Impact of Information and Communication Technology on Economic Growth in Selected Islamic Countries

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Abstract

Information and communications technology (ICT) is one of the key factors explaining growth differentials across countries. Investment in ICT contributes to overall capital deepening and therefore helps raise economic growth.

The objective of this study is to explore the impacts of ICT investment on economic growth in a cross section of 48 Islamic countries using the data over the period 1995-2005. Panel data analysis is carried out to examine the factors affecting economic growth. To understand the current state of ICT and macroeconomic situation of 48 Islamic countries, a comprehensive review of pertinent statistics related to ICT and economic growth is examined to find common stylized facts in the economies.

The standard Solow growth model is extended to take into account the technological progress, embodied in the form of ICT investment, and human capital. The model is modified to take the speed of convergence into consideration. Moreover, steady-state income regression and economic growth regression are specified and estimated. Three ICT indexes are used to test the model. They comprise network index, ICT usage index, and ICT Opportunity Index. Three separate models are estimated for the whole sample as well as the two sub-samples distinguished by the level of ICT development indexes.

The findings shows that the main engines of economic growth are ICT capital, non-ICT capital and human capital in a sample of 48 Islamic countries. Inflation has a negative impact on economic growth. While ICT investment has positive and significant effect on economic growth, the marginal products of ICT investment are smaller than the marginal products of investment in non-ICT capital confirming the productivity paradox of ICT. ICT investment has a stronger influence on economic growth in the sub-sample of 24 countries that have relatively a higher ICT Opportunity Index. Moreover, non-ICT investment has positively effect on economic growth. However, neither openness nor population growth seems to have significant impact on economic growth. Finally, the speed of convergence in both sub-samples is about the same.

Keywords: Economic Growth, Information and Communication Technology, Panel Data, Islamic Countries.
JEL Classification: O33, O47, C33, F43

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1. Introduction

Information and communications technology (ICT) is one of the key factors explaining growth differentials across countries. Investment in ICT contributes to overall capital deepening and therefore helps raise economic growth. Rapid technological progress in the production of ICT goods and services may contribute to more rapid growth in the ICT producing sectors. The greater use of ICT may help firms reduce their costs, enhance their productivity and increase their overall efficiency, and thus raise economic growth. Moreover, greater use of ICT may contribute to network effects, such as lower transaction costs, higher productivity of knowledge workers and more rapid innovation, which will improve the overall efficiency of the economy.

The objective of this study is to explore the impacts of ICT investment on economic growth in a cross section of 48 Islamic countries using the data over the period 1995-2005. Panel data analysis is carried out to examine the factors affecting economic growth. To understand the current state of ICT and macroeconomic situation of 48 Islamic countries, a comprehensive review of pertinent statistics related to ICT and economic growth is examined to find common stylized facts in the economies.

The standard Solow growth model is extended to take into account the technological progress, embodied in the form of ICT investment, and human capital. The model is modified to take the speed of convergence into consideration. Moreover, steady-state income regression and economic growth regression are specified to estimate the impact of ICT measures. Three ICT indexes are used to test the model. They comprise network index (ICT infrastructure), ICT usage index, and ICT Opportunity Index. Three separate models are estimated for the whole sample as well as the two sub-samples distinguished by the level of ICT development indexes.

The next section reviews the theory linking ICT to production and economic growth. Section three offers the review of empirical studies of ICT and economic growth. Section four explores stylized facts of Islamic countries. Section five presents empirical specification of the model, data and results and finally, section six concludes.

2. Review of theory

A variety of studies have addressed the issue of economic growth using either cross-country or panel data approach. While most of these studies utilize the standard neo-classical growth model or its extended version that includes human capital, more recent studies focus on endogenous growth models. A key element of the neoclassical growth theory is the assumption that technical change is exogenous and that the same technological opportunities are available across countries. This assumption implies that steady state growth solely depends on exogenous population growth and exogenous technical progress.

Classical economists had been essentially development economists. After the neoclassical revolution, the major contribution to development economics came from

Schumpeter[3]. Following Schumpeter (1942) and Solow (1956), it is well understood how important the technology is in economic growth and development. But it is very difficult to identify and assess its role in empirical terms because it is not directly observable. Most of times, technology is embodied in productive inputs or disembodied as neutral technical progress and shifts in total factor productivity (TFP). In a neo-Schumpeterian endogenous growth model, the fundamental engine of growth is tied to technological progress (see, for example, Grossman and Helpman, 1991; Aghion and Howitt, 1992 and 1998).

The endogenous growth literature has three broad strands: one strand emphasizes research and development (R&D) as a driver of knowledge; a second strand emphasizes the role played by human capital; and a third strand introduced by Schumpeter (1934), highlights 'creative destruction', the way in which new ideas (as embodied in new technologies such as ICT) may supplant existing ideas. Although, on the face of it, the various neoclassical and endogenous theories are quite different, they also share an important commonality. Each strand of the endogenous growth literature is about the incentives to accumulate a factor of production: human capital, knowledge, and new Schumpeterian 'technologies'.

Considering the effects of technology on economic growth, we move to focus on the Information and communication technology (ICT). ICT could affect output and economic growth in the following three basic ways. First, the production of ICT goods and services forms part of the total value added generated in an economy. Second, the use of ICT capital as an input in the production of all goods and services generates economic growth. Finally, ICT can enhance economic growth via the contribution of ICT industries to technological change. Besides their direct contribution to GDP, ICT industries are also an important source of technological progress. But this impact is even harder to assess than the output contribution because industry-level data on the factors of production are needed to estimate the sources of total factor productivity. If the rapid growth of ICT production is based on efficiency and productivity gains in these industries, this contributes to productivity growth at the macroeconomic level as well. The problem, however, is that this impact cannot be directly deduced from the estimation of the production function. The estimation of the impact of ICT investment has been approached in three principal ways in the literature: production function estimation, growth accounting and applied growth theory. The estimation of capital stocks can be avoided by applying growth theory.

The archetype of growth model that has been more frequently considered in empirical growth applications is the Solow (1956) model. The Solow growth model, sometimes called the neoclassical growth model, is the workhorse of research on economic growth, and often the basis of more recent refinements. In the Solow model, the impact of the investment is only transitory and technological change is the only driver of growth which is exogenous.

In this study the standard Solow growth model is extended to take into account the technological progress, embodied in the form of ICT investment, and human capital. Moreover, the model considers more than one type of capital which could be accumulated (Mankiw, Romer and Weil, 1992). In fact as shown in Nonneman and Vanhoudt (1996), the

[3] Schumpeter (1947)

model can be extended to include *m* types of capital. As the interest here lies in the impact of ICT on growth, the number of different types of capital is narrowed down to only three: physical capital, human capital and ICT. Production is assumed to follow a Cobb-Douglas production function:

$$Y = C^{\alpha_c} K^{\alpha_k} H^{\alpha_h} (AN)^{1-\alpha_c-\alpha_k-\alpha_h} \quad \textbf{(1)}$$

where *K*, *C* and *H* represent physical, ICT and human capital, respectively. *N* is labor. As usual, *A* represents technological progress. The difference is that technological change here is assumed to be of the labor augmenting type and that constant returns prevailing in production. The model can be closed by specifying the accumulation of each of the three types of capital stocks—ICT, other physical capital and human capital. The Solow model assumes that a constant fraction of output is invested in each type of capital. If we define $y = \frac{Y}{AN}$, $k = \frac{K}{AN}$, $c = \frac{C}{AN}$, $h = \frac{H}{AN}$ output, physical, ICT and human capital in terms of effective labor, respectively, the following equations of motion for the state variables cloud be identified:

$$\frac{dc(t)}{dt} = s_c y(t) - (\alpha + n + \delta_c) c(t),$$
$$\frac{dk(t)}{dt} = s_k y(t) - (\alpha + n + \delta_k) k(t),$$
$$\frac{dh(t)}{dt} = s_h y(t) - (\alpha + n + \delta_h) h(t) \quad \textbf{(2)}$$

where $\boldsymbol{s_k}$, $\boldsymbol{s_c}$ and $\boldsymbol{s_h}$ are the fractions of income invested in physical ICT and human capital, respectively, and δ's are the rates of their depreciation. The steady-state level of output per labor, i.e. of labor productivity, is positively related to the rates of saving in each type of capital but negatively related to the rates of population growth and depreciation of capital. Labor input is assumed to grow and technology to advance at the exogenous rates of *n* and *a*, respectively. Then, the following assumptions cloud be made

$$A_t = A_0 e^{gt} * A_{C_0} e^{g_c t} \text{ and } L_t = L_0 e^{gt} \quad \textbf{(3)}$$

The first assumption, which distinguishes our model from the common Solow type model, is that overall technological progress is the product of ICT and non ICT technological progress. From an econometric perspective, this makes clear that the hypothesis of no correlation between the observable (proxied by ICT diffusion) and the non-observable part of technological progress is quite weak. Our model has the following implications for steady state dynamics. In the steady state, the log of per-capita output is given by

$$\ln y_j = \alpha_0 + (\frac{\alpha_c}{1-\beta}) \ln s_{cj} + (\frac{\alpha_k}{1-\beta}) \ln s_{kj} + (\frac{\alpha_h}{1-\beta}) \ln s_{hj} - (\frac{\alpha_c + \alpha_k + \alpha_h}{1-\beta}) \ln(\alpha + nj + \delta) + e_j \quad \textbf{(4)}$$

where $\alpha_0 = \ln \mathrm{A}(0) = at, \beta = \alpha_c + \alpha_k + \alpha_h$ and β < 1 by assumption. Here the depreciation rates δ are assumed to be the same for all types of capital.

