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The Impact of Diffusion of Information Communications Technology (ICT) on Iran Sectoral Productivity Growth

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Abstract

An attempt is made to establish a link between ICT sector investment and economic growth and to assess the specific impact on the productivity of the economy through network of 10 industrial sectors. By using improved techniques comprising input and output technique and economic modeling, that results suggested that ICT productivity has outpaced the economy wide productivity level. Furthermore, we found that ICT was a negatively contribute to the performance of economic system as a whole. Indeed the analysis conducted in this paper shows that more industries especially service sector have not been benefited from the incorporation of advances in telecommunications technology which might have, amongst other things, emanated from the policy of discouraging information investment in their production processes. To achieve this, the government must address a number of policy and regulatory issues to ensure the sector's continued growth and its extension into underserved areas.

Key word: Information Communications Technology, Development, Input- Output

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1- Introduction

There is no doubt that use of Information Communication Technology (ICT) is perceived as a catalyst for economic growth. Investing in ICT is widely regarded as having enormous potential for reducing costs, enhancing productivity and improving living standards.

In recent decades there has been tremendous investment in ICT that had a considerable effect on enhancing productivity and economic growth in developed countries. But, despite enormous improvements in the underlying ICT infrastructure, the benefits of such spending have not been found in aggregate output statistics in most of developing countries. Developing countries has mainly attempted to profit from ICT growth for improving service efficiency, reducing cost and economic growth.

Analytically, the contribution of ICT can be viewed at two different but interrelated Levels; ICT growth and ICT diffusion. The former refers to the contribution in output, employment, export earning, etc., resulting from the production of ICT related goods[1] and services that are limited to just one segment of the economy (Kraemer and Dedrick2001). The latter refers to ICT induced development through enhanced productivity, competitiveness, growth and human welfare resulting from the use of this technology by different sectors of the economy and society. Strategy of ICT growth for promoting export earning is not favour in Iran, because of the whole of economic segments are not extended and they are limited to just one segment of the economy and high cost production of ICT goods and services compare to another developing and developed countries. However, second strategy has more effect relation to first strategy for enhanced productivity and economic growth in Iran. Iran has mainly attempted to profit from ICT growth through a series of institutional innovations based on the implicit assumption that market-oriented ICT growth strategy will also result in the diffusion of new technology and ICT induced development for enhanced economic growth. Hence, the often-claimed achievements with respect to Iran's ICT have not been in terms of harnessing new technology for

1- Such benefits are not confined to the developed countries alone. A classic example is India, which has emerged as a major player in the ICT trade in recent years.

enhanced efficiency and productivity growth, service efficiency and reducing costs. It maybe arise factors such as competition, liberalization and foreign investment. While, there is less efficiency and even somewhere loss from ICT in Iran (ICT industry in Iran is almost state-owned and high cost production of ICT goods and services). Therefore the culture of the public sector is not suitable for large ICT projects. When the activity fails, usually no person is ready to commit responsibility or after-effects. The public sector usually accepts all system, quality and price offered by supplier; so, suppliers have to incentive.

In other word, the diffusion and advancement of new technology makes decrease in ICT's price and increase competition. Three mechanisms that arises reduced ICT prices involves a direct stimulation to final demand, while the second take places through intermediate demands. The third is indirect and reflects multiplier and accelerator feedbacks which arise from the initial stimulation of final demand. The mechanism that was missing from our point of views was a direct impact on investment by ICT users from lower ICT prices and the availability of new services. So, an attempt is made in this paper the impact of ICT investment empirically on sectoral productivity growth level as well as economy as a whole by using input-output model.

More macroeconomic studies showed that investments in ICT had a considerable effect on the productivity of labor force and on economic growth. A number of researchers (Norton, 1992) have hypothesized that ICT infrastructure lowers both the fixed costs of acquiring information and the variable costs of participating in markets. Wong (2002) found that the disparity in the intensity of ICT adoption among Asian countries is wider than disparities in their GDP per capita, and that Asia's share of global consumption of ICT goods, while gradually increasing over time, was consistently lower than its share in global production. This implies that the competence of the developing economies to benefit from ICT developments is limited. Röller and Waverman (2001); Qiang and Pitt (2004) showed a clear link between investment in ICT and productivity At the firm level, research shows that use of ICT can result in higher productivity and profitability. Qiang, Clarke, and Halewood (2006) concluded that

"enterprises that use ICT more intensively are more productive, grow faster, invest more, and are more profitable".

