MEASURING THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY CAPITAL (ICT-CAPITAL) ON ECONOMIC GROWTH: EVIDENCE FROM SAARC COUNTRIES

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Abstract

Since early 90's the information technology is playing an important role in economic activities . Information and Communication Technology (ICT) is important drivers of Productivity. Modern growth theories argued that economic growth is driven by ICT related capital. However, empirical literature on this issue have produced mixed results, regarding different geographical configuration. Here, we study the impact of ICT related capital on the economic growth of south Asian countries (SAARC) from 1990-2014. Study also provides a view on this issue by assessing the role of ICT and non-ICT capital in total factor productivity of selected countries. We found that both types of capital have positive impact on growth. Empirical analysis also concludes that contribution of ICT capital for TFP is effective involving time lag.

Keywords: Economic Growth, ICT-capital, Total Factor Productivity, Information Technology.

JEL Classification: Z000

Introduction

Information and communication technology plays an important role in economic growth (Bresnahan et al., 1999). A study by Griffith and Van (2004) found that labor productivity in the long run is increased due to improvement in information technology. Estimates by Colecchia and Schreyer (2000) supports Grifith where contribution of ICT in productivity growth is found positive and significant in the long run. Information technology could be a source of growth, it increases investment which causes fall of its prices and it raises the use of ICT . secondly, ICT decreases the prices of newly installed capital which plays a pivotal role in the growth of an economy (Colecchia & Schreyer, 2000).

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A case study of Norway by Sapprasert (2010) suggested that the intensive ICT using industries growing faster as compare to less intensive ICT using industries. Another study by Kvochko (2013) found ICT as employment creator sector in the United States, employment in this sector is estimated by 22% up to 2020. Information and communication technology is one of the main determinant of growth in emerging sectors. Adoption of ICT improves the effeciency, transation cost and quality of final good (Ranasinghe, 2004).

On the other side, the capitals which is not related to information and communication technology is also important factor of production. A study by Van et al. (2004) , found that Non-ICT capital is still the main determinant of economic growth for transitional economies. Where the capital related to ICT is significant for the growth of developed world. Developing economies cannot absorb the technologies due to lack of capacity but ICT has the ability to turn these economies to achieve a higher growth. In the last two decades South Asia has achieved higher growth, physical capital is the main determinant of growth in these emerging economies. A study by Dewan and Kraemer (2000) estimated An inter country Cobb Douglass and found that the impact of physical capital is positive and ICT capital is insignificant for the emerging economies.

There are huge difference in per capita between developed and developing countries. Some developing thirty years ago are now highly industrialized, such as Korea and Singapore. Some transition economies in Eastern Europe have substantial populations with quite high income level. The impact of ICT in these economies may well be closer to those of developed EU economies. But there may be substantial differences between the economic behavior of large low-income economies (such as India and Pakistan) . These economies have industrial capacity and mass markets in spite of low income. A large number of literature shows that information technology is one of the main determinant of growth for developed economies (Kretschmer, 2012; Holt & Jamison, 2009; & Detschew, 2008) but the role of ICT in transitional economies is still interesting area. Therefore, a study on South Asian emerging economies could fill the literature gap.

The main objective is to measure the impact of ICT capital on economic growth. We used panel data of South Asian countries from 1990-2014. The study also provides a view on this issue by assessing the contribution of ICT and non-ICT capital on TFP. We found that both types of capital have positive impact on GDP growth. Empirical analysis also concludes that contribution of ICT capital is effective for total factor productivity involving time lag. Hence, ICT has a positive impact on South Asian economies.

The review of previous discussions and literature is in section 2, section 3 presents the analytical framework and econometric modeling followed by estimation procedures, data and variables used for analysis, graphical representation and data source are in section 4, section 5 presents the empirical findings and results , discussion, limitations of study and future directions are in section 6.

Literature Review

Adaptation of ICT has integrated economies, expanding production performance at macro and micro level, improving the living standards and thus enhancing the growth of the economy. Countries with advance technologies have major contribution in total outcome worldwide because of it amazing expansion in the field of ICT. Developments through Information Communication Technologies are more pervasive than other fields of development. Information Communication Technologies, recently is more stimulating than other technologies, (Matteucci et al., 2005). Rotmans et al. (2005) establishes that all kinds of research works are influenced by information technology and it make easy also diffusion or distribution of other technologies. Information Technology have conceded significant changes in the effectiveness and usefulness of labor by extending access to information and knowledge, it enhances the productivity by rising the labor's expertise and efficiency.