Notice immediately that, in the steady-state, the growth rate of per capita GDP, obtained time differencing this equation is equal to $\boldsymbol{g_c}$ + $\boldsymbol{g}$. This implies that the initial level of technology has no bearings on the steady state growth rate: as usual in exogenous growth models, the latter is just a function of the exogenous rate of technological improvement.

Alternatively, it might be interesting in computing the value of the growth rate of output per effective worker in a neighborhood of the steady state. From linearization around the steady state, the following expression is obtained:

$$\frac{d \ln y_t}{dt} = \lambda(\ln \overset{*}{y} - \ln y_t) \tag{5}$$

The augmented Solow model predicts that countries reach different steady states determined by factors specified in equation (4). As the convergence to the country-specific steady state is known to be slow, the model can be modified to take the speed of convergence into account by using

$$\ln y_j(t) = (1 - e^{-\lambda t}) \ln y_j + e^{-\lambda t} y_j(0) \tag{6}$$

Where λ=β (α+n+δ) governs the speed of convergence, for an arbitrary initial value y_j.

For a given gap between the initial level and the steady state level of log GDP per effective worker ($\ln \overset{*}{y} - \ln y_0$), the growth rate of output per effective worker (at time *t*) with respect to its initial value, is rising in the value of λ, which hence measures the speed of convergence. In terms of output per effective worker, the relevant estimable equations (after substitution for y_j) is[4]

$$\ln \frac{Y(t)}{L(t)} - \ln \frac{Y(0)}{L(0)} = \theta \ln A(0) + at + \theta(\frac{\alpha_c}{1-\beta}) \ln s_c + \theta(\frac{\alpha_k}{1-\beta}) \ln s_k + \theta(\frac{\alpha_h}{1-\beta}) \ln s_h - \theta(\frac{\alpha_c + \alpha_k + \alpha_h}{1-\beta}) \ln(\alpha + n + \delta) - \theta \ln \frac{Y(0)}{L(0)} \tag{7}$$

where $\theta=(1-e^{-\lambda t})$ with λ=β(α+n+δ) which measures the speed of convergence. Typically, it is assumed that *n* can change by country while g and δ are common (see Mankiw, Romer and Weil,1992 for the details) and where *Y*(0) and *L*(0) denote output and labor in the initial period. This equation predicts that labor productivity grows faster temporarily, i.e. until a higher steady state is reached, in those countries which invest more than the others in ICT capital, other things being equal.

Within the framework here proposed, the rate of change of ICT diffusion is interpreted as part of the technology growth rate (the realized rate), hence affecting positively the steady state growth rate. Empirically, a positive relationship between the rate of change of ICT diffusion and the "steady state" growth rate of per capita GDP is expected.

In this study, we complement these studies with a growth-regression approach in which a Solow-type model is estimated in a neighborhood of the steady state. Three ICT indexes are used as a proxy for the diffusion of ICT. They comprise ICT density index, ICT usage index, and ICT Opportunity Index. The hypothesis that the growth rate of technology can be proxied by three ICT indexes is quite consistent with studies that have documented that TFP in ICT producing sector are among the determinants of the changes in relative prices that have lead to the diffusion of ICT technology. This approach has some interesting implications for convergence analysis. In fact, once controlling for the level and rate of change of technological progress, it is expected that convergence rates increases, hence

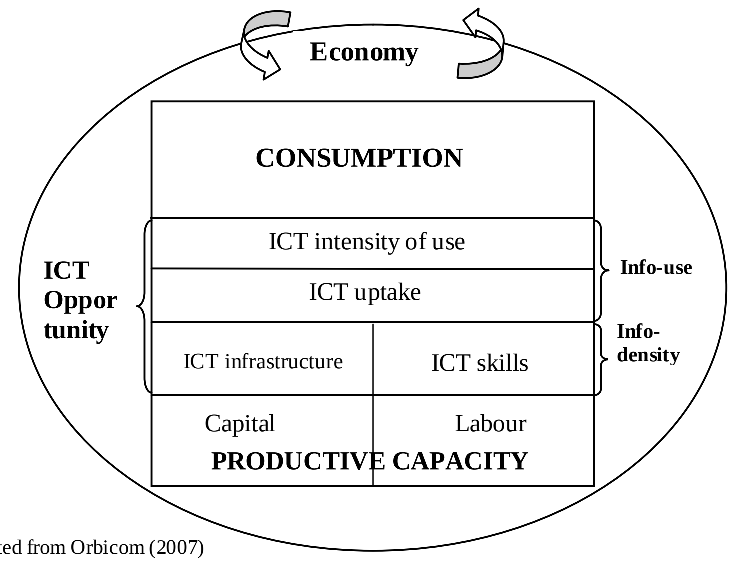
[4] Pohjola M. (2000)

strengthening and reducing at the same time the economic relevance of the Solow-type model as a growth model. In other words, it is expected that our results confirm that, one conditioning on all the appropriate variables, countries are close to their steady state.

A composite index such as the ICT-OI is particularly useful for comparisons over a set period of time and between countries of similar income levels, or with similar social, regional or geographic characteristics; it provides useful insights to policy makers and analysts. It should also be noted that the main objective of the ICT-OI is to track the digital divide and to help particularly developing countries measure their progress or shortcomings (Figure 1).

The conceptual framework of the ICT Opportunity Index has been adopted from Orbicom's Digital Divide Index. The framework, which is closely linked to economic theory, is based on a dual nature of ICT; ICT is a productive asset, as well as a consumable.

Figure 1: The ICT-OI conceptual framework, which is set within the socio-economic, geopolitical and cultural environment of every economy



Source: ITU adapted from Orbicom (2007)

The conceptual framework developed the notions of a country's info-density and info-use. Info-density refers to the slice of a country's overall capital and labor stocks, which are ICT capital and ICT labor stocks indicating the productive capacity. Info-density symbolizes the productive capabilities and capacity of the economy in terms of ICT labor stocks and ICT capital. The quality and the quantity of these two inputs are fundamental factors for growth and for economic development. ICT capital is made up of ICT network infrastructure, as well as ICT networks machinery and equipment. ICT labor is the total stock of ICT skills of an economy's labor force. As for all other (non-ICT) forms of labor and capital, the total output will be an increasing function of these ICT stocks. The extent of network and infrastructure development was captured through penetration rates of fixed telephone lines, mobile cellular subscribers and international internet bandwidth.

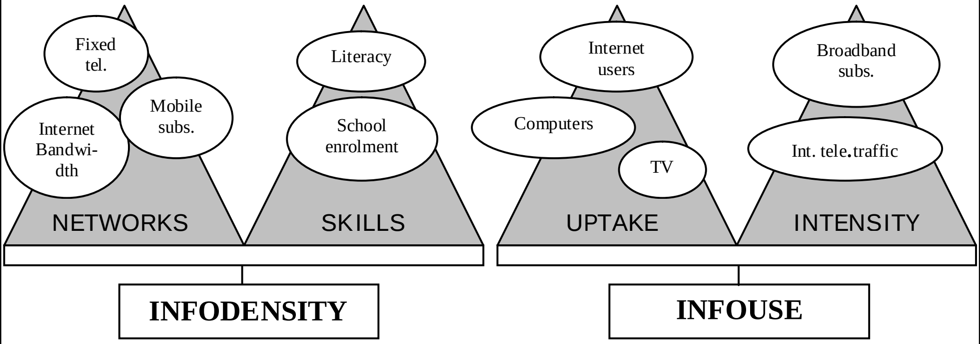
Info-use refers to the consumption flows of ICT. Technically, it is possible to aggregate the two and arrive at the degree of a country's ICT-ization, or info-state. Info-use refers to an economy's ICT consumption (or use) within a given period. Since ICT goods are a necessary prerequisite for the use of ICT services, a distinction is made between ICT uptake and ICT intensity of use.