Cronin et al (1997) in several studies have used an I-O framework to calculate a total benefit in resource saving from advances in the telecom sector. They used US telecommunications data for the period 1963-91 in their study. They followed a two step estimation procedure in their study. First the I-O system was solved to obtain the relevant input requirement corresponding to actual 1991 relative prices and telecommunications technology. In the second step the system was solved under the assumption that the relative price of the technology of telecommunications service had remained at its initial 1963 level. They calculated the total benefits (decomposed into production and consumption effects) of the advancement of telecommunication service had remained at its initial 1963 level. They reported a total benefit or USD 134.4 billion in resource saving in 1991 due to advanced in telecommunications since 1963. The result showed that the main benefits of telecommunications investment occur in industries such as finance and insurance, wholesale and retail trade, other services such as construction, agriculture transportation and motor vehicles.

Correa L (2003) carried out another study titled 'The economic impactof telecommunications diffusion on UK productivity growth. This study investigated the relationships between telecommunications infrastructure competition, investment and productivity. She used econometric modelling and input-output technique to examine and measure the extent to which telecommunications has contributed to national and sectoral productivity performance. The results showed that sectors such as the financial intermediation sector, transport industry, construction, wholesale and retail trade had benefited more from advanced telecommunications technology.

Albadvi and keramati(2006) also provided the satisfactory evidences to show that IT implementation increase productivity when supported by rational complementary investment. The current paper conducted to study the role of two intervening variables including organizational infrastructures and business processes reengineering in such a relationship. Data from 200 car part manufacturers were gathered in a field survey. The empirical work indicated that constructed measures demonstrated the key psychometric properties including reliability and validity. The findings also demonstrate

moderating effects of organizational infrastructures and mediating role of business processes reengineering on the relationship between the use of information technology and firm performance.

Hosseini nassab and Aghaei (2009) has done study on the effect of ICT on economic growth. This paper employs a Generalized Method of Moments (GMM) within the framework of a dynamic panel data approach and applies it to the economy of OPEC member countries over the time span of 1990-2007. The estimates reveal a significant impact on economic growth of investments in ICT in the OPEC member countries. This implies that if these countries seek to enhance their economic growth, they need to implement specific policies that facilitate investment in ICT.

Moshiri and Jahangard (1383) studied the case of Iran and found that there was no meaningful relationship between ICT and economic growth in Iran up to year (2000).

As mention above, ICT can have been strongly contribution on national and sectoral productivity and economic growth, therefore this study examines the impact of ICT investment on sectoral productivity of Iran by using improved techniques comprising input and output technique. The data are base on National Accounts of Iran and Input-Output Transactions Table 2000-01. The paper organized as follows: section 2 quantifies the model and definition data, section 3 presents the estimation method, section 4 reports and discusses the results and finally section 5 summarized and bring the paper to its conclusions and suggestions.

2- Methodology and Data:

Total factor productivity is defined as the change in final output per unit of combined labour, capital. Growth in total factor productivity implies that a given level of output can produce with a smaller quantity of inputs or that a given amount of inputs can produce a greater quantity of output.

In this study, definition of ICT-producing sector is adapted according to the following industries:

1- ICT-Manufacturing(manufacture of office, accounting and computing machinery, manufacture of electrical wire and cable,manufacture of electronic valves and tubes and other electronic components, manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods)
2- ICT-Services (Communications, Computer and related activities).

