dr. in Economy,URDEE, FSEG, University of Sfax, Tunisia
Business address: University of Sfax, Faculty of Economic Sciences and Management, Airport Road, km 4.5, Sfax 3018
Personal address: Post Office Maghreb Arab, BP N°3, 3049 Sfax, TUNISIA
[2]PhD. In Economy UREA, FSEG, University of Sfax, Tunisia
Personal address: Road of Tunis, Tactac city in Grocer of Mohamed Tactac, km 2.5, 3002 Sfax, Tunisia
[1]neffati.med@gmail.com, [2] lobna_besbes@yahoo.fr

ABSTRACT

The new theory of growth (endogenous growth) shows that information and communication technology (ICT), and the skills of the workforce constitute the main factors of economic growth. In this survey, and after an econometric study on 22 Arab countries between 2000 and 2010, we found that the contributions of these factors are very important when there is a substantial correlation between them. Indeed, a strong economic integration with a high opening rate makes the country disposed to the adoption of technology, due to the fact that a better investment in education improves the skills of the workforce which is a prerequisite condition in the absorption of ICT. The higher the level of the skills is the more the diffused technology is absorbed and used in a profitable way, and the more the objective of growth is achieved.

Keywords: *ICT, Absorption of technology, education, growth.*

Classifications JEL: *C23, D83, I25, O11*

1. INTRODUCTION

The new theories of growth state that education and technological innovations play a leading role in the explanation of economic growth. Lucas [15] and Howitt [10] emphasized the importance of the skills of the human resources and of the educational system in the discovery and adoption of the new technology. The simultaneous analysis of these two growth factors (education and ICT), became then a major topic for both the economists and the decision-makers of the economic policy.

A synthesis of economic studies accomplished by the UNESCO, shows that the level of education has a positive influence on level: (i) At the individual level: the more an individual is endowed with an admitted certificate, the less likely he is exposed to unemployment, and the higher the average income he will earn will be when he is employed.

(ii) At the collective level, studies of the OECD [20] showed that the effectiveness of the educational system (adequacy of the training with the economic needs, etc.) as well as the number of years of education had positive effects on the income per capita. These effects are borne out at the same time in the developed and developing countries, where the outputs of education are still very important.

Information and communication Technology (ICT) is a necessary tool which facilitates the approval of information and a development tool which meets the essential needs of the emergent countries, notably the Arab economies, both on the qualitative and quantitative level. To make the environment more interactive and more intelligent, ICT offers a lot of opportunities such as the use of software facilitating learning, the access to networks or communicating by video conferencing, technologies facilitating people's functional independence and social inclusion, and also the transfer of knowledge between all the interested parties and collaborative decision making.

The challenge for the Arab countries is to integrate the economy and the knowledge society to accelerate their development process. The most notable examples of these countries are the United Arab Emirates and Egypt. These economies have developed a great interest in the information industry and made national plans to upgrade their countries in terms of infrastructure and training. They have even created free zones such as "Internet City" in Dubai and "Smart Village" in Egypt (author, year). Other countries such as Morocco and Tunisia have also done much to evolve their environment by the installation of a relatively modern infrastructure of telecommunications, the integration in the global society of knowledge and the creation of technology parks in the framework of technological cooperation with their European partners.

The current paper analyzes the performance of the appropriation of information and communication technology and shows the effect of the interaction ICT-education on the growth of the Arab economies. We focus, in a first part, on a review of the literature consolidating the role of the ICT and the educated human capital in growth.

A second part is devoted to an empirical assessment of the impact of the digital revolution and its interaction with the schooling level on the growth of the Arab economies.

2. ICT, Education and Economic Growth: Literature Review

The economic literature has long recognized that the quality of the labor factor plays an essential role in the process of growth. The conventional economies [16] have already highlighted the quality of the workforce in the competitiveness and in the long-term economic growth. Adam Smith has shown that the wealth of individuals and nations depends on the skill level of the workers. The specialization of the workforce assumes that there are some different types of tasks and that each individual performs the one he mastered the most. The concept of "division of labor" also highlights the potential increase of the product related to the improvement of the organization or of the production method. This improvement is possible thanks to the dynamic and competent entrepreneurs, and to the workers who have the ability or the qualification to perform the specific tasks. In addition, since the labor and the capital factors are not enough to explain economic growth, it becomes necessary to talk about other factors within the framework of endogenous growth.

