INFORMATION TECHNOLOGY AND PRODUCTIVITY GROWTH IN ISLAMIC COUNTRIES

Authors[1]*:*

Mostafa SALIMIFAR, Mehdi BEHNAME

Abstract: *The aim of this research is the study of information and communication technology effects on productivity in Islamic countries. We have applied a balanced panel data model. Hausman (1978) test shows that we should apply fixed effects model. We have estimated our model for Islamic countries for the period of 1990-2010. The results show that gross domestic product, openness, human capital, capital formation, labor force and information and communication technology have positive impact on productivity. Therefore, these countries can increase their productivity with augmentation of expenditures on ICT.*

Keywords*: Islamic countries; Information and Communication Technology; Productivity; Panel Data*

JEL Classification*: D24, L63*

1. Introduction

Labour productivity is a factor for material wellbeing, because lead to sustainable income and consumption growth (Jorgenson and Stiron, (2000)). There is an idea that ICT is a determinant of productivity. But certain of clairvoyants believe in that ICT is a technological revolution that in short run, as long as we apply new equipments, has a negative impact on labour productivity.

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[1]Mostafa Salimifar, Professor in Economics, Head of Economics Faculty of Ferdowsi University of Mashhad (FUM), Mashhad, Iran, Email: mostafa@um.ac.ir.; Mehdi Behname, Department of Economics of Ferdowsi University of Mashhad (FUM), Mashhad, Iran, Email: mehdi_behname@yahoo.com.

The difference between productivity level in American and European countries in 1990s lead to economists and policy makers that study the different of ICT effects on productivity in these regions. In this line, in decades 1990s, the most of developing countries have increased their expenditures on information and communication technology, even certain developing countries have augmented their ICT expenditures more than developed countries. Nonetheless, recent studies show that ICT expenditures in developing countries have a different impact on labour productivity. Therefore, this is expected suitable that we study ICT effects on labour productivity for Islamic selected countries. The purpose of this article is studying ICT expenditures on labour productivity in Islamic selected countries.

We can study ICT effects on labour productivity in two stages: macroeconomics and microeconomics (Van Ark et al., (2003) and Jorgenson, (2001)).

Schreyer et al. (2003), Colecchia and Schreyer (2002) have had a macroeconomics view in this subject. Their studies, in OECD countries, reveal that investment in ICT lead to economic growth. But Van Ark (2002), Pilat et al (2002) and Inklaar et al (2003) have studied the relationship between ICT and productivity in microeconomics view. The recent studies show that increasing in ICT expenditure augment productivity growth and multifactor productivity in certain OECD countries. In this paper we study ICT effects on labour productivity in macroeconomics level.

With studying the data in microeconomics level, we can understand that why ICT expenditures have not impact on labour productivity in certain regions. The factors that lead to decreasing this effect including: organisation factors and competitive effects after ICT extend for example new firms entry, bankruptcy of existing firms and variations in market share. But in this paper, we survey the ICT effect on productivity in macroeconomics level.

Greenwood and Yorukoglu (1997) and Martinez et al. (2008) by a case study from Spain have revealed that a rapid growth in ICT expenditures don't support very well output growth. But, on the contrary, Baldwin et al. (2004) by a case study for UK show that ICT effects on labour productivity and economic growth is positive and significant. In this way, Crepon and Heekel (2002) have studied ICT effects on value added growth for France in period 1987-1998. Results from this study indicate that investment in ICT lead to increase in value added in France.

In the following sections, we study: 2) theoretical basis that show ICT expenditure effects in labour capital and physical capital on labour productivity; 3) methodology that explain data, method and econometric model; 4) results from specification of our model; 5) conclusion.

2. Theoretical basis

There are variations of productivity that come from technique changes and is not the result of increasing of capital and labour, then in the recent years, other variable was studied for these variations. This is information and communication technology. Capital stock in ICT and labour stock in ICT lead to accumulation of information that this accumulation in itself increases output. Capital stock in ICT including network infrastructures and ICT equipments and labour stock in ICT including skill of labour power in ICT, not labour hours.