To compute the benefit to economy of the impact of ICT investment, a measure of actual productivity is formulated and then compared with a measure of hypothetical productivity where ICT technology has been constrained to the base year. We are using redefining the underlying technology of the input-output system in terms of vertically integrated sectors (VIS) for measure of productivity growth (Peterson (1979)). This means that each sector final output, making use as primary inputs to do so. Using following equations:

$$X=AX+Y \quad (1)$$

$$X= (I-A)^{-1}Y \quad (2)$$

We obtain:

$$Z=B\,[I-A]^{-1}Y=MY \quad (3)$$

Where X: n-vector of gross output
Y: n-vector of final demand
Z: m-vector of primary input
A: [aij] = (n×n) matrix of inter-industry technical coefficient
B: [bij] = (m×n) matrix of primary technical coefficient

Equation (3) is obtained by substituting for X in Z=BX from $X= [I-A]^{-1}$ and M a (m×n) matrix defined as $M= B\,[I-A]^{-1}$. The elements m_{jk} of the matrix M refer to the average quantity of primary input j employed directly and indirectly in the production of a unit of final output from sector k. Then Z is a 2-by-1 vector of total labour and capital consumed by the actual economy in producing actual final products in period 1. The above system is solved again under the restriction that technology has not changed.

We first replace period 1 ICT technique (A_1^{ICT},B_1^{ICT})with the period 0 ICT technique (A_0^{ICT},B_0^{ICT}) where (A^{ICT},B^{ICT})denote the intermediate and primary coefficient for the telecom industry . In fact to reflect the fact that if the relative price and technology of ICT had not changed since period 0, named $A^{\wedge}$ is defined by adjusting A to reflect the hypothetical industry–specific input choices (identical to A except that telecom service column and row is set equal to the ICT column and row of the period 0 A-matrix). Additionally, $B^{\wedge}$ is created by adjusting B to reflect the fact that if the relative price and technology of ICT had not changes since period 0, industries would have consumed more labour and capital or with same output, industries have consumed less labour and capital in 1 period than they actually did. This gives:

$$M^{\wedge}=B^{\wedge}\,[I-A^{\wedge}]^{-1} \tag{4}$$

Where

$$B^{\wedge}=\begin{pmatrix} B_1^{All} \\ B_0^{ICT} \end{pmatrix} \qquad A^{\wedge}=\begin{pmatrix} A_1^{ALL,\,ALL} & A_0^{ALL,\,ICT} \\ A_1^{ICT,\,ALL} & A_0^{ICT,\,ICT} \end{pmatrix}$$

Then calculate,

$$Z^{\wedge}=B^{\wedge}\,(I-A^{\wedge})\,Y \tag{5}$$

Subtracting the sum of Z from the sum of $Z^{\wedge}$ yield the total economy wide resource saving. We investigate the total benefits due to ICT sector investment using input-output tables, wholesale indices, capital, labour, .. of the 2-digital industry. We collected data from National Accounts of Iran and Input-Output Transactions Table 2000-01. Since input-output tables are usually compiled for every 10 years, so we are using RAS method for estimation of input-output table in 2004. We applied the ratio to the data on 2004 constant prices. For the study, we selected 10 sectors and total impact on an economy as a whole.

3- Empirical Result of Impact of ICT on Sectroal Productivity:

Iran's telecommunications industry is almost entirely state-owned, dominated by the Telecommunications Company of Iran (TCI). Among the infrastructure systems, the telecommunications sector has the best prospects of growth under private sector ownership. Economic structure of ICT sector in Iran has been undergoing due to privatization since 2004. The ultimate goals that the government hopes to attain are increased competition and the large productivity gains. Achieving these gains is therefore contingent on a number of factors including investment and access to ICT sector and the needed skills. This study analyzes data for empirical study to reveal whether telecom service make been enhanced efficiency and productivity growth in Iran. ICT can be substituted for labour forces and capital and decreases employment and capital and make to cost-reduction. It makes decrease price of production of ICT goods and services relative to the retail price index considerably. Figure (1) shows unlikely this fact that telecommunications price has increased more than retail price index before privatization that maybe arising state-owned of ICT sector and inspired price which has increased by government, but after privatization telecom price has fallen. On vertical axis, figure (1) shows telecommunication price and retail price at the prices prevailing 2004 and on horizontal axis the over period.