Benhabib and Spiegel [5] have revived a more "technological" vision of the role of education in economic growth, which had been developed in an embryonic way by Nelson and Phelps [19]. These authors also stress that, in an economy with a technical progress, the level of education affects the long-term growth through its effects on the adaptation speed to the technological change.

2.1. Education and growth

The importance of the quality of the workforce is a question that takes again an important place in the studies and the economic debates especially in the new economy. Indeed, since the 1960s, the theory of human capital, which was developed with the work of Becker [4], has emphasized that the knowledge gained by individuals plays a crucial role in the society. According to this theory, education is seen to be an investment because it is a factor in improving productivity. On the empirical level, Denison [8], using the growth accounting, has determined the main factors of growth of the United States. He found a high value for the total productivity of the factors attributed to the improvement of the quality of the workforce due to the improvement of the educational level.

The new economy adopted an enriched view of the human capital. According to its pioneers; Mankiw, Romer and Weil [17], the basic idea is that the human capital plays the same role in production as the physical capital. In this sense, the accumulation of the years of studies comes to multiply the labor force, in other words, to increase the productive efficiency with a constant technology. This increased efficiency permits to award the falling returns on capital and therefore backs the growth in the long term.

2.2. ICT and growth

Until the 1970s, the theories of growth have maintained the idea of Solow [24] according to which technical progress is regarded as an exogenous phenomenon, that is to say, its origin is not analyzed in the context of this model. Under the impetus of Romer [23], the theory of endogenous growth has developed. It considers, as a starting point, that the endogeneity of technical progress should be explained as an economic phenomenon.

The advent of the endogenous growth theory has encouraged the research on the channels through which the dissemination of technology can influence economic growth of the nations. Most of these researches have shown that the link between the technology transfer and economic growth can be positive and conditioned by the ability of a country to adapt itself to the technological changes. In fact, the increase in the technological factor results in the increase of the infrastructure expenses, the social protection and education which, in turn, help the economic growth of the country.

The theory of growth has regained interest thanks to the efforts deployed for the purpose of explicitly including the determinants of technical progress in the growth models and then making them endogenous. These models, known as of endogenous growth, have appealed for explanations of technical progress related, among other things, to the presence of the increasing returns to scale in production, to the on-the-job learning as a source of innovation, to the importance of public spending on health and education that could help increase the human capital, to the development of a financial sector to better channel the savings available for investment purposes as well as to the opening of economies on international trade. The basic reference for the study of endogenous growth models is the voluminous work of Aghion and Howitt [2].

The OECD, [20], stresses that the role of technology in the economy is essential. It also states that long-term knowledge, especially technological knowledge, is the primary engine of economic growth and of the improvement of the living standard. The nations which operate and manage effectively their knowledge capital are those which perform the best.

2.3. Interaction ICT-education and growth

A strong debate was animated by international experts and analysts about the impact of ICT on education. The interest of promoting the integration of the ICT in education is a part of the goal of broad participation in the new economy. This integration was also supported by several studies ([5], [13] and [9]). Despite being flexible and accessible and providing opportunities for increased communication and interaction and being able to vary the

teaching and learning modes, the ICT has many advantages over the educational process [14].

Berman, Bound and Thing [6] were very much interested in the impact of the technological change on the gaps of competence noticed in the labor markets in case when the technological changes have an impact on the skills of the working force. In this respect, it is necessary to mention not only the important role of the knowledge economy, as the foundation of economic growth, but also the importance of skilled labor.

Economy and labour market of all the Arab countries have gone through considerable evolutions in the recent years following the globalization of markets and the big technological changes [11]. We speak more and more about knowledge economy therefore, success depends on the competence and on the quality of the human capital. The public decision-makers agree even about the fact that highly qualified workers represent an essential strategic resource for the good performance of the economy. Indeed, the notion of a highly qualified worker refers to the one who uses advanced technologies requiring particular skills and a high level of competence [31].

More precisely, Tardif [25] maintains that new technology enables the school students to improve their capacity of solving problems and to use meta-cognitive strategies. On this basis, ICT allows the motivation of the learner and foster school success. The effort of integration of ICT would have an interest elsewhere only when technology helps either the teacher to improve his pedagogy or the learner to establish a better link with knowledge.