Growth of the economies is stimulated favorably by increasing marginal productivity of the factors of production. Recent theory of growth observes that in the long run country's growth positively depends on technological and scientific progress (Solow, 1957; Romer, 1990; Aghion & Howitt, 1992). Sichel and Oliner (2007) established that the elevated productivity of recognized states is primarily achieved by improvement in information communication technology. They explained how America's economic growth, for extended period, was maintained due to the improved ICT. Therefore, improving the information communication technology has favorable impacts on output.

Similarly, Van et al. (2003) discussed ICT's role in other elements of production and found that efficiency of labor was increased by improving ICT in organizations and industries. ICT's contribution in growth is also highlighted by Niebel (2014), in emerging and developing countries ICT indicated average growth rate comparatively but growth rate was low in developed world, also Non-ICT capital services growth were low as compared to ICT capital. Moradi and Kebryaee (2010) examined the impact of ICT on economic growth by using three ICT index. Economies with comparatively higher Opportunity index of ICT have stronger impact of ICT investment on economic growth. Therefore ICT investment has a significantly positive impact on economic growth as it contributes 0.8 percentage points per year to GDP. Empirically Guetet and Drine et al. (2007) works with country-level panel data for the fourteen (14) MENA countries, and evaluated the role of information communication technology development on income inequality as well as on economic growth. They found positive impact for the Oil rich countries. Jorgenson and Vu (2007), analyzing the quantification of the Information Communication Technologies capita's effects on growth for fifty countries on ICT spending, the global IT market of these countries jointly account for more than 90%. In developed economies, per capita's ICT accumulation have considerable causal effect on the efficiency of economic growth.

For Central and Eastern European transition Economies (CEEs), multi channeled contribution of information communication technology was examined by Van and Piatkowski (2003).

In case of Poland, their results indicated that capital of information communication technology will show a statistical significant contribution to productivity growth in the long-run. The Findings reveal that capital of information communication technology plays an important role in knowledge diffusion and speed of innovation, which lead to greater productivity in industries and economy through absorption of techniques, ideas and concepts of more advance economies. Ranasinghe (2004) through survey based data for Sri Lankan economy to examine the impact of information communication technology on labor market. The survey based data shows evidence for feeble user of information communication technology due to rural areas of Sri Lankan economy are not assimilated to the use of information communication technology and is much far from where it should be. Information communication technology has rapid diffusion in some parts of economy so it will accelerate extension of labor market by creating new job opportunity and destroying old jobs. In study on consents and endorsement of workers, Chandrasekhar (2001) examined that information communication technology assisted them in saving their huge goods market.

Similarly, a study by Bacchini et al. (2014) found that information and communication technologies can assist in the recovery of an economy from depression; it can contribute in the increase of 0.4 % in GDP and 1.2% in capital stock. Research by Mahyideen et al. (2012) examined ICT's contribution in infrastructure development leading to output growth for five nations of ASEAN. They examined contribution of ICT through new and conventional channels. Infrastructure affects development by private input efficiency through conventional channels. By applying more Non-ICT capital will cause lower cost of production, private capital return will be increased by rising productivity and have a helpful impact on economic growth. The infrastructure has indirect impact on productivity of labor through new channels given that public infrastructure has been improved as it can lower cost and save time. The research accomplished favorable impact of IT infrastructure on selected ASEAN nation's economic growth. Sridhar et al. (2007) observed relationship between economic growth and telephone penetration. The results, as reported for OECD economies, are significant by using simple Pearson's Correlation Coefficient, however significance level is not high as compared to reported in OECD countries. The impact of landline phones on growth indicates that landline phones add 1.62% to growth. Though, estimates are significant yet not high.

Theoretical Models and Estimation Procedure

We use traditional growth framework to analyze the contribution of information technology in output. Here, we disaggregate the capital input in to ICT and non-ICT capital, Since economic growth is diverse phenomenon, we use following production process.

$$Y = A\,F(K_{ICT}, K_N, L) \quad \text{.....(1)}$$

Here, capital stock is disaggregated into ICT capital services (K_{ICT}) and non-ICT capital services (K_N). The effect of ICT revolution on productivity can be analyzed through investment, the

production, and possible "spillovers" of ICT (Van Ark & Inklaar, 2005).

