

# **The Information and Communication Technologies impact on the MENA countries growth performance**

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## **Abstract**

This article aims at testing the effect of Information and Communication Technologies (ICT) on growth performance of the MENA countries. This paper employs an extension of the standard growth accounting framework introducing an ICT indicator using estimates of stock of ICT capital (hardware, software, and telecommunication equipment), to estimate the direct and indirect contribution of ICT to growth in 14 MENA countries (Algeria, Bahrain, Egypt, Iran, Israel, Jordan, Kuwait, Morocco, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, and United Arab Emirates) during the 1992-2004 period. We use GMM estimators applied to dynamic panel data technique to analyze regional specific ICT effects on growth performance. To account for the potential endogeneity of ICT (as well as that of other regressors), we use a variety of GMM estimators based on both internal and external instruments, and report results using both aggregated and synthetic measures of ICT. We focus on highlighting the mechanisms through which ICT affects the regions growth. We try to answer the following questions: does the ICT impact on growth performance differs from developed to developing countries (respectively positive and negative impact)? Has the ICT direct or indirect impact on growth especially for the MENA region? Is the ICT impact on the MENA region growth similar for the MENA oil and non-oil countries?

**Key Words:** ICT impacts, Conditional convergence, Growth determinants, MENA countries, Economic Development, and Panel data.

## 1 Introduction

The growing importance of the Information and Communication Technology (ICT), and the way they are transforming the world received an increasing attention among economists especially over the last decade. They tried to answer the question what is the ICT's impact on growth?

A debate was raised to link the rapid progress in ICT diffusion and the economic growth. On the one hand some recent theoretical and empirical literature studies the positive effect of ICT on productivity (Jorgenson & Stiroh (1995), Mansell & When (1998), Pohjola (2000 and 2001) and Haacker & Morsink (2002)). The initial empirical studies focused on the impact of ICT on the United States growth for which the effect seemed very clear and the required data available (Oliner and Sichel (2000)). Subsequently, Goldman Sachs (2000), Daveri (2000), Bassanini et al. (2000), and Candarelli (2001) extended the investigation to Europe, Japan, and Australia. These literatures proved that the accumulation of ICT capital stock improves labor productivity. This is the direct effect of ICT on productivity. However there are indirect effects of ICT on productivity, through the use of ICT in other sectors. Currently the important contribution of ICT to the labor productivity growth is established but the indirect effects of ICT on the general efficiency of production need to be more investigated.

On the other hand some other recent empirical literature shows the potential negative impact of ICT on economic growth especially for the developing countries (Dewan & Kraemer (2001), Ambert & Chapelle (2003), Mingat & Winter (2002) and Satti & Nour (2003)). The majority of these studies are based on the debate that technical changes are creative destruction. ICT has some positive impacts to enhance economic development; however in the other hand it has some negative impacts on some dimensions of economic development. Hence some studies (Aghion and Howitt (1998), Freeman and Soete (1985), Freeman and Soete (1994) and Freeman and Soete (1997)) discuss the negative impacts of ICT on employment and labor market in particular the unemployment effect. The main argument of these literatures is that ICT is similar to various kinds of technical change in producing the so called labour saving or skilled biased effect, through the displacement of some unskilled labour due to either reduction or elimination of some unskilled workers. In addition, that ICT could create some negative impacts for growth and convergence of developing countries. In fact the developed countries will have some more competitive advantages raising their domination on global world. ICT will facilitate attracting and opening new markets for the developed countries at the expense of the developing countries. It will provide developed countries comparative advantageous. Developing countries will be not only less competitive in the international market, but also will be threatened in their original local markets. So, this process might delay the catching up of the developing countries to the developed countries. Hence, it could widen the already existing gap between developed and developing countries. ICT might also create some negative impacts in the income distribution within the developing countries. The poor might be excluded from the ICT learning which needs some expensive equipment so the rich

might be the most prepared and well furnished for such formation and qualification. In this case the rapid accumulation of ICT will aggravate the already existing income inequalities and so increasing the poverty of the poor in the developing countries.