The UNESCO report shows that education is crucial to the long-term economic and social development since it helps to fight against poverty and automates people by equipping them with the knowledge, competence and confidence they need to exploit their productive efforts and forge a better future. This report also ensures a high priority to the use of ICT for a fairer and more pluralist development in education, aiming at the improvement of knowledge, the exchange of education as a merchandize and globalizing it in cultural diversity implications. The impact of education on growth passes by technical progress, notably the strong correlation between education and ICT.

3. EMPIRICAL METHOD

3.1. The model

By referring to the econometric approach of the panel data and to the methods of estimates adapted in the case of an empirical analysis (GMM), we will try to test the effects of the ICT and the schooling rate and their correlation on the economic growth in relation to the Arab economies.

$$R_{GDP\,it} = {}_0 R_{GDP\,it-1} + {}_{ICT} ICT_{it} + {}_{GER} GER_{it} + {}_{ICT*GER} (ICT * GER)_{it} + u_{it}$$

G: growth rate of the GDP
ICT: indicator of access to communication and information technology
TBS: gross schooling rate

3.2. The indicator of the information communication technology

This explanatory variable (ICT) is the most important in our study. The ICT is defined, by the main organisms which monitor it (UIT, OECD), as the « implemented tools and techniques to have access to information and recover it, stock it, organize it, manipulate it, produce it, introduce it and exchange it through electronic means and other automated methods.

These means include equipment, software and telecommunication equipment, personal computers, scanners, numerical cameras, numerical pocket helpers, telephones, fax machines, modems, compact disc and DVD drives and recorders, numerical videos, radios and television and programs such as the database systems and multimedia applications». From this wide definition, we kept four main indicators listed below which have a composition that forms the composite indicator of the variable ICT:

- (ict1) number of subscribers in the Internet at a high rate per 100 inhabitants
- (ict2) number of subscribers in the telephone lines per 100 inhabitants
- (ict3) mobile cellular subscriptions per 100 inhabitants
- (ict4) users of Internet per 100 inhabitants

These variables chosen as an indicator of measuring information technology can catch the different aspects of the development process of the ICT sector. They will then be more appropriate to study the contribution of the ICT to the growth of productivity, in the case of our sample. However, we need a synthetic and available indicator for all the individuals rather than separated variables which differ from an individual to another.

In order to do that, we construct, by using the method of analysis in main element, an indicator of ICT being the linear combination of all its main elements;

$$ICT_{it} = \sim_j \sum_{j=1}^{4} ict_{ijt}$$

With: i = country; j = 1,...,4 ; components of ICT variables; and t = 2000,..., 2009 ; years.

The coefficient vector $\sim_j$, is constant for all the 20 countries over the period (2000-2004).

This method of calculating the ICT, which we adopted, was used by several researchers such as [12] and [18], in order to calculate a composite indicator.

The table below shows the main elements of the ICT indicator as well as their diffusion speed represented by the rate of growth based on the population of the Arab countries.

Table1: Access to Information and Communication Technology

Pays	Subscriptions to mobile and fixed phones		Internet Users		Accessibility and Costs In ($)	
	(per 100 peoples) 2008	(in % of growth, based on the population) 2000-2008	(for 100 people) 2008	(in % of growth, based on the population) 2000-2008	Expenses of connection of mobile phones	Expenses of connection of fixed phones
Qatar	**152**	**593**	**34**	**1 353**	**54,9**	**54,9**
Kuwait	**126**	**284**	**36,7**	**601**	**17,3**	**130,1**
Libya	**93**	**809**	**5,1**	**3 130**	**3,8**	**38,1**
Saudi A.	**163**	**837**	**31,5**	**1 612**	**80**	**4**
Tunisia	**95**	**813**	**27,1**	**973**	**16,2**	**2**
Jordan	**99**	**494**	**27**	**187**	**50,5**	**6**
Algeria	**„**	**„**	**11,9**	**2633**	**46,5**	**7**
Egypt	**65**	**678**	**16,6**	**2 916**	**74**	**2**
Morocco	**82**	**585**	**33**	**5 121**	**77,4**	**26**
Yemen	**21**	**1 172**	**1,6**	**2 367**	**85,1**	**1**
Mauritania	**67**	**6 227**	**1,9**	**1 100**	**18,5**	**22**
Comoros	**19**	**1 706**	**3,6**	**1 441**	**120,6**	**15**
Djibouti	**15**	**1 186**	**2,3**	**1 253**	**56,2**	**8**
Sudan	**30**	**2 916**	**10,2**	**46 567**	**„**	**6**
Iraq	**61**	**2 652**	**1**	**„**	**159,4**	**1**
Lebanon	**52**	**65**	**22,5**	**215**	**29,9**	**8**
Oman	**125**	**810**	**20**	**559**	**26**	**65**
A. U. Emirates	**242**	**344**	**65,2**	**282**	**49**	**3**
Bahrain	**214**	**341**	**51,9**	**907**	**53,2**	**5**
Palestine	**38**	**236**	**9**	**922**	**„**	**„**
Syria	52	547	17,3	12 156	5,7	28,7