ICT Opportunities depend on the degree of info-density and info-use. The ICT-OI represents an important contribution to the measurement of the Information Society. The ICT-OI, which was acknowledged by the World Summit on the Information Society (WSIS), is a useful statistical tool to compare ICT developments in different countries and different regions over time.

The prime objective of the ICT Opportunity Index is to identify the digital divide and to help understand how it has evolved in one decade. Apart from cross-country comparisons, the ICT Opportunity Index's methodology is able to highlight relative movements of different ICT-OI groups. It shows how fast the four ICT-OI groups are making progress compared to each other.

ICT-OI is derived from ten indicators, grouped into four sub-indices: the networks index, the skills index, uptake index and the intensity index. These sub indices and the indicators that they are composed of are illustrated in Figure 2.

Figure 2: ICT-OI: sub-indices and indicators



Source: ITU

3. Review of Empirical studies

Now the empirical studies are analyzed. Different measurement approaches have tried to capture the different aspects of ICTs. These measurements have not been comparable for the most part, leading to a lack of clarity on how ICTs should be measured. In an earlier study, Avegrou (1998) argued that there is not much evidence to indicate that ICT has deterministically led to economic growth in most of the developing countries.

Recent empirical studies in the literature discuss the positive impacts of ICT on economic growth of the most developed countries. Lau and Tokutsu (1992) examined the relationship between ICT and economic growth in the US over the period 1960 to 1990 using the production function approach. They found that ICT contributed to nearly half of the national output during the study period. Kraemer and Dedrick (1993) examined the impact of ICT to economic growth in eleven Asia Pacific countries for the period 1983 to 1990. This study found that there was a significant and positive relationship between ICT and economic growth. Another notable study of the role of ICT in economic growth is the World Bank (1998a), World Development Report, which argues strongly for the increasing role of technology in economic development. A cross-country analysis of economic growth is support of the argument (World Bank 1998a). It pools the data from the Penn World Table Mark and the World Development Indicators for 74 countries and the averages of economic variables over three decades. In GDP growth rate regression, it is shown that IT is correlated positively and significantly with GDP growth. The growth regression implies that a country can increase its GDP growth rate by investing in IT. The growth impact can be as large as 4 percentage points for a country that succeeds in raising IT infrastructure.

Jorgenson (2001) found that capital inputs have raised output growth since 1995 by nearly a full percentage point - with ICT accounting for more than half of that increase. In contrast to the contribution of ICT capital deepening to economic growth in the US, evidence supporting TFP growth due to ICT is more opaque, particularly for ICT utilization. In Europe, ICT's contribution to growth has been more sporadic. Schreyer (2000) used data for G7 countries from a private data source (International Data Corporation) on ICT expenditure and computed the contribution to growth of ICT. This estimate reveals that ICT capital contributed some 0.4 percentage point per annum on average to economic growth in the United States over the period 1990-1996, compared to about 0.2 percentage points in Germany, France and Italy over the same period. Colecchia and Schreyer (2002) in their study of the US and OECD countries found that during the second half of the 1990's, the contribution of ICT to economic growth ranged between 0.3 to 0.9 percentage points per year. Jalava and Pohjola (2002) point out that the ICT goods and services typically constitute between 3 and 5 percent of total GDP (at current prices) in OECD countries.

Daveri (2001) covers all EU countries as well as the United States in his study. The author found that contribution of ICT capital to real GDP growth in EU countries varied from 0.3 to 0.6 percentage points in the period 1991-1999, compared to 0.9 percentage point in the United States over the same period. Roeger (2001) presented different scenarios for the contribution of ICT capital to output growth in EU countries. The estimated contributions of ICT to output growth varies from 0.2 to 0.3 percentage point in the years 1992-1994, and from 0.3 to 0.6 percentage point in the period 1995-1999 – with an increase in the contribution in each case between the earlier and the later period.

Dewan and Kraemer (2000) estimate an inter-country Cobb-Douglas function - with GDP as output and ICT capital, non-ICT capital and labor hours as inputs - by pooling annual data from 36 countries over the period 1985-93. Dewan and Kraemer's benchmark estimation results indicate that the returns from ICT capital investments are positive and statistically significant for developed countries, but non-significant for developing countries. For the 22 developed countries in their sample, the output elasticity of ICT capital, non-ICT capital and labor are 0.057, 0.160 and 0.823, respectively. Thus, a ten percent increase in ICT capital stock increases annual output by 0.57 percent. This estimate implies that the marginal social product of ICT capital lies in the range of 50 to 100 per cent if the share of ICT capital in the total capital stock is assumed to be 3-4 percent and if the value of the capital output ratio is between 2 and 3. For the average values of these variables in the authors' sample, the return to ICT capital is 79 percent.

By contrast, Dewan and Kraemer's analysis indicates that in the 16 developing countries included in their sample, non-ICT capital investments are quite productive whereas the evidence on ICT investments is inconclusive. The output elasticity of non-ICT capital is 0.593 but the ICT elasticity is statistically indistinguishable from zero. This finding leads the authors to conclude that a substantive base of capital stock and infrastructure is a prerequisite for ICT investments to be productive.

In some regions such as South Asia, the Middle East and Africa, there are few cross-country findings on ICT's contribution to economic growth. ICT investment levels are too small to measure their impact on economic growth, according to Piatkowski (2002). In East Asia, the ICT sector is growing in importance, particularly in production. However, high levels of ICT production have not resulted in increased use of the technology. Wong (2002) observes that while East Asia has captured a disproportionately high share of global ICT production, it trails behind other regions in ICT adoption.

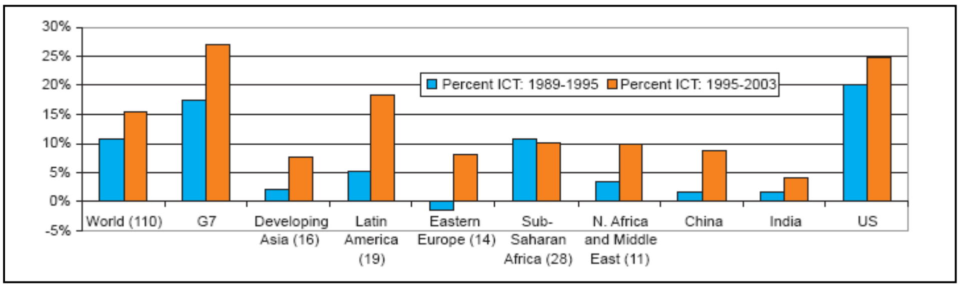
Developing countries spend much less on ICT. So far, however, there have been very little empirical studies for the developing countries in this field. Lee and Khatri (2003) of the International Monetary Fund (IMF) present some findings for selected Asian developing countries in the 1990s, most of which experienced decline in their GDP growth rates between the two halves of the 1990s, except for the Philippines and India, caused mainly by the Asian financial crisis which started in mid 1997. Meng and Li (2002) maintain that the role of the ICT industry in developing countries is far from clear. They reason that it might be due to the fact that developing countries are short of capital investment and knowledge and they thus lag far behind in ICT-industry development and diffusion in comparison to the industrialized nations.

Information on the economic effect of ICTs in developing countries is scarce, although some researches were carried out in transition economies. Piatkowski (2004) analyzes eight transition economies in Central and Easter Europe highlights that ICT had a large contribution to GDP and labor productivity growth in CEE countries. This study shows that the new EU member countries have been successful in using ICTs to increase their income levels relative to the other EU member states. Spillover effects, which are more difficult to measure, have further helped theses countries to catch-up to its western neighbors. However, similar to studies in developing countries, a major conclusion is that ICT will not be productively utilized without changes in the structure, organization and business models of firms and without improvement in ICT skills of the labor force, nor without institutional or regulatory changes.