International studies comparing cross countries the ICT effects on economic growth are lacking specially those including developing countries. Pohjola (2000) found an important positive effect ICT investment on the economic growth of 23 OECD countries. Dewan and Kraemer (2001) estimated a cross countries Cobb-Duglas production function with ICT capital, non ICT capital and labour as inputs. They concluded that the ICT capital returns are positive and statistically significant for developed countries, but non-significant for developing countries. The ICT effect in the MENA region countries economic growth performance is not well explored. Hence, very few studies focused in this issue. Abutaleb and Hashem (2005) used a computable general equilibrium model (CGEM) relating the different sector of the economy to technology, capital, labour and GDP. They found that ICT will increase the economic growth of Egypt and Tunisia. Satti and Nour (2003) concluded that ICT diffusion is positively correlated to economic growth and human capital/education. However in both cases, the degree of significance is somewhat doubtful and ambiguous in both Egypt and Gulf countries.

The goal of this paper is to provide a comprehensive empirical evaluation of the impact of ICT development on growth and income inequality. The purpose of our article is to highlight the impacts of ICT on the MENA countries economic growth performance. We use the framework of the neoclassical economic growth model particularly the augmented Solow model to explain ICT role in the cross-countries income variations. To do this, we build a large data set of ICT index covering 71 countries. Using this data set, we estimate empirical growth and inequality equations including a standard set of control variables augmented by the ICT index and ICT synthetic variables and controlling for the potential endogeneity of infrastructure indicators. We estimate a set of regressions introducing an ICT indicator regional indicators and MENA-specific variables to find out if the Information and communication technology has any specific effect on the MENA countries long run growth. While performing the analysis, the paper tries also to find out if ICT effects growth directly or indirectly.

The paper is organized as follows. Section 2 briefly presents the data, the ICT compounded index and the econometric methodology. Section 3 gives the empirical results, it analyzes in a first subsection the global effect of ICT on long run growth, in the second subsection the specific regional direct and indirect effect on growth including MENA area by introducing MENA-specific regressors and region-specific regressors, and in the third subsection specific ICT effect on growth within the MENA countries specially the oil (gulf) and non-oil countries. Section 4 concludes.

## 2 Data and Econometric Methodology

We use data taken from the world Development Indicators (2006), published by the World Bank and 6.2<sup>1</sup> Summers, Heston and Aten (2006)'s Penn World Table Version dataset for pooled sample of 71 countries from 1992 to 2004.

The variables included are: the logarithm of the average value of the rate of investment on the period 1992-2004 (*linvest*), the logarithm of population (*LPOP*), gross average School enrolment in tertiary (%) (*kh*), Exchange Rate (*xrat*), openness (*open*), Risk Guide (*icrg*) risk rating is an overall index, ranging from 0 to 100 (highest risk to lowest), based on 22 components of risk, dummy variable for oil exporters (*oil*) taking 1 for countries whose fuel exports represent 50% or more of the total of exports in 2000, and 0 others (see appendix 2 for the variable definitions). We also introduce regional dummy variables, in the regressions the complete sample of 71 countries is sub-divided into six disjoint areas. East and south Asia (*esa*), the Central and South America (Latin), Sub-Saharan Africa (*SSA*), Middle East and North Africa<sup>2</sup> (*MENA*), OECD countries and East Europe and Central Asia (*EECA*). Table 1 in appendix 1 presents the regressions using regional dummy variables thus made up.

As shown in Appendix 3, an index for Information and Communication Technology is computed using estimates of stock of ICT capital (hardware, software, and telecommunication equipment) data: Internet users (per 1,000 people), Personal computers (per 1,000 people) and Fixed line and mobile phone subscribers (per 1,000 people).