Source : Human Development Report 2010

During the recent years, the Arab economies have had a massive diffusion of ICT. However, the problem of this diffusion is that it depends on the ability of the country to implement the necessary infrastructures. Actually, the table clearly shows a differentiation between the oil producing countries and the non oil ones regarding the access to information technology. This explains the high number of fixed and mobile telephone subscribers and the Internet users in the oil producing countries such as Qatar, Kuweit, Saudi Arabia, the United Arab Emirates, etc. contrary to the non oil producing countries such as Tunisia, Egypt, Morocco, Lebanon and Syria.

3.3. The education variable

Concerning the variable reflecting the level of skills or education, we retained, as indicator of measure of this variable, the average schooling rate in the secondary and tertiary education. The choice of this indicator is first justified on the theoretical level due to the fact that it is used a lot in the empirical literature [3] as a main indicator of education and of qualification level. It is also justified on the statistical level since it is available for all the countries of our sample.

The gross schooling rate (GSR) is defined, for a given year, as the ratio between the total number of registered pupils in a specific level of the primary, secondary, or tertiary education, whatever their age is, and the overall population having the right and legal age to go to school at the same level of education. This rate can be superior to 100 % (repeaters).

$$GER\ {}^{t}_{h} = \frac{E\ {}^{t}_{h}}{P^{t}_{h,a}} \times 100$$

YBS: schooling rate at the level of education ***h*** during year ***t***.

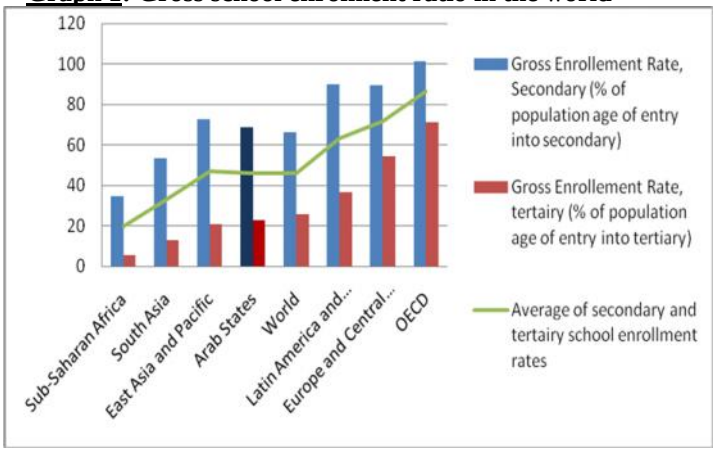
S: population sent to school at the level of education h during school year t.

P: population of age group α which officially corresponds to the level of education t during school year t.

The gross schooling rate is a general indicator of the level of primary and secondary school attendance. It is, at the same time, an indirect measurement of the vacancies at schools and their use. In our empirical study, we used the gross schooling rate of the secondary and tertiary education.

International statistics [27] shows that the gross schooling rates differ not only from a region to another throughout the world but also between the Arab countries. This is apparently justified in the two following graphs:

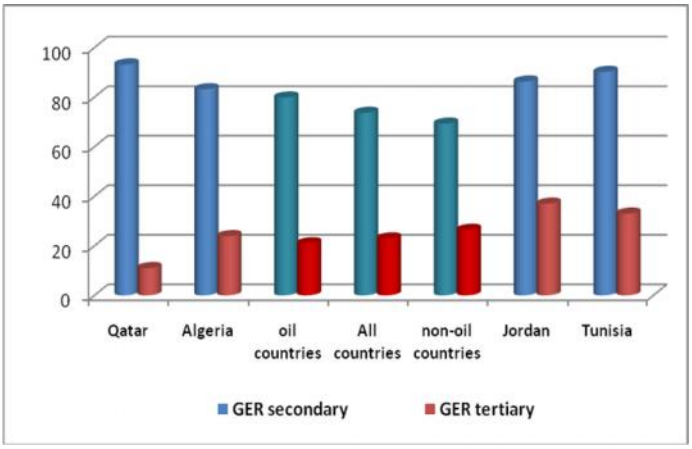
Graph 1: Gross school enrolment ratio in the world



Source: Statistical institute of UNESCO [27].