More recent research has, however, found increasing evidence that there exist positive relationships between ICT investment and various measures of economic performance. Jorgenson (2005), comparing the period 1989-1995 with 1995-2003, uses separate measures of ICT investment, non-ICT investment, and several measures of labor to determine the correlation between changes in ICT investment levels and GDP growth

(Figure 3). According to he results of this study, the group that benefited the most from ICTs was the G7, where almost one third (27 percent) of the GDP growth that occurred from 1995-2003 was due to ICT investment. However, in major developing and transition countries (countries adopting a market orientation), ICT capital played a smaller (although increasing) role. Sub-Saharan Africa shows similar economic impact from ICT capital growth over time – about ten percent – while most other groups showed a greater impact in the later period. Latin America jumped considerably from the first time period to the second.

Figure 3: ICT's contribution to economic growth



Source: ITU adapted from Jorgenson and Vu, 2005

Similar results are highlighted in Vu K. (2005) that confirms ICTs have a significant impact on economic growth. The study, which analyzes 50 major ICT-spending countries, highlights that ICT contribution to economic growth is a global phenomenon, which is evident not only in developed economies but also in developing ones. However, key determinants why ICT contribution to growth varies include educational levels, institutional quality and openness. To estimate the contribution of ICT to economic growth and efficiency going beyond the growth accounting methodology, Thompson and Garbacz (2007) use a stochastic frontier production function approach to determine the impact of communication networks and economic reform on economies below the frontier. They find a positive contribution of information networks to economic growth. Gholami, Guo et al. (2007) use a broad definition of ICT, not separating ICT hardware, ICT software and telecommunication equipment but focus more on the differences of ICT and R&D spillovers between developed and developing countries. Guitat and Drine (2007) used estimates of the stock of ICT capital (hardware, software, and telecommunication equipment) to estimate the direct and indirect contributions of ICT on economic growth in 14 MENA (Middle East and North Africa) countries between 1992 and 2004. They concluded that there is a positive and significant direct impact of ICT on GDP (especially for oil producing countries). The indirect impact through the effect on human capital is less significant. They made comparison with other regions and found that the overall impact of investing in ICT capital on GDP is positive and significant for OECD countries and East Asian countries.

4. Stylized Facts of Islamic Countries

The Organization of the Islamic Conference (OIC) is the second largest inter-governmental organization after the United Nations which has membership of 57 states spread over four continents. The Organization was established upon a decision of the historical summit which took place in Rabat, Kingdom of Morocco on 25 September 1969 The OIC aims to preserve Islamic social and economic values; promote solidarity amongst member states; increase cooperation in social, economic, cultural, scientific, and political areas; uphold international peace and security; and advance education, particularly in the fields of science and technology. The selected countries of this study are 48 members whose data are available.[5]

Generally speaking, world is witnessing ICT opportunity and usage divide. The digital gap between developed and developing countries is huge. Western European countries have achieved very high Info-states, whereas African countries are heavily concentrated at the bottom of the list. Both Info-density and Info-use contribute to the digital divide, with networks and ICT uptake more than other components.

In recent years the digital divide is changing from inequalities in basic availability of ICTs to differences in the quality of the user experience. The implications for the digital divide are clear. Digital opportunity is becoming more sharply divided by region. The digital divide suggests how future divides in wealth may take shape, as ICTs are increasingly determining the ability of individuals, firms and nations to create future wealth. The evidence suggests that sector reform has played a positive role in promoting ICT development and narrowing the digital divide.

Table 1 provides a very useful overview of the evolution of digital opportunities in terms of the different ICT-OI categories for high, upper, medium and low income countries over the world over the period 2001-2005. The table shows that all categories are steadily making progress over the period.

Table 1: The Didital Divide over the World: 2001 - 2005

Group	*(A) ICT-OI*						
	2001	2002	2003	2004	2005	Change	Growth
High	204.3	231.7	262.0	289.0	312.2	107.8	52.8
Upper	120.0	133.6	148.4	165.8	185.4	65.4	54.5
Medium	69.4	76.6	84.1	92.4	101.2	31.8	45.9
Low	24.7	28.4	32.1	35.5	38.2	13.5	54.8
Reference country (average)	**100.00**	**110.52**	**122.51**	**134.62**	**147.56**	**47.6**	**47.6**

Source: ITU (2007)

[5] The countries include Albania, Algeria, Azerbaijan, Bahrain, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Cot dIvoire, Djibouti, Egypt, Gabon, Gambia, Guinea, Guinea-Bissau, Guyana, Indonesia, Iran, Jordan, Kazakhstan, Kuwait, Lebanon, Libya, Malaysia, Mali, Mauritania, Morocco, Mozambique, Niger, Nigeria, Oman, Pakistan, Saudi Arabia, Senegal, Sierra Leone, Sudan, Syria, Tajikistan, Togo, Tunisia, Turkey, Turkmenistan, Uganda, U.A.E, Uzbekistan and Yemen.

The current 57 OIC member countries are dispersed over a large geographical region spread out on four continents, extending from Albania (Europe) in the North to Mozambique (Africa) in the south, and from Guyana (Latin America) in the west to Indonesia (Asia) in the east. As such, the OIC countries as a group account for one sixth of the world area and one fifth of the total world population. The OIC member countries constitute a substantial part of the developing countries, and, being at different levels of economic development, they do not make up a homogenous economic group. As a group, the OIC countries are well-endowed with potential economic resources in different fields and sectors such as agriculture and arable land, energy and mining, human resources, and forming a vast strategic trade region. Yet, this inherent potential does not manifest itself in the form of reasonable levels of economic and human development in many OIC countries and in the OIC countries as a group. This becomes clear when the average economic performance of the group of OIC countries is compared with that of the developing countries where the OIC countries still lag behind the overall performance of the developing countries.

With almost 22 percent of the world total population, the 57 OIC member countries accounted for only 6.8% of the world total output (GDP) and 9.8% of world total merchandise exports, in terms of current US Dollars. Although the average growth rates of both real GDP and per capita GDP recorded the OIC member countries during the last five-year period were higher than those of both the developed countries and the world averages, they were still comparatively lower than those maintained by the group of developing countries.

Out of the world's 50 least-developed countries, 22 are OIC member countries, almost all of which depend, concerning their growth and development, on the exports of a few non-oil primary commodities, mostly agricultural commodities. Moreover, 17 OIC countries are classified as fuel-exporting countries, for which the prospects of growth and the development of their economies are dependant mainly on producing and exporting of only oil and or gas. In such a set-up, the gap between the rich and the poor OIC countries is substantial. In this context, 26 OIC member countries are currently classified by the World Bank (World Bank 2008) as low-income countries and 25 are middle-income countries (18 lower middle-income and 7 upper middle-income). In contrast, only 6 OIC member countries are classified as high-income countries (Table 2). Therefore, the total output (income) and trade of the group of the OIC countries are still heavily concentrated in a few of them; only 10 countries accounted for 74 percent of the total income (GDP) of the OIC countries and 76 percent of their total merchandise exports, both in terms of current US Dollars.

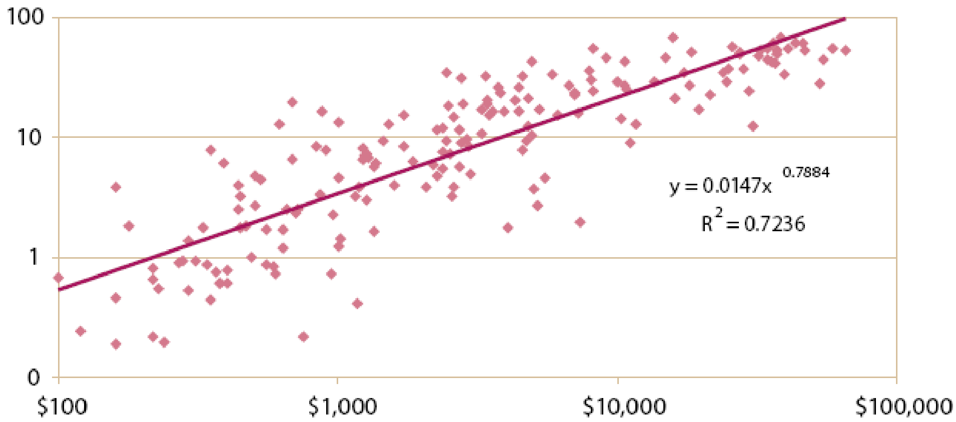
Figure 4 illustrates the close relation between per capita income and Internet usage. While the term 'relation' does not explain the correlation, nor cause or effect of these two factors, it has often been suggested that ICT, or some or all of its components, could expand economic development and accelerate growth in low-income countries. It is also suggested that in addition to any direct or indirect impacts on a country's GDP growth, ICTs could help by increasing information flow leading to more open societies.