As the empirical growth literature has grown, so has the critical evaluation of it. There is by now a wide-ranging discussion of the shortcomings of growth regressions. The typical cross-country growth regression suffers of a lack of robustness due to two different type of bias: simultaneity or variable correlation and variable endogeneity. Panel data econometrics solves the first type of bias by allowing individual fixed effect. However it does not solve the second type of bias. To account for the potential endogeneity of ICT (as well as that of other regressors), we use a variety of GMM estimators applied to dynamic panel data based on both internal and external instruments, and report results using both aggregated and synthetic measures of ICT.

Assessing empirically the impact of ICT on growth and income distribution in our panel data set poses some econometric issues that can be illustrated in the context of a simple dynamic equation:

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<sup>1</sup> Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006.

<sup>2</sup> 14 MENA countries: Algeria, Bahrain, Egypt, Iran, Israel, Jordan, Kuwait, Morocco, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, and United Arab Emirates

$$\begin{aligned}
y_{it} - y_{it-1} &= \alpha y_{it-1} + \phi' K_{it} + \gamma' Z_{it} + \mu_t + \eta_i + \varepsilon_{it} \\
&= \alpha y_{it-1} + \beta' X_{it} + \mu_t + \eta_i + \varepsilon_{it}
\end{aligned}$$

Here  $K$  is a set of standard growth or inequality determinants, and  $Z$  is a vector of ICT measures. The terms  $\mu_t$  and  $\eta_i$  respectively denote an unobserved common factor affecting all countries, and a country effect capturing unobserved country characteristics. The second equality follows from defining  $X_{it} = (K'_{it}, Z'_{it})'$  and  $\beta = (\phi', \gamma')'$ .

For the growth equation,  $y$  denotes (log) per capita GDP. For the inequality equation,  $y$  denotes a suitable (in)equality indicator, and the equation omits any dynamics –i.e., it is a simplified version of the above expression with  $\alpha = -1$ , so that the lagged dependent variable drops out from both sides.

The estimation of the above equation faces the potential problem of endogeneity of the regressors such as indicators of human capital, trade openness, government expenses, investment, risk rating index, real exchange rate and population.

### 3 Empirical results

We turn to the evaluation of the impact of ICT on growth. We first examine if there is a specific effect of ICT on growth for MENA region, comparing specific effect of the different world region. Then we highlight ICT direct or indirect impact on growth especially for the MENA region. Finally we compare the ICT impact on growth for the MENA oil and non-oil countries.

#### 3.1 ICT and Long-Term Growth

As noted, our strategy involves estimation of an ICT-augmented growth regression. We include the following standard growth determinants: indicators of human capital, trade openness, government expenses, investment, risk rating index, real exchange rate and population. In addition, the set of explanatory variables includes the index of ICT describe in appendix 3. For our empirical experiments, we use a panel data set over the 1992-2004 period, with a total number of observations exceeding 550.

Table 1 in appendix 1 reports the regression results obtained with the basic growth equation augmented by the synthetic index of ICT. Variables  $l_{invest}$ ,  $l_{pop}$ ,  $xrat$ , and  $l_{gov}$  are significant and have the expected signs in all considered cases;  $kh$  is non significant;  $icrg$  is significant in all regressions but has the expected positive sign starting from Model 4, less risk (higher level of  $icrg$ ) improves growth and  $open$  is significant with a negative effect on growth which is special for developing countries with abundant natural resources. In model 1 we find that the coefficient estimate of the ICT index is negative and significant at 1%. Neither the Sargan test of over identifying restrictions nor the test of second order serial correlation reveals symptoms of

misspecification. This negative effect of ICT on growth is already mentioned in the recent literature especially for the developing countries (Dewan & Kraemer (2001), Ambert & Chapelle (2003), Mingat & Winter (2002) and Satti & Nour (2003)). This is explained by the creative destruction of technical changes. ICT has some dimensions of economic development like employment and labor market in particular the unemployment effect (Aghion and Howitt (1998), Freeman and Soete (1985), Freeman and Soete (1994) and Freeman and Soete (1997)). ICT is considered to be similar to various kinds of technical change in producing labour saving or skilled biased effect, through the displacement of some unskilled labour due to either reduction or elimination of some unskilled workers. ICT create negative impacts for growth and convergence of developing countries in fact it gives additional competitive advantages raising their leadership and capability to open new markets including those of developing countries. Thus the ICT widen the gap between developed and developing countries delaying the catching up of the developing countries.