According to Neo-Classical model, total factor productivity plays important role in economic growth, see (Solow, 1956). The growth in TFP is derived as the growth of output minus weighted shares of the growth of inputs.

$$\Delta \ln A = \Delta \ln Y - \alpha_1 \Delta \ln K_{ICT} - \alpha_2 \Delta \ln K_N - \alpha_3 \Delta \ln L \quad \text{.....(2)}$$

A study by Bresnahan et al. (1999) also highlighted the importance of relationship between ICT and TFP. Information and communication technology can be a factor of production ICT and used as an input which boots the productivity of other sectors. By rearranging equation 2 , following equation shows the contribution of ICT, non-ICT capital and labour

$$\Delta \ln Y = \alpha_1 \Delta \ln K_{ICT} + \alpha_2 \Delta \ln K_N + \alpha_3 \Delta \ln L + \Delta \ln A \quad \text{.....(3)}$$

We use following panel regression models in order to find the determinant of growth is South Asian countries

$$\Delta \ln Y_{it} = \alpha_i + \alpha_1 \Delta \ln K_{ICT\,it} + \alpha_2 \Delta \ln K_{N\,it} + \alpha_3 \Delta \ln L_{it} + u_{it} \quad \text{.....(4)}$$

Here, we use sample of t = 1,2,.....24 observations for each country i = 1, 2,…4. A Hausman test is estimated in order to select the panel model for estimation. We also estimate the impact of ICT capital and non-ICT capital on total factor productivity by using Eq.5 . We used lags (i.e. j=2) in equation 5 because currently adopted ICT by labor force will take significant time period to become familiar and efficient in utilization (Jorgenson & Stiroh, 2000). One reason of insignificant association is found in the industry level data is time lag. With passage of time Non-ICT capital utilizes ICT and be effective input factor. A study by Basu et al. (2004) also highlighted the importance time lags in ICT productivity.

$$\Delta \ln TFP_{it} = \gamma_i + \sum_{j=1}^{2} \gamma_j \Delta \ln KNICT_{it-j} + \sum_{j=1}^{2} \varphi_j \Delta \ln KICT_{it-j} + \varepsilon_{it} \quad \text{.....(5)}$$

Data and Variables

Information on total factor productivity, information and communication related capital, non ICT capital and labour is taken from Groningen Growth and Development Centre (GGDC)for the time period 1990 to 2014 for SAARC. Information on gross domestic product is taken from WDI economic indicators. The details of these variables are following:

• **Growth rate of GDP:** Growth in output (GDP in constant). The GDP series is obtained by extrapolating 2011 benchmark PPPs from the World Bank.

• **Growth rate of TFP:** Growth in TFP is in percentage points estimated as a tornqvist index.

TFP growth accounts are estimated as the residual.

• **Growth rate of ICT Capital:** Growth in ICT capital services include hardware of computers , equipment of telecommunication, software and other services.

• **Growth rate of Non-ICT capital:** This variable refers to the change in the flow of services provided by capital assets, such as buildings, transport and machines.

• **Growth in Labor:** Labor is taken in growth of person employed (in thousands of person).

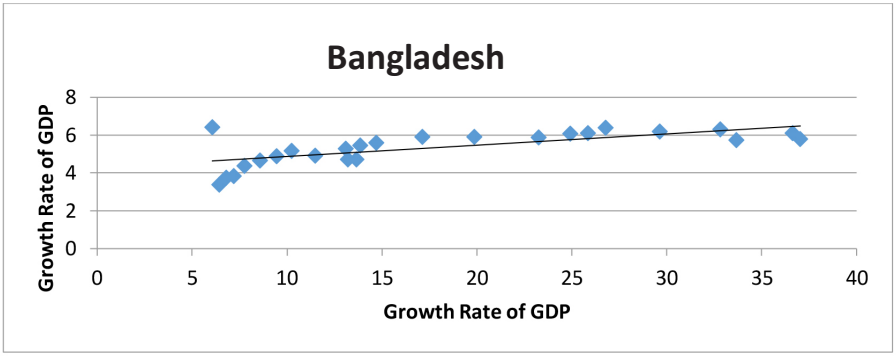
Statistical and Graphical Analysis of Data

Relationship between growth in ICT-capital and GDP growth : Regression line in Figure 4.1 and table 4.1 shows that growth in ICT related capital is positively related with growth rate of GDP for SAARC countries. Literature published recently also highlighted importance of ICT for economic growth, employment, work organization and competitiveness (Matteucci, 2005).