Table 2: Real GDP per capita and growth rate of Islamic countries

Country	GDP per capita in 2000	GDP per capita In 2006	GDP Growth over 1995–2000 (avg. annual%)	GDP growth over 2001–06 (Avg. annual%)
High-income	-	36,608	-	2.3
Kuwait	16,790	30,630	1.8	7.3
U.A.E	19,270	26,210	5.1	8.2
Iran	1,670	2,930	3.7	5.6
Low-income	-	649	-	6.5
Niger	170	270	3.4	3.9
Guinea-Bissau	160	190	-2.7	0.4
Latin America Caribbean	-	4,785	-	3.1
Middle East & North Africa	-	2,507	-	4.2
East Asia & Pacific	-	1,856	-	8.6
Sub-Saharan Africa	-	829	-	4.7

Source: WDI (2007)

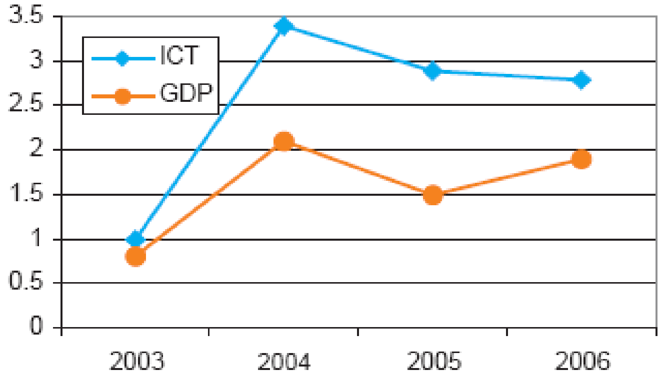
Figure 4: Relationship between internet user penetration and GNI, 2005



Source: ITU (2007)

Other factors influence Internet usage (e.g., literacy, education and age), the ability to pay for ICTs is the most important. Nevertheless, this is particularly true in developing nations, where incomes are lower and more sensitive to pricing and where the impact is much greater, as shown by the non-linear trend in Figure 5. For example, an increase in average annual income from US$ 100 to US$ 1’000 per capita is associated with an increase in Internet user penetration of 2.9 percentage points, whereas an increase in income from US$ 10,000 to US$ 11,000 per capita is associated with an increase in penetration of just 1.6 percentage points.

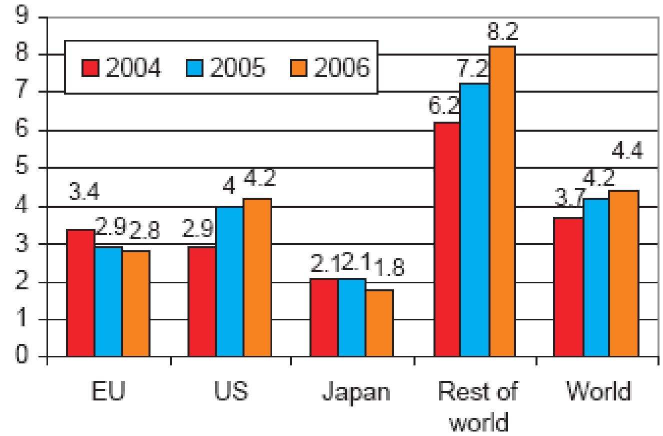
Figure 5: EU ICT and GDP growth: 2003-2006 (%)



Source: EITO (2007)

The European Information Technology Observatory (EITO) publishes data on the overall ICT market. Similar to other sources, EITO data on the ICT market highlight the growing importance of the ICT sector and growth rates that lie well above GDP growth rates. The European Union's ICT market value has steadily risen since 2002; a market value of 614 billion EUR in 2005 represented 5.7 percent of the EU's GDP. EITO data also suggest that ICT growth is particularly important in developing parts of the world since the world's average growth rates lie above those of the (highly developed) regions of Europe, the US and Japan.

Figure 6: ICT market annual growth by region: 2004-2006 (%)



Source: EITO (2007)

ITU in its World Information Society Report (2007) divided economies into four categories, ranging from high to low ICT Opportunities. The division into these categories is based on the results of the latest available data. The basis of the division is the reference country (overall average value) of the index, which lies at ICT-OI value 148 (2007 ICT-OI values range from as low as 12, to as high as 378). The 57 economies which lie above the average were divided into two categories: high and upper, with 29 economies in the high and 28 economies in the upper category. The same was done for all economies that lie below the average: the 126 economies below average were divided into two categories, by an equal number of countries: medium and low. The highest score in the ICT-OI, it was Sweden with 377. Five Islamic countries (Qatar, UAE, Bahrain, Kuwait and Malaysia) are in upper category. Other Islamic countries are in the medium and low categories. In this study Islamic countries based on ICT-OI are divided into two groups based on the ICT-OI development. The first group is those 24 economies with more than 50 points ICT-OI. The Islamic countries with ICT-OI less than 50 points classifies as second group. Table 3 shows that the ICT-OI score among Islamic countries is the highest U.A.E with 190 points. U.A.E rank in the world is 41.

Table 3: ICT opportunity Index in Islamic countries

Country	Rank	2001	2005	Avg. annual growth (%)
U.A.E	41	133.57	190.99	42.99
Bahrain	44	130.72	182.4	39.53
Kuwait	54	106.27	153.88	44.8
Malaysia	57	107.61	150.19	39.57
Global average	**---**	**100**	**147.56**	**---**
Iran	98	62.25	89.74	44.16
Burkina Faso	176	14.52	19.69	35.62
Niger	181	7.9	14.75	86.75
Chad	182	11.3	13.82	22.33

Source: ITU (2007)

Use of the Internet continues to grow, with the estimated number of Internet users exceeding one billion worldwide at the end of 2006 and an estimated 113 million websites. Internet user penetration rates remain relatively low (at an average of four percent in 2005) for countries with low ICT-OI levels, compared to close to 30 and over 55 percent for the upper and high categories. Despite the differences, penetration rates are increasing across all categories. Some specialists believe that Internet user penetration in the developed countries approaches saturation level and, therefore, demand for new Internet access will be stabilized in the near future. This suggests that most of the growth is expected to be realized in the developing countries. Internet users in OIC countries amounted to approximately 42.8 million in 2004. A high growth in the number of Internet users, OIC countries still account for only 4.5 percent of users worldwide.

Furthermore, a more indicative statistic in this regard is the Internet user penetration rate, which is measured as the number of Internet users as a percentage of the total population. In 2006, the number of Internet users was the highest in Malaysia with 42.2% and U.A.E with 31.1%. In some OIC countries, the figure is very low. Internet user penetration in just five Islamic countries is upper than global average. Low levels of Internet user penetration rate in the OIC countries, as compared to those of global average, indicate the urgent need for developing the basic ICT infrastructure and activating Internet access in order to promote e-commerce in such countries. Fixed telephone lines and appropriate terminals to access the Internet constitute the essential part of the ICT physical infrastructure. PCs are the most common terminals used and, together with the main telephone lines, play a significant role in providing access to the Internet. Fixed telephone lines just in five Islamic countries is more than global average. The rapidly increasing number of Internet users in a country implies that there is a continuous demand for Internet services and that the Internet users are, in general, satisfied with the services provided by the ISPs in that market.

It is not a surprise that those OIC countries with higher GDP per capita, such as U.A.E. and Malaysia have, at the same time, higher rates of Internet user penetration. On the other side, the OIC countries with lower levels of per capita GDP have considerably lower levels of Internet user penetration.