On the other hand we include in Models 5 and 7 two synthetic variables *indkh* and *indinv*, measuring respectively the impact of ICT on human capital and the investment profitability's on long term growth rate and or the human capital and the investment on ICT profitability. These Models investigate the indirect effect of ICT on growth and the threshold human capital and investment on ICT profitability for growth. The ICT variable continues to be significant but at a lower level respectively 10% and 5%. *indkh* and *indinv* are not significant. This reveals an absence of an absolute indirect effect of ICT on growth through an impact on human capital and investment.

### **3.2 ICT specific regional effect on growth**

In Model 2 of Table 1 in appendix 1 we include regional dummy variables. The majority of the control variables coefficients did not change when taking into account the regional indicators. However, this model reveals a specific negative effect for Sub Saharan Africa (*ssa*) % and Latin America (*lam*) at 10%. This result suggests differences in growth among these two regions comparatively to the omitted one OECD.

In purpose to catch the specific regional impacts of ICT on growth we complete specific regional ICT index. These variables (*indexesa*, *indexssa*, *indexlam*, *indexmena*, and *indexeurc*) are introduced in Model 3. The index variable remains significant at 1% and producing a negative global effect. However, the regression shows an important specific effect ICT on growth for East and south Asia (*esa*) Sub-Saharan Africa (*ssa*), significant at 1% in both cases. This high impact is positive for *esa* and negative for *ssa*. So, ICT is very profitable in the emerging Asian countries their effect on growth is the largest for these countries compared to OECD. In contrast, ICT has a large negative effect on growth performance for the least developed countries of Sub Saharan Africa which confirm the negative impact of ICT

on economic growth for the developing countries. There is no specific effect of ICT on MENA growth compared to the OECD region.

To test the impact of ICT on human capital and the investment profitability's on long term growth rate and or the human capital and the investment on ICT profitability we include in Models 6 and 8 regional specific synthetic variables *indkh* and *indinv* (respectively: *indkhesa*, *indkhssa*, *indkhlam*, *indkhmena*, and *indkheurc* & *indkhinvesa*, *indinvssa*, *indinvlam*, *indinvmena*, and *indinveurc*). These Models investigate the indirect effect of ICT on growth and the human capital and investment on ICT profitability for growth across the world regions. Using the regional synthetic variable of ICT with human capital and investment, we note in model 6 that both *kh* and ICT index are significant. This result reveals a regional indirect effect of ICT on growth via human capital probably affecting his productivity and a regional threshold effect of human capital volume and quality on ICT profitability for East and South Asia, Sub Saharan Africa and Latin America groups of countries. This effect is positive for East and South Asia and Latin America and negative for Sub Saharan Africa compared to the OECD countries. However, in Model 8 human capital variable becomes significant, investment variable remain significant but ICT index insignificant. This model shows an important role of investment on the ICT profitability for certain regions. The investment allow a positive and significant ICT effect on East and South Asian growth and a significant and high negative effect on growth in Sub Saharan Africa compared to OECD standard. MENA region has no specific effect of investment on ICT profitability compared to OECD.

### **3. 3 Specific ICT effect on growth within the MENA region**

The absence a specific direct or indirect effect through an impact on human capital and investment of ICT on MENA region growth performance is found to be specific to the non-oil MENA countries. In deed, a high positive specific effect of ICT on growth for the oil-MENA countries (*golf*) quasi-equal to that of the East and South Asia is highlighted in Model 4.

The coefficient of the specific ICT regional effect for East and South Asia (*esa*), and oil MENA countries (*golf*) are significant and show a positive expected sign. The ICT Sub Saharan Africa (*ssa*) impact on Growth is significant and negative reflecting their very weak performance in catching the new technology.