Before of 1980s, technology and knowledge have been considered as an exogenous variable in the growth models. But, in the mid decade 1980, Romer studied the relationship between economic growth and knowledge in endogenous form. Endogenous growth pattern consider technology effect in production function via the variables such as human capital and improvement of production quality Sala-i-Martin (2001). Quah (2002, 2003) has shown endogenous growth model as following:

$$Y = A(t)F(K_{ict}, K_0(t), L(t), H(t))$$

where Y = output,

K_{ict} = ICT capital services,

K_0 = other capital services,

L = labour power services,

H = human capital stock, and

A= technology level

For studying ICT effects on labour productivity we divide both side of equation on $L(t)$, then $\frac{Y(t)}{L(t)}$. Labour productivity will increase by addition of capital services in ICT per unit of labour power. ICT is a capital that influences output and productivity in tow ways. In the one hand, it considers such as production technology Dedrick et al (2003), and on the other hand, ICT such as knowledge augment returns to increasing scale. Knowledge produced by ICT spread easily between firms, industries and countries. This act directly and indirectly lead to capital deepening (increasing in capital services in unit of time), improvement of technique, labour quality, increasing in value added and productivity in different economic sectors (Rincon and Vecchi (2004)).

Atkinson and Mckay (2007) believe that ICT influence productivity in three ways: network foreign effects, improvement of complements and improvement of knowledge accessibility. The effects of these factors accompany with temporal lag therefore, it may be in some of model certain variable coefficients become negative (Stiroh (2002)).

Methodology and data

Following Seo and Lee (2006) we apply the below model for the study of effective factors on productivity. In this model macroeconomic variables have been used.

$$TFP_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 OPE_{it} + \beta_3 ICT_{it} + \beta_4 LAB_{it} + \beta_5 CAP_{it} + \varepsilon_{it}$$

where TFP stands for productivity and it is the dependent variable. Following Levinsohn and Petrin (2003), a separate intermediate input is used as a proxy variable for productivity. We take communications as our proxy for the unobserved productivity. GDP is gross domestic product per capita (constant 2000 US$). This variable has positive effect on productivity. OPE is openness $\frac{M+X}{GDP}$. M is import and X is export. ICT is ICT expenditures divided on GDP. Information and communications technology expenditures include computer hardware (computers, storage devices, printers, and other peripherals); computer software (operating systems, programming tools, utilities, applications, and internal software development); computer services (information technology consulting, computer and network systems integration, Web hosting, data processing services, and other services); and communications services (voice and data communications services) and wired and wireless communications equipment. LAB stands for labor force. Total labor force comprises people who meet the International Labour Organization definition: all people who supply labor for the production of goods and services during a specified period and they are employed. HUM stands for human capital, this is secondary education teachers. Secondary education teachers include full-time and part-time teachers. CAP is capital formation. *i* stands for the countries and t for time and ε is error term. The sources of variables are UNdata, WDI, and World Bank. The countries are: Iran, Malaysia, United Arab Emirates, Pakistan, Saudi Arabia, Qatar, and Turkey on the period of 1990-2010. Our sample was limited because of the lack of data for some countries.

Results

We have applied Hausman (1978) test for the determination of fixed effects or random effects model. The Hausman test calculated is $\chi^2 = 2.45[0.01]$ and shows that we should apply fixed effects model. We show the results of benchmark model in table 1.