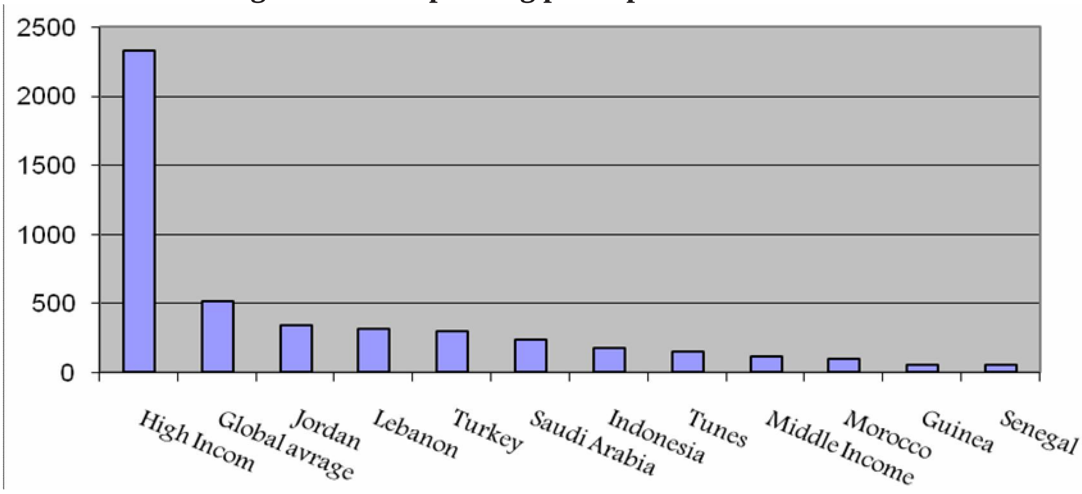
Table 4: sub-categories of ICT in the OIC countries

Country	Mainlines	Cell phones	Internet Users	PCs	TVs(% of households)	Bandwidth
Malaysia	16.8	75.2	42.4	21.5	95.2	12.3
U.A.E	27.5	100.9	31.1	23.4	85.9	93.1
GLOBAL average	19.6	45.4	18.2	16	65.5	133.2
Asia	17.2	40.9	15.3	17.2	71.7	75.3
Iran	27.3	10.4	10.1	12.5	76.6	1.4
Niger	0.2	2.1	0.2	0.1	5.4	0.2
Tajikistan	4.1	4.1	0.1	5.2	79.5	0

Source: ITU (2007)

Except in few of OIC countries, ICT spending is considerably low or even non-existent in. According to ITU database, in all OIC countries, ICT spending is less than global average. Thus, another emerging challenge for OIC countries is to increase allocations for ICT spending. The level of ICT spending is compared among Jordan, Lebanon, Turkey, Saudi Arabia and Malaysia and Turkey to determine their overall prospects.

Figure 7: ICT spending per capita in selected OIC



Source: ITU (2005)

This overview suggests that while the digital divide keeps shrinking, the world continues cloud be separated by major differences and disparities in terms of ICT levels. High growth rates in some areas, and particularly the mobile sector, are not sufficient to bring digital opportunities to all and many developing countries risk is falling behind, particularly in terms of Internet access and newer technologies such as 3G and broadband.

5. Empirical Analysis

After this brief survey of the recent literature on the impact of ICT in economic growth and the review of stylized facts of Islamic countries, let us develop an empirical analysis of formulations of technical change of the impact of ICT on economic growth. Equation (8) can be estimated, for a cross-section of countries if data are available on the rates of investment in each type of capital. We use inflation and openness to trade as environmental variables.

$$\ln y_j - \ln y_0 = \theta \ln A(0) + at + \theta(\frac{\alpha_c}{1-\beta})\ln s_{cj} + \theta(\frac{\alpha_k}{1-\beta})\ln s_{kj} + \theta(\frac{\alpha_h}{1-\beta})\ln s_{hj} - \theta(\frac{\alpha_c+\alpha_k+\alpha_h}{1-\beta})\ln(\alpha + nj + \delta) - \theta \ln y_0 + \alpha_4 \log(openess) + \alpha_5 \inf lation + e_j \quad \textbf{(8)}$$

After specifying the model, the variables and the sources of the data are introduced. The dependent variable is the change in the real GDP per capita from the year 1995 to 2005, measured in purchasing power parities, 2000 international dollars. DGP and investment in physical capital is measured by the average of annual real investment shares of GDP are collected from the latest version of the World Bank's (2007) World Development Indicators database. Human capital is approximated by the human capital index of Human Development Indicators (2007).

Inflation is measured by the annual growth rate of the GDP implicit deflator defined as the ratio of GDP in current local currency to GDP in constant local currency. Openness is measured as the sum of exports and imports of goods and services as a share of GDP. *n* compounds annual population growth rate. Source of info-density index, info-use index, and ICT Opportunity Index is ITU World Telecommunication Indicators. Similar to Mankiw, Romer and Weil (1992), it is assumed that the sum of the depreciation rate and labor-augmenting technological change, $\alpha+\delta$, is set equal to 0.05 in estimating equations for all countries.

For analytical purposes and based on the stylized facts findings, the 48 economies covered by the empirical application are divided into two categories to have two different homogenous samples. The division into these categories is based on the latest available data (2005) observed. The basis of the division is the reference country (overall average value) of the index, which lies at ICT-OI value 148 (2007 ICT-OI values range from as low as 14, to as high as 191). The 24 economies lie above the average categorized as group one and the 24 economies lie below the average called as group two. Three separate models are estimated for the whole sample as well as the two sub-samples distinguished by the level of ICT development indexes. The availability of the data are constrained us to use the data only for the period 1995-2005.

Now the empirical models are estimated and analyzed for both steady state income regression and growth regression using the data for the whole and two sub samples. Panel data analysis is carried out to examine the factors affecting economic growth. By pooling of these cross-section data for ten years, the panel data is generated. The method used for the estimation is the fixed effect panel (FEM). A choice between log linear Pooled Regression Model (PRM) and FEM, based on the F-test, shows that the FEM is empirically preferred to the PRM. The Hausman's test for a choice between the log linear FEM and Random Effects Model (REM) is in the favor of FEM. Considering the results of the above tests, the log linear FEM is empirically preferred to remaining estimated models.[6]

Let us start the review of the empirical findings with an application of the production function approach. Steady-state income regression and economic growth regression are estimated for the whole sample as well as the two sub-samples distinguished by the level of ICT-OI index. The results of all estimated models confirm that the effects of non-ICT capital are higher than the impacts of ICT capita on GDP.

Table 5 shows the results of steady state income regression estimation for the whole sample of Islamic countries. Results from Fixed Effects Panel Data estimation show that both ICT density and ICT Usage and also ICT Opportunity have a significant (at 99% confidence levels) and positive effect on GDP growth and the estimated coefficients are 0.031, 0.051 and 0.05, respectively. The total contribution is obtained as the sum of the impacts of density and usage of ICT. The regression results imply that the ICT contributed up to 0.8 percentage points per year to GDP. It means that one percent increase in ICT investment contributes to 0.8 percent of GDP in the Islamic countries.

[6] The details of the following models' criteria (i.e. F-test, Lagrange Multiplier test, and the Hausman test) are given in Chapter 14, Green (1997).

Table 5: steady state income regression results for the whole sample of 48 Islamic countries

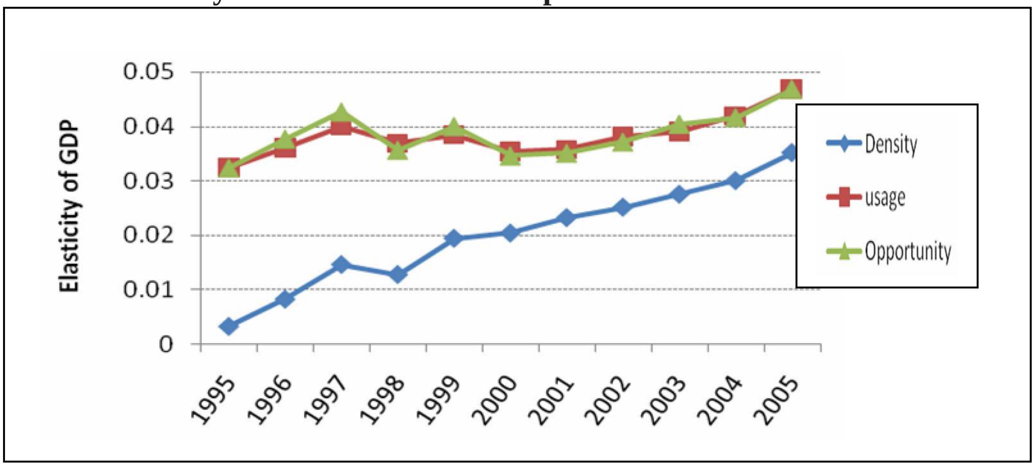
Variable	ln *y*					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	6.58***	6.22***	6.89 ***	6.40***	6.67***	6.30***
Physical capital	0.16***	0.17***	0.11***	0.10***	0.15***	0.15***
ICT infrastructure	0.031***	0.027***	-	-	-	-
ICT-use	-	-	0.051***	0.044***	-	-
ICT opportunity	-	-	--	–	0.05***	0.044***
Human capital	0.11	0.08	0.11	0.09	0.10	0.08
Population	0.20	0.18	0.17	0.16	0.16	0.15
Inflation	-	-0.0002**	-	-0.001***	-	-0.0003***
openness	-	0.08**	-	0.13**	-	0.09**
$\bar{R}^2$	0.99	0.99	0.99	0.99	0.99	0.99
F-test	131.1	133.6	173.5	193.5	165.4	171.5
H-test	150.4	148.1	198.6	192.2	181.9	180.6

Notes:

- Panel regressions is used with fixed effects and the data employed to estimate the models cover the period from 1995 to 2005 (48 counties and 370 observations).
- * means significant at 10 per cent, ** at 5 percent and *** at 1 per cent level.