Table 1

Average yearly in 1995–1999, and 2010-2014

Countries	Pakistan		India		Bangladesh		Sri Lanka	
Variables	1999-1995	2010-2014	1999-1995	2010-2014	1999-995	2010-2014	1999-1995	2010-2014
GDP	3.3	3.7	6.3	6.2	4.98	6.09	4.8	7.2
ICT-capital	10.74	15.18	22.5	22.6	10.56	24.89	8.9	24.1
Non.ICT-capita	3.9	3.18	5.7	6.7	8.26	6.71	2.8	6.5
TFP	0.3	0.36	3.8	4.1	3.64	3.49	3.9	3.6



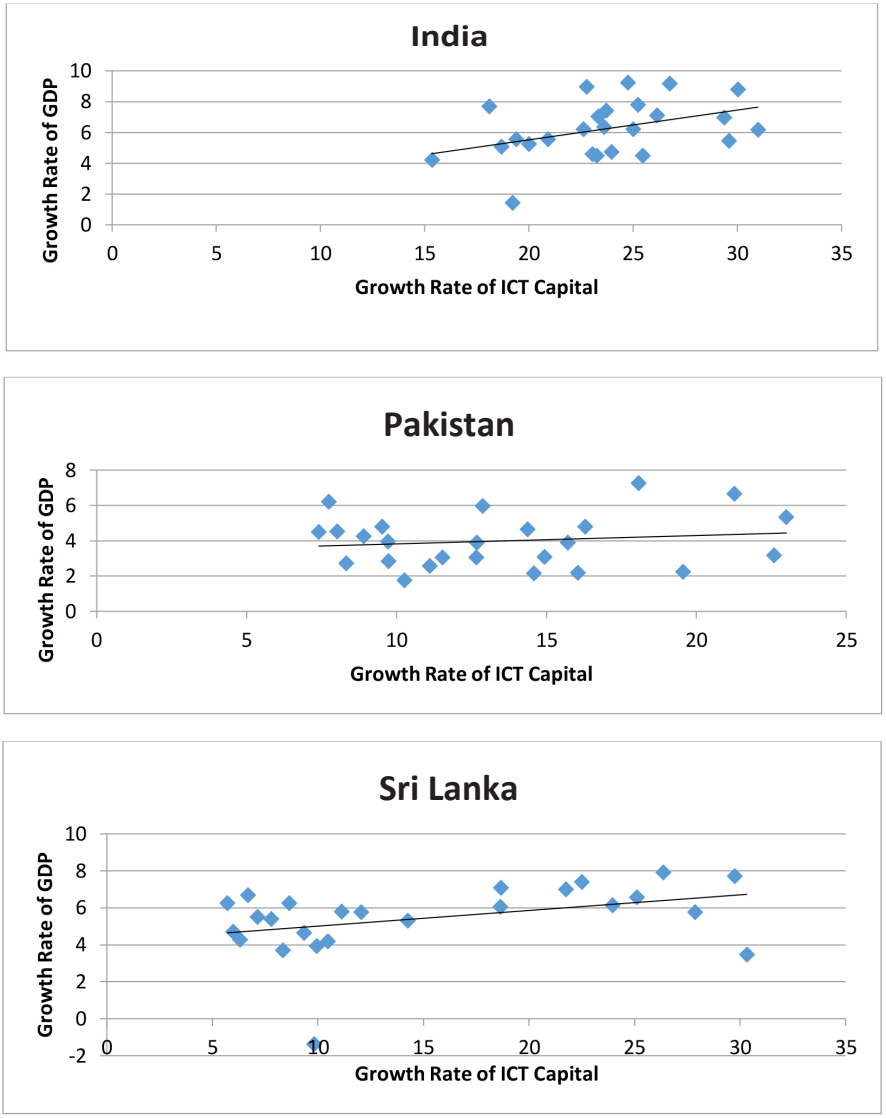
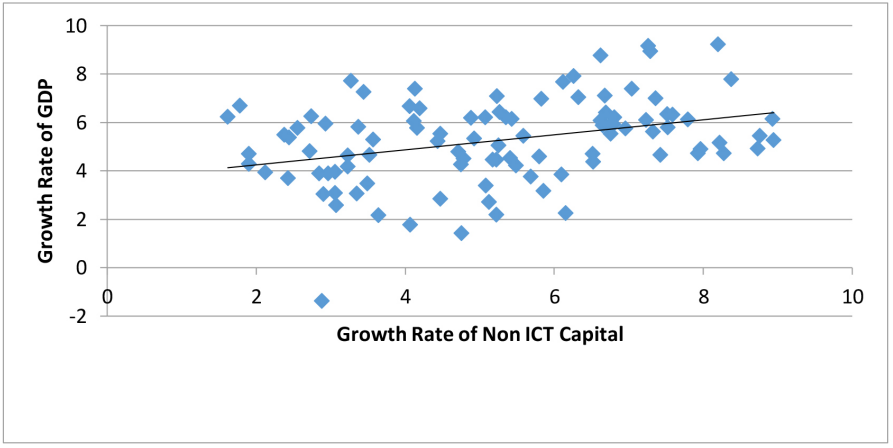