In the first column we have estimated our model with three variables. These variables are GDP, OPE and ICT. GDP have positive effect on productivity because GDP itself is a part of productivity calculation then rising in output increases productivity. Because, the variables are on logarithm 1% rising in GDP augments 0.12% productivity. Casolaro and Gobbi (2007) show GNP has positive effect on productivity in Italia. In this column OPE hasn't any effect on productivity. But, Miller and Upadhyay, (2002) show that this variable has positive effect on productivity. ICT has positive and significant effect on productivity. ICT is a capital that influences output and productivity in tow ways. In the one hand, it considers such as production technology Dedrick et al (2003), and on the other hand, ICT such as knowledge augment returns to increasing scale. Marinez, et al (2009) show ICT specific technological change accounts for about 35% of total growth in labor productivity.

Table 1 ICT effects on productivity

	1.1	1.2	1.3	1.4
C	2.34**	-1.33	2.11*	1.32**
	(2.34)	(-1.21)	(1.92)	(2.42)
Ln GDP	0.12**	0.21**	0.14***	0.04*
	(2.13)	(2.24)	(3.11)	(1.94)
Ln OPE	0.012	-0.014	0.02**	0.01**
	(1.43)	(-0.98)	(2.30)	(2.11)
Ln ICT	0.01**	0.02*	0.03**	0.02**
	(2.15)	(1.89)	(2.02)	(2.03)
Ln HUM		0.02***	0.011**	0.02*
		(2.98)	(2.21)	(1.89)
Ln CAP			0.03**	0.01**
			(2.14)	(2.35)
Ln LAB				0.03**
				(2.14)
N	21	28	35	42
R^2	0.34	0.23	0.42	0.21

Note: t-statistics are provided in parentheses. * , ** and*** represent significance at the 10%, 5% and 1% respectively.

In the second column we have estimated our model with four variables; it means we have added HUM in our model. The effect of this variable on productivity is positive. 1% rising in human capital increases 0.02% productivity. When human capital is high the labor forces apply the new technology easer then output will increase. Fukao et al. (2009), and Nakane and Weintraub (2005) have revealed the same results in their researches. In this column, the effects of other variables on productivity are similar to the first model.

In third and forth columns, we have added capital formation and labor force respectively. The impacts of these variables are positive and significant. These variables are the factors of production. Economic growth models show that labor and capital are the important determinants of output. Fukao et al. (2009), and Nakane and Weintraub (2005) have revealed the same results in their researches. Bresnahan et al. (2002) find a positive correlation between the accumulation of IT capital, innovation in workplace organization and the use of highly skilled workers. Brynjolfsson and Hitt (2003) estimated a production function for a panel of 600 large US firms, finding that the contribution of IT investments to output growth significantly exceeds its factor share, implying a positive effect of computers on productivity growth in the long run. The results also suggest that IT capital deepening is associated with far-reaching organizational changes within the firm.

Conclusion

The aim of this research is the study of information and communication technology effects on productivity in Islamic countries. Following Seo and Lee (2006) we have applied a balanced panel data model. Hausman (1978) test shows that we should apply fixed effects model. The countries are: Iran, Malaysia, United Arab Emirates, Pakistan, Saudi Arabia, Qatar, and Turkey on the period of 1990-2010. Our sample was limited because of the lack of data for some countries.

We have estimated the variables in four models. In the first model we have applied three variables and in each column we have added one variable. The results show that gross domestic product, openness, human capital, capital formation, labor force and information and communication technology have positive impact on productivity. Human capital and capital formation increase the capacity of output then value added and productivity will rise. GDP have positive effect on productivity because GDP itself is a part of productivity calculation then rising in output increases productivity. ICT is a capital that influences output and

productivity in tow ways. In the one hand, it considers such as production technology Dedrick et al (2003), and on the other hand, ICT such as knowledge augment returns to increasing scale.

If there is a positive correlation between productivity and ICT expenditures in Islamic countries, it is a requirement for ICT expenditures rising. In this case propositional policies are tax incentives and subsidies on ICT for extension of ICT in firms. Other polices are reinforcing of ICT infrastructures, diminution of business and foreign direct investment barriers. Business and foreign direct investment bring and adopt ICT.

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