It is also found that the proxy for human capital and population rate have positive but insignificant impact on GDP. Openness has positive and meaningful effect. Figure 8 shows that the effects of density, usage and opportunity of ICT increase over the period of 1995-2005. It also shows that elasticity of GDP with respect to ICT usage is more than elasticity with respect to ICT density. ICT's total contribution is rather low, in the initial years but picked up in the following years.

Figure 8: elasticity of GDP with respect to ICT usage, density and opportunity in the steady state for the whole sample of 48 Islamic countries



The elasticity of GDP with respect to ICT usage, density and opportunity are computed for the whole sample countries in the growth state. Table 6 contains growth regression results for the whole sample of 48 Islamic countries over the period 1995-2005. The results show that ICT have positive impact on GDP growth and it is statistically significant. This Table presents the results from growth regression of this model. This table reports GDP elasticity derived from the estimated equations. The implied elasticity of GDP with respect to physical capital is around 0.18, whereas the elasticity with respect to ICT capital is about 0.06. Human capital is found to have a positive impact on GDP growth. However, the impact is not statistically significant at the standard level. Openness impact is positive and significant at the 5 percent level.

Notice also that the rate of convergence implied by the results is about 0.04. This rate of convergence should be interpreted as an average rate of convergence for the various countries. A comparison of panel data estimation results from growth estimation and steady state forms suggest that the effect of physical capital and ICT capital are almost equal.

Table 6: growth regression results for the whole sample of 48 Islamic countries

Variable	$\ln y - \ln y_0$					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-1.40***	-1.70***	-1.15***	-1.67***	-1.30***	-1.65***
Physical capital	0.18***	0.18***	0.11***	0.11***	0.15***	***0.15
ICT infrastructure	0.036***	0.030***	-	-	-	-
ICT-use	-	-	0.06***	0.048***	-	-
ICT opportunity	-	-	-	-	0.058***	0.049***
Human capital	0.01	0.02	-0.01	-0.01	0.001	0.007
Population	0.24	0.23	0.21*	0.20	0.20	0.20
Initial value	-0.30***	-0.31***	-0.26***	-0.27***	-0.26***	-0.27***
λ	0.04	0.04	0.03	0.04	0.03	0.04
Inflation	-	-0.0006**	-	-0.0006***	-	-0.0002
openness	-	0.07*	-	0.14*	-	0.09**
$\bar{R}^2$	0.80	0.82	0.86	0.88	0.86	0.87
F-test	24.8	25.5	32.2	37.4	35.5	37.9
H-test	162.2	188.7	100.3	127.8	87.2	104

Notes:

- Panel regressions is used with fixed effects and the data employed to estimate the models cover the period from 1995 to 2005 (48 counties and 365 observations).
- * means significant at 10 per cent, ** at 5 percent and *** at 1 per cent level.

Now we proceed to analyze the results of the first sub sample countries as shown in Table 7. Physical capital seems to matter, but human capital is not statistically significant. All the estimated coefficients, except the coefficient of human capital, have predicted signs and are statistically significant at the standard level. The magnitude of the estimated coefficient of physical capital is higher than the other estimated coefficients in both sub samples countries.

Table 7: steady state income regression results for the first sub sample countries

Variable	ln *y*					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	6.67^{***}	6.46^{***}	7.11^{***}	6.97^{***}	6.87^{***}	6.68^{***}
Physical capital	0.26^{***}	0.25^{***}	0.19^{***}	0.18^{***}	0.22^{***}	0.19^{***}
ICT infrastructure	0.036^{***}	0.031^{***}	-	-	-	-
ICT-use	-	-	0.05^{***}	0.045^{***}	-	-
ICT opportunity	-	-	-	-	0.055^{***}	0.049^{***}
Human capital	0.43	0.40	0.42	0.39	$^{*}0.35$	$^{*}0.34$
Population	0.16	0.14^{*}	0.15^{*}	0.14^{*}	0.17^{*}	0.16^{*}
Inflation	-	-0.0003^{***}	-	-0.0008^{**}	-	-0.001^{**}
openness	-	0.07^{**}	-	0.06	-	0.09^{*}
$\bar{R}^2$	0.99	0.99	0.99	0.99	0.99	0.99
F-test	147.2	148.1	198	202.4	197.2	207.1
H-test	32.5	30.7	43.6	41.8	40.8	40.1

Notes:

- Panel regressions is used with fixed effects and the data employed to estimate the models cover the period from 1995 to 2005 (24 counties and 180 observations).
- * means significant at 10 per cent, ** at 5 percent and *** at 1 per cent level.

Figure 9 shows the effects of density, usage and opportunity of ICT increase in the steady state for the first sub sample countries over the period of 1995-2005. The lesson is that the output contributions from ICT use have in general increases over time.

Figure 9: elasticity of GDP with respect to ICT usage, density and opportunity in the steady state for the first sub sample countries

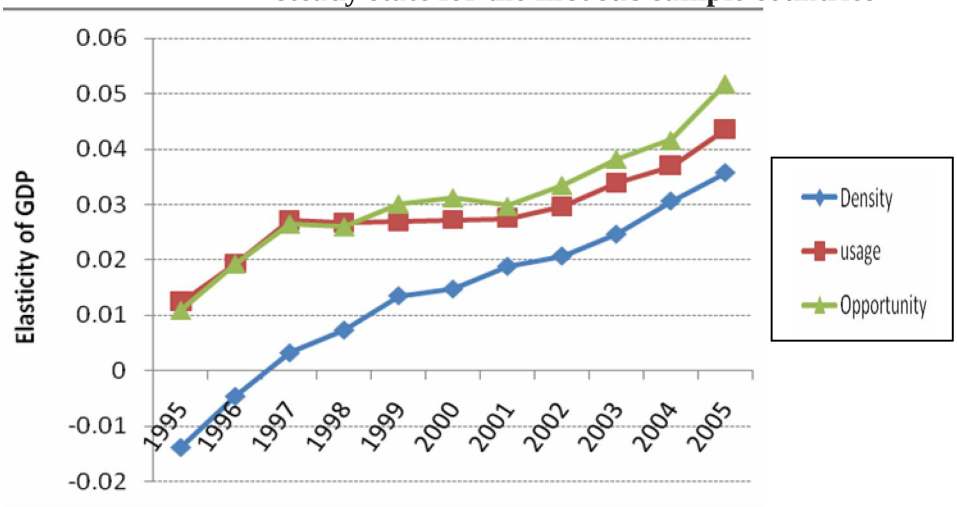


Table 8 summarizes the findings of growth regression results for the first sub sample countries. The elasticity of ICT indexes on GDP is in the range of 0.03 to 0.07.

Table 8: growth regression results for the first sub sample countries

Variable	$\ln y - \ln y_0$					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-2.11***	-2.42***	-1.72***	-1.95***	-1.88***	-2.14***
Physical capital	0.29***	0.28***	0.23***	0.20***	0.23***	0.20***
ICT infrastructure	0.037***	0.029***	-	-	-	-
ICT-use	-	-	0.058**	0.048**	-	-
ICT opportunity	-	-	-	-	0.066***	0.057***
Human capital	0.02	0.01	-0.01	-0.01	-0.03	-0.02
Population	0.15*	0.13*	0.08	0.05	0.14*	0.13*
Initial value	-0.47***	-0.47***	-0.45***	-0.44***	-0.39***	-0.38***
λ	0.06	0.06	0.06	0.06	0.05	0.05
Inflation	-	-0.0008***	-	-0.0008**	-	-0.001**
openness	-	0.11**	-	0.10**	-	0.11**
$\bar{R}^2$	0.89	0.89	0.91	0.92	0.92	0.93
F-test	38.3	39.4	44.7	47.5	47.7	45.3
H-test	235	247.9	110.9	97.4	106.6	112.4

Notes:

- Panel regressions is used with fixed effects and the data employed to estimate the models cover the period from 1995 to 2005 (24 counties and 175 observations).
- * means significant at 10 per cent, ** at 5 percent and *** at 1 per cent level.