A significant Growth Payoff from ICT in MENA countries is verified to be very clear only for the oil-MENA countries. It seems that these countries succeed in the investment categories and quality choices and in capturing and forming the needed qualification for human capital to be able to benefit from the Information and Communication Technology.

## 4 Conclusions

In this paper we have provided an empirical evaluation of the regional and global impact of Information and Communication Technology on economic growth. We estimate the direct and indirect contribution of ICT to growth across six world regions and especially for 14 MENA countries. We highlight a regional indirect effect of ICT on growth via the human capital and the human capital and investment impact on ICT profitability. The region's leader in terms of ICT contribution to growth is East and South Asia and the looser region is the Sub Saharan Africa. MENA has no specific effect of ICT on Growth compared to OECD region. MENA region as a whole needs sustained increases in human capital volume and quality and in investment in ICT equipment to catch-up with the East and South Asian country performance in ICT profitability for growth.

However, sharing the MENA group of countries in two sub-groups: oil and non-oil countries (golf) shows to be very significant for ICT impact on the region growth. IT reveals a high positive specific effect of ICT on growth for the oil-MENA countries (golf) quasi-equal to that of the East and South Asia. A significant Growth Payoff from ICT in MENA countries is then valid only for the oil-MENA countries. It seems that these countries succeed in there investment categories and quality choices and in capturing and forming the needed qualification for human capital the essential backgrounds to benefit from the Information and Communication Technology.

While the magnitude of these growth effects is quite substantial, we should keep in mind that they refer to the long run, and that transition toward an increased level of investment and human capital would demand large government implication. This would likely pose tough policy choices to the authorities, as they would have to reconcile these large investment increases in infrastructure, ICT equipment and education with the maintenance of adequate spending on other growth-enhancing items and keeping in check the overall government dispenses, which in light of our regression results are also significant determinants of long-run growth.

**Appendix 1: Table 1: Regressions of global convergence with MENA and regional specifics**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	1.478*** (5.53)	2.743 *** (2.00 )	3.317 *** (3.31)	--	--	--	--	--
linvest	6.521*** (3.49)	4.545 * (1.94 )	6.223*** (3.54)	9.599*** (4.470)	7.218*** (3.44)	7.343*** (-5.551)	6.742*** (3.32)	6.843*** (3.56)
kh	-0.035 (-0.77)	-0.018 (-0.40)	-0.031 (-0.67)	-0.029 (-0.63)	-0.003 (-0.07)	.056* (-1.05)	-0.046 (-1.14 )	-0.097*** (-2.32)
lpop	-48.360*** -4.10	-31.985*** (-3.49)	-62.171 *** (-6.04)	-56.286*** (-6.01)	-33.662*** (-3.74 )	-52.966*** (-5.70 )	-34.919*** (-4.13)	-41.617*** (-4.25)
lcvov	-7.75267** (-1.96)	-7.454 *** (-1.57)	-13.644*** (-4.08)	-6.327*** (-1.92)	-6.447 *** (-2.10)	-6.966 *** (-2.28)	-6.959 *** (-2.26 )	-7.258** (-2.56)
index	-15.396*** (-5.58)	-11.642*** (-2.93 )	-11.377*** (-3.07)	-15.848*** (-3.66)	-12.044* (-1.62)	-21.984** (-2.84)	-18.816** (-1.96 )	-9.172 (-0.97)
icrg		-0.0240 (-1.32)	-0.024* (-1.79)	0.022*** (7.110)	0.016*** (5.52 )	0.020*** (7.17)	0.017*** (7.18)	0.021*** (7.17)
fuel	0.094 (0.35)	0.066 (0.27)	0.181 (0.72)		0.090 (0.37)			
sopen	-0.206*** (-5.11)		-0.196*** (-4.76)	-0.211*** (-5.19)	-0.166*** (-4.41)	-0.170*** (-4.67)	-0.153*** (-4.73)	-.191*** (-4.68)
xrat	-0.00003*** (-13.53)		-0.000034*** (-10.79)	-0.000026*** (-11.95)	-0.000029*** (-14.63)	-0.000027*** (-11.04)	-0.000029*** -12.78	-0.000029*** -13.43
esa		-0.346 (-1.15)						
ssa		-0.858*** -2.82						
lam		-0.541* (-1.74)						
mena		-0.0828 (-0.30)						
eeca		-0.318 (-1.20)						
indexesa			53.190*** (7.42)	7.199*** (4.48)				
indexssa			-81.288*** (5.09)	-13.355*** (-5.05)				
indexlam			9.593 (0.53)	1.917 (0.43)				
indexmena			-2.988 (-0.31)					
indexeeca			-7.879 (-1.15)	-1.099 (-0.70 )				
indexoecd				-0.940 (-1.60)				
indexgolf				7.125** (2.41)				
indkh					-0.092 (-0.96)	0.028 (0.28)		
indkhesa						0.987*** (4.62 )		
indkhssa						-3.746*** (-5.07)		
indkhlam						1.026** (2.39)		
indkhmena						0.154 (1.44)		
Indkheeca						0.113 (1.10)		
indinv							0.025 (0.06)	-0.518 (-1.21)
indinvesa								1.276 *** (4.75)