Figure 1: Growth in ICT-capital and Growth Rate of GDP

Relationship between growth in Non-ICT-capital and growth: Figure 2 shows that Non-ICT capital is also positively related with GDP growth

Relationship between growth in Non-ICT-capital and growth: Figure 4.2 shows that Non-ICT capital is also positively related with GDP growth



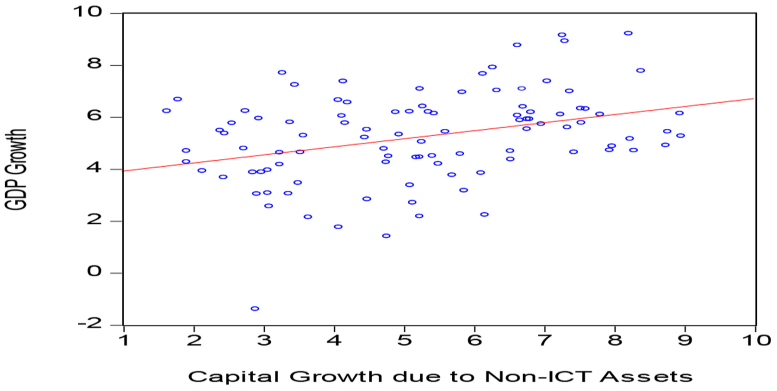


Figure 2: Growth in Non-ICT capital and Growth Rate of GDP

Results

In order to estimate the models mentioned in section 3 (i.e. Eq.5 and Eq.6), we need to know the order of integration of $(\Delta 1n\, Y_{it})$ and $(\Delta 1n\, K_{ICTit})$ series. We apply five different panel unit root tests. Table 2 indicates these series are stationary

Table 2
Panel Unit Root Test Results

	$\Delta \ln Y_{it}$		$\Delta \ln K_{ICT_{it}}$		$\Delta \ln K_{N_{it}}$	
TEST	T-val	p-val	T-val	p-val	T-val	p-va
LLC	-14.78	0.00***	-12.22	0.00***	-8.85	0.00***
Breiuing	-11.33	0.00 ***	-6.65	0.00 ***	-6.20	0.00 ***
IPS	-19.50	0.00 ***	-13.72	0.00 ***	-12.46	0.00 ***
Fisher-ADF	327.19	0.00 ***	223.92	0.00 ***	197.37	0.00 ***
PP-test	42.67	0.00 ***	402.44	0.00 ***	303.76	0.00 ***

We analyze the ICT-capital and GDP growth nexus by using Eq.4. Hausman test is used for the choice of appropriate panel estimation . Table 1A in appendix shows that fixed effect model is more appropriate.