The gross schooling rates in the secondary education (68.8 %) and in the tertiary (22.7 %) in the Arab economies occupy a medium position compared with those of the world (respectively 66.4 % and 25.7 %). They are higher in relation to those of Sub-Saharan Africa, Europe, central Asia and the OECD.

Graph 2: Gross school enrolment ratio in the Arab economies



Source: Statistical institute of UNESCO [27].

The bar chart points out that the non oil producing countries show gross schooling rates (secondary and service sector) higher than those of the oil producing countries. It also shows that education high level is of course spread only in the secondary level especially in the oil producing countries (Qatar, Algeria) in relation to the non oil producing ones (Jordan and Tunisia). This last point is due to several reasons:

- Considering wealth, the oil producing countries encourage the students to carry on their higher education abroad (in the United States and Western Europe). Besides, given the availability of the leisure means and of family commitments (marriages) at a precocious age, the students aren't motivated to continue their advanced studies. The women weak schooling rate can also explain the weak enrolment rate of the tertiary education. This behavior of individuals confirms the theory of the human resources according to which "the economic agents, in order to decide or not to continue their studies, arbitrate indeed between the wage increase they will benefit from, once they enter the labor market, and the loss of income (wage and studying fees) that they incur if they carry on their studies for an extra year" [1].
- The non oil producing countries encourage higher education and improve the level of skills of their workforce to meet the local and international requirements and requests. Inversely, the oil producing countries aren't compelled to have a skilled workforce since they can get it from other countries such as the case of Saudi Arabia, The United Arab Emirates etc.

3.4. Study of the variables stability

The table below presents the study of the variables stability according to the Im, Peasaran and Shin method (W-stat). Variable G is stationary in level therefore it is included of the order 0, I(0), variable TBS is stationary at first difference I(1) and variables TIC and TIC*TBS are stationary at second difference, I(2)

Table 2: Results of the tests of stationnarity of the variables

Unit test of Root.			
Automatic selection of the delay number			
Period: 2000-2009 Cross-sections included: 20			
Method: Im, Pesaran and Shin W-stat			
Series:	**Statistic**	**Prob.****	**Int. Rait**
R_{GDP}	-3.42434	0.0003	I(0)
ICT	-4.86815	0.0000	I(2)
GER	-6.94975	0.0000	I(1)
ICT*GER	-4.40956	0.0000	I(2)

3.5. - Sample and sources of data

The Oil producing Countries	**The Non-Oil producing Countries**
Algeria,	Comoros
Bahrain	Djibouti
UAE	Egypt
Iraq	Jordan
Kuwait	Lebanon
Saudi Arabia	Morocco,
Libya	Mauritania
Qatar	Oman
Sudan	Syria
	Tunisia
	Yemen

In this empirical job, we are interested in the study of the impact of the numerical revolution and in education on the growth of the Arab economies. These countries are divided between oil producing countries and non oil producing ones as it is shown in the table below.

In order to obtain reliable and standardized data for all the countries of our sample and to gather our statistical database, we used the basic data of the World Bank and some Internet sites:

3. Interpretation of results

Table 4: Total sample: Arab countries

Endogenous Variables / Exogenous Variables	G_{PIB}	*D(GER)*
$R_{GDP\ t-1}$	**-0.370044** (0.0000)	
$D(GER)_{t-1}$		**0.*951430*** (0.0000)
D(ICT,2)	**-0.367282** (0.0000)	0.004063 (0.1381)

D(TBS)	**0.252298** (0.0633)	
D(ICT*GER,2)	**0.005221** (0.0000)	
J-statistic	15.59020	17.66247
Instrument rank	20	21
Test of Wald	0.129956 (0.006806)	
Test Jarque-Bera	13651.39	
Nbrs obs	140	160

This first table presents the estimate result of all the Arab countries. It shows, as a result of dynamic regressions, strong significant correlations between the schooling rates, the indicator of access to numerical technology and those of economic growth.