## **Appendix 2: Definitions and sources of the variables**

The data are pooled from the world Development Indicators (2006), published by the World Bank and 6.2<sup>3</sup> Summers, Heston and Aten (2006)'s Penn World Table Version dataset for pooled sample of 71 countries from 1992 to 2004.

### ***National aggregates and variables***

linvest	Natural logarithm of the Investment Share of reel the GDP between 1992 and 2004.
xrat	Exchange Rate unit: US=1 in General Variables.
open	Is the total trade (Exports plus Imports) as a percentage of reel GDP. in Constant Prices unit: % in 2000 Constant Prices

### ***Population***

lpop	Natural logarithm of the population, unit: 000s.
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### ***Government Expenditure***

lgov	Natural logarithm of the government Share of reel GDP between 1992 and 2004
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### ***Education***

kh	Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Tertiary education, whether or not to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level.
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### ***Institutional variables***

icrg	Risk Guide risk rating is an overall index, ranging from 0 to 100 (highest risk to lowest), based on 22 components of risk
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### ***Natural resources***

oil	Dummy variable for oil exporters' countries taking 1 for countries whose fuel exports represent 50% or more of the total of exports in 2000, and 0 others.
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<sup>3</sup>Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006.

## ***Information and Communication Technology***

index      The Information and Communication Technology index for 1992-2004 is an average of three component indexes:

- Internet users (per 1,000 people): Internet users are people with access to the worldwide network.
- Personal computers (per 1,000 people): Personal computers are self-contained computers designed to be used by a single individual, per 1,000 people.
- Fixed line and mobile phone subscribers (per 1,000 people): Fixed lines are telephone mainlines connecting a customer's equipment to the public switched telephone network. Mobile phone subscribers refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology that provides access to the public switched telephone network.

See appendix 3 for the calculation method.

### **Appendix 3: The Information and Communication Technology index for 1992-2004**

To calculate the Information and Communication Technology index for 1992-2004 we calculate minimum and maximum values for each of its three components (Internet users (per 1,000 people), Personal computers (per 1,000 people) and Fixed line and mobile phone subscribers (per 1,000 people)). We compute then individual indices for the three components using the following formula:

$$\text{Index } X_i = \frac{\text{Actual } X_i \text{ value} - \text{Minimum } X_i \text{ value}}{\text{Maximum value} - \text{Minimum } X_i \text{ value}}$$

The global index is then calculated as a simple average of the three component indexes: Internet users (per 1,000 people), Personal computers (per 1,000 people) and Fixed line and mobile phone subscribers (per 1,000 people).

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