Table 3
Determinant of GDP growth from Eq.4
(N = 4, T = 24, 1990–2014) (HCSE t-values)

Dependent variable = $\Delta \ln Y_{it}$		
Variables	**Coefficients**	**P-value**
C	1.39	0.084
$\Delta \ln K_{ICT_{it}}$	0.08	0.000^{***}
$\Delta \ln K_{N_{it}}$	0.12	0.000^{***}
$\Delta \ln L_{it}$	0.02	0.887
$R^2 = 0.69$ No observation =92 D-Watson stat 2.65		

Table 3 shows positive and statistically significant impact of information and communication technology related capital ($\Delta 1n\ K_{ICT_{it}}$) on growth rate of GDP ($\Delta 1n\ Y_{it}$). Estimation indicates that 1% increase in the growth of ICT related capital leads 8 % increase in economic growth. Where, 1% increase in the growth of Non-ICT related capital and growth of labour employed lead 12% and 2% increase in growth rate of GDP of four SAARC countries, respectively.

The cost of research depends on the skills of labor. Highly skilled labor reduces the cost of R&D. According to the theory of endogenous growth , R&D is key for long run growth in TFP. Research and development also increases the magnitude of innovator's revenue (Comin, 2010). A study by Heshmati and Shiu (2006), support above argument. study found positive impact of information technology on total factor productivity and economic growth of China. Industries investing in ICT should have higher impact on growth of TFP because of the improved management system diffusion of best practices (Venturini et al. , 2013).

Table 4

Relationship between TFP and ICT- Capital from Eq. 5

Panel results (N = 4, T = 24, 1990–2014) (HCSE t-values)

Dependent variable: $\Delta \ln TFP_t$ **Lag length m = 1**		**Dependent variable:** $\Delta \ln TFP_t$ **Lag length m = 2**
Variable	Coefficient	Coefficient
$\Delta \ln TFP_{t-1}$	0.30*** [3.43] (0.000)	0.15** [3.07] (0.03)
$\Delta \ln TFP_{t-2}$		0.12*** [2.35] (0.08)
$\Delta \ln K_{ICT_{t-1}}$	0.10 [0.30] (0.77)	0.08 [0.76] (0.40)
$\Delta \ln K_{ICT_{t-2}}$		0.11 [1.58] (0.10)
$\Delta \ln K_{N_{t-1}}$	-0.02** [-1.69] (0.09)	-0.07 [-1.08] (0.37)
$\Delta \ln K_{N_{t-2}}$		0.09** [2.16] (0.03)
No of Observations	90	90
R^2	0.67	0.68
D.W statistic	2.95	2.97
Country Dummy	YES	YES
Time Dummy	YES	YES

Note: We mention t- statistics in Prentiss [..] and probability or p-value in small brackets (...)

Table 4 shows that the coefficient of ICT is statistically insignificant at first lag but the probability of significance has improved with second lag. These results are consistent with theory that technology has small or no impact on factor productivity in Short run. Moreover, capital related to non-ICT has negative impact on TFP. According to growth theory , the prices of information and communication technology affect the investment which leads to raise the capital per capita. Therefore, capital intensity increases. Hence capital intensity has effect on productivity but do not have any effect on TFP. Increase in TFP is shown during the production of ICT, using technological advancement (Stiroh, 2005).

Conclusion

The objective of this paper is to analyze the impact of impact of information technology on economic growth , labour productivity and on TFP of south Asian countries. We used fixed effect method of estimation in panel setting. The impact of ICT-capital on growth rate of GDP and on TFP is positive. The rate of diffusion of information technology is slow in developing economies, therefore, lags should be involved to explore the impact (Baliamoune-Lutz 2002).

We used lags and results show that the impact of ICT on TFP is not significant at first lag but became significant at second lag. A study by Jorgenson and Stiroh (2002) finds that developing economies can not absorb technology in a short period of time. South Asian developing countries adapted ICT related capital in the late 1990 or early 2000. Significant result is due to the lagged effect of ICT. It requires more than a year to get benefits from ICT. So a more strategic policy should be formed in developing countries as one year is penetration of ICT. . This study found that ICT is playing a role in economic growth south Asian economies. Therefore, it is necessary for all countries to increase the use of ICT in order to boost economic growth.

This study found that ICT is playing role in economic growth south Asian economies. It is necessary for all countries to increase the use of ICT in order to boost economic growth. Shares of services sector in GDP is increasing in all South Asian economies. For example shares of services sector in Pakistan is more than 56% of GDP. Information and communication technology has pivotal role in services sector. Therefore, diffusion of information technology in services sector could increase the productivity.

Appendix

Table 1A
Results of Hausman test:

Test summary	Chi-Sq. Statistic	P-value
Period Random	4.618126	0.062

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