The obtained results show that economic growth of the Arab countries, represented by the growth rate of the GDP, is negatively influenced by its previous values. This economic decrease is in fact explained by the fluctuations of the oil and cereals prices in the first half of 2000 and by the contagion of the American financial crisis "Subprimes" which started in August, 2007 [7], to spread later allover the world. These events contributed to the slowing down of growth in most Arab countries.

The regression of the ICT variable, measured by the rate of access to numerical technology on the growth rate, shows a significant result of a negative sign. The negative sign of this variable can be explained by a foreclosure effect on growth caused by an uncontrolled access by the Arab countries to technology. This has as an origin the excessive use of information and communication technology by people for non productive activities (leisure).

The variable "schooling rate" is statistically significant. It introduces a positive sign which is explained by the fact that when the schooling rate increases, the skilled workforce increases, the thing which causes an increase of productivity.

Growth rate in the Arab countries increases if there is quick access to technology and better skills, that is to say the integration of ICT in the training and educational institutions with a major correlation effect on the improvement of economic growth.

The table below also shows that the gross schooling rate increases from one year to another since it is positively influenced by its previous value. However, it is not significant in case there is a regression of this rate on the ICT.

Table 5: Estimations by country group

	Oil countries		***Non-oil countries***	
Variables endogenous	R_{GDP}	***D(GER)***	R_{GDP}	***D(GER)***
Exogenous Variables				
$G_{GDP\ t-1}$	-0.1851 (0.3477)		-0.3517 (0.0000)	
$D(GER)_{t-1}$		0.9390 (0.0000)		0.8876 (0.0000)
D(ICT,2)	-0.5242 (0.0862)	0.0242 (0.0000)	-0.6628 (0.0869)	0.0174 (0.0025)
D(GER)	0.2184 (0.2791)		-0.0421 (0.9524)	
D(ICT*GER,2)	0.0098 (0.0247)		0.0084 (0.0146)	
J-statistic	8.0903	7.6353	8.6560	8.5138
Instrument rank	11	11	9	9
Test of Wald	-0.6851 (0.1958)	0.4390 (0.0100)	-0.8517 (0.0205)	0.3876 (0.0206)
Test Jarque-Bera	5.9808 (0.0000)	3033.845 (0.0000)	1591.162 (0.0000)	472.876 (0.0000)
Nbrs. Obs.	77	88	63	72

The growth of the Arab countries, whether they are oil or non oil producing countries, is falling from one year to another due to the fact that the growth rate of year (T-1) negatively influences that of year (t)

In the oil producing countries, graduates have no intention to work due to the fact that their financial standings are good, the thing which could lead to a reduction of productivity and as a result to a fall of the GDP growth rate. On the other hand, the reduction of the growth rate in the oil producing countries is explained by the under use of skilled human capital due to the fact that most graduates are unemployed

Variable ICT appears to be non significant for the oil producing countries, while for the producing ones, it is statistically significant at the threshold of 10 % and negatively affects their growth. This result can be explained by the use of new technology for non productive activities.

The schooling rate has effect on growth both for the oil producing countries and as the non producing ones. This result does not comply with that of Aghion and al. [1] and to that of Ouerghi [21] who underline that the schooling rate is considered as being a fundamental determinant of economic growth.

The interaction variable of access to technology gives a strong explanatory power on the growth rate of the oil producing and non producing Arab countries. The access of the graduates to new technology improves the schooling rate more, the thing which reinforces the growth of these economies.

4. CONCLUSION

The role of education in growth is nowadays glorified by international institutions and reinforced by the economic theory. In a world where technological innovations are part of our daily life, the utility and accessibility of new technology (ICT) has become necessary to improve the functional and productive capacities of individuals. Indeed, technological innovation and adaptation are the engines of growth of productivity, a source of growth of long term of a country or of a sector of

the economy. However, the massive schooling development in the developing countries often has a limited impact, if none, on their growth rate (Parienty, 2006).

The main idea we came up with, following the analysis in this paper, consists in showing that the numerical revolution can contribute to the growth of the economies only by a better taking over and exploiting ICT which are compelled by a high competence reached by a high qualification level. In other words, a strong interaction between the ICT and the qualification level can relaunch the growth of the Arab economies.

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