The estimated results presented in Table 9 show that in addition of physical capital, the impact of ICT capital on the GDP growth is positive and significant.

Table 9: Steady state income regression results for the second sample countries

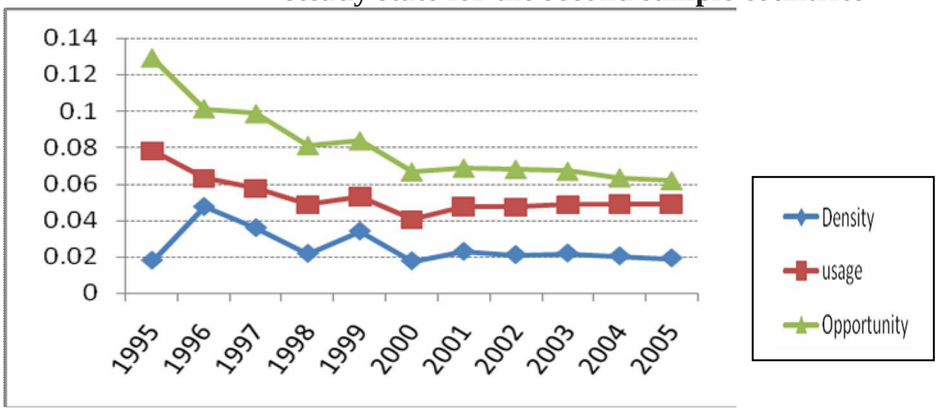
Variable	$\ln y$					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	6.98***	6.63***	6.64***	5.83***	6.56***	6.14***
Physical capital	0.11***	0.12***	0.08***	0.07***	0.12***	0.12***
ICT infrastructure	0.021***	0.021***	-	-	-	-
ICT-use	-	-	0.046***	0.042***	-	-
ICT opportunity	-	-	-	-	0.039***	0.037***
Human capital	0.07	0.06	0.09	0.07	0.08	0.05
Population	-0.12	-0.09	0.07	0.16	0.02	0.03
Inflation	-	-0.0002	-	-0.0008	-	0.0008
openness	-	0.05	-	0.16**	-	0.09*
$\bar{R}^2$	0.96	0.96	0.97	0.97	0.96	0.96
F-test	122.2	109	111.4	126.4	107.4	108
H-test	10.4	40.7	23.3	33.2	13.1	37

Notes:

- Panel regressions is used with fixed effects and the data employed to estimate the models cover the period from 1995 to 2005 (24 counties and 191 observations).
- * means significant at 10 per cent, ** at 5 percent and *** at 1 per cent level.

Figure 10 shows the effects of density, usage and opportunity of ICT decreases in the steady state for the second sub sample countries over the period of 1995-2005. The lesson is that the output contributions from ICT use have in general declines over time.

Figure 10: elasticity of GDP with respect to ICT usage, density and opportunity in steady state for the second sample countries



The results for growth regression results of the second sample countries are summarized in Table 10. The elasticity of ICT and physical capital on GDP growth is positive.

Table 10: growth regression results for the second sample countries

Variable	$\ln y - \ln y_0$					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-0.53^{***}	-0.82^{***}	-1.09^{***}	-1.97^{***}	-0.96^{***}	-1.38^{***}
Physical capital	0.10^{***}	0.11^{***}	0.07^{***}	0.06^{***}	0.11^{***}	0.12^{***}
ICT infrastructure	0.032^{***}	0.03^{***}	-	-	-	-
ICT-use	-	-	0.068^{***}	0.058^{***}	-	-
ICT opportunity	-	-	-	-	0.057^{***}	0.050^{***}
Human capital	0.05	0.07	0.02	0.01	0.06	0.04
Population	0.09	0.14	0.36	0.05	0.22	0.26^{*}
Initial value	-0.22^{***}	-0.24^{***}	-0.23^{***}	-0.24^{***}	-0.26^{***}	-0.27^{***}
λ	0.03	0.03	0.03	0.03	0.03	0.03
Inflation	-	-0.0005	-	-0.0003	-	0.0001
openness	-	0.03	-	0.18	-	0.07^{**}
$\bar{R}^2$	0.76	0.78	0.81	0.85	0.80	0.81
F-test	18.9	17.3	27.3	31.2	25.5	24.8
H-test	11.1	16.4	31.9	53.5	16.6	22.5

Notes:

- Panel regressions is used with fixed effects and the data employed to estimate the models cover the period from 1995 to 2005 (24 counties and 189 observations).
- * means significant at 10 per cent, ** at 5 percent and *** at 1 per cent level.

6. Conclusion

The objective of this study was to examine the relationship between ICT investment and economic growth in 48 selected members of OIC. A number of measurement approaches have been used for measuring ICTs at country level. Methodological challenges, including distinct classifications of the different ICT sub-sectors, make national analysis and international comparisons, particularly for developing countries, very difficult. To best of our knowledge, no prior work has attempted to achieve ICT impact on economic growth of OIC. Based on the results of literature review and the analysis of common stylized facts in the economies, the standard Solow growth model is extended to take into account the technological progress, embodied in the form of ICT investment. Much of the current effort to measure the impact of ICTs on economic growth is based on the production function estimation. The steady-state income regression and economic growth regression using panel data specifications are defined and estimated.

To effectively measure impacts of ICT on economic growth, it is necessary to measure not only access to, but also, use of ICTs. Within the limitation presented by absence of a comprehensive database, three ICT indexes (density or infrastructure of ICT index, ICT usage index, and ICT Opportunity Index) were used as proxy of ICT investment to test the hypotheses. The empirical analysis was conducted for the whole sample as well as the two sub-samples distinguished by the level of ICT development indexes over the period of 1995-2005.

The study finding is in line with earlier empirical works which suggested significant returns to ICT (proxied by the ICT-OI) in terms of economic growth. The empirical results ascertain that ICT has become an important contributor to the growth of OIC economy. The sum of elasticity of density and usage ICT for the wholes sample countries is less than 0.09 and elasticity of GDP to ICT-OI is 0.06. The empirical results suggest a significant growth effect from the accumulation of physical capital and a rapid speed of convergence to the steady state growth path of output. The conclusions concerning the strong growth impacts of physical capital and the weak influence of human capital confirm the findings of many previous cross-country analyses including Delong and Summers (1991); Levine and Renelt (1992); Benhabib and Spiegel (1994) and Hamilton and Monteagudo (1998).

The insufficient technological base of ICT in some OIC member countries requires taking initiatives to strengthen it. To this end, an efficient ICT infrastructure needs to be developed to provide open access to international and national network. If ISPs upgrade their current networks, they will be able to meet an increasing demand from Internet users. In this respect, the use of technological advancements will help the available infrastructure in a country to improve maximum connection speed provided by ISPs.

Measures to attract more investments in ICT and related fields will provide an environment for encouraging the wider use of the Internet. Increasing the level of education in ICT and related sectors will ensure a larger percentage of the population in the members of OIC to use the Internet and benefit from ICT. In this respect, providing new facilities will help promote ICT training and computer-aided training at all levels of education, starting from the primary level.

Implementing standards related to e-Commerce and the use of ICT is a major challenge for those OIC members that have not yet been able to promote sufficient confidence in ICT usage. The paper proposes the following recommendations to serve as policy guidelines on which attention of the Islamic countries needs to be focused:

- More attention should be given in Islamic countries to the availability of information and to its even distribution.
- Giving high priority to science and technology, it is recommended that the countries particularly increase the use of ICT in formulating the national educational plans and programs.
- To strengthen national institutions in operating in the area of ICT, the countries should enhance and build up their capacities and capabilities to facilitate developing the national science and technology based on the development of R&D.
- To ensure and secure appropriate financial resources financing investment in ICT-related infrastructures, the governments should develop financial markets to create new capacities and facilities in this field.
- It is recommended that the members cooperate in technological activities and development programs to promote, expand and develop ICT.

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