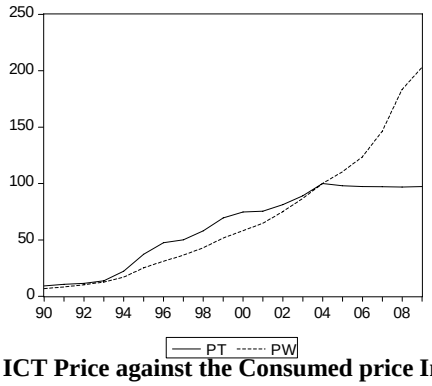

Figure 1: The ICT Price against the Consumed price Index (2004=100)

p_t: Telecommunications price

pw: Retail price index

However, technology advancement of ICT sector in the world have made positive payoff from ICT investment. Because of ICT advances are

rapidly exploited in the production process. The benefits from ICT infrastructure advancement also extend to those segments that have dramatically increased usage of ICT sector because of competition and decreased price over time. But ICT advances have not had rapidly exploited in the production process in Iran. Table (1) shows the share of ICT sector's intensity in total production of each industry. It shows the share ICT sector's intensity in total agriculture production is 0.26% according ۲۰۰1 input-output tables. It is minimum quantity through other segments and its growth is negative over a 3 years period. For real comparesion of data, input-output table in 2001 re-express into 2004 prices.

Table1: Share ICT production of total production 2001-2004(%)

Industry	2001	2004
Agriculture, Hunting, forestry& Fishing	0.26	0.106
Mining& Quarrying	1.2	0.108
Manufacturing	4.17	4
Electricity, Gas& Water Supply	2.07	1
Transport &storage	1.86	1.06
Construction	0.7	0.18
ICT	83	67
Trade	7.6	1.8
Insurance& Banking	1.5	0.105
Other Service	1.4	0.28

Estimated by author:

As the table shows, the ICT sector itself is the most ICT intensive industry in 2004 using 67 Rial of ICT sector to produce 100 Rial of output. After ICT, sectors such as trade, manufacturing and electricity are the most ICT intensive industries. Unfortunately, none of industries showing an increase in ICT sector intensity before privatization. This may be arise high price of ICT.

Although, extension of ICT investment through geographical areas and economic segment differ and amount of this investment is less, but this ICT investment has made enhanced productivity (not high) through a few segments. Table (2) shows productivity gains made by each sector.

Table 2: Direct and Indirect Resources Saved Nationwide due to ICT Advances During 2001-2004(Rial billion).

Industry	Total saving	Saving due to increased ICT consumption	Saving due to improved ICT productivity
Agriculture, Hunting, forestry& Fishing	-2601.073	-2110.073	-491
Mining& Quarrying	-3516.54	-1064.54	-2452
Manufacturing	16973.6	16336.61	637
Electricity, Gas & Water Supply	4591.04	4495.26	95.78
Transport &storage and warehousing	833.98	944.91	-104.3
Construction	2215.8	2295.81	-80
ICT	-15860.95	769.175	-16630
Trade	-5920.19	-6315.23	395.04
Insurance& Banking	-496.6	-1033.8	536.37
Other Service	-11747.36	-6824.76	-4649.6
Total	-15255.99	7493.35	-24579.46

Estimated by author:

Table (2) presents the actual observed gained made possible by ICT infrastructure investment since 2001. It shows a substantial slowing of the rate of growth of total factor productivity in sectors such as ICT, transport &storage and warehousing, mining and other services during the years in which ICT sector expansion has been. Thus, there has not been output expansion and could not substantially influence the creation of employment and wealth in these sectors when ICT sector expansion has been. The results show the main benefits of ICT investment occur in sectors such as manufacture, electricity, construction and trade that this benefit is more due to increased ICT consumption. The benefit of ICT investment on sectors such as manufacture, insurance and trade is also due to improved productivity that this enhanced productivity would be more during recent years.

Iran can not get the full benefits of ICT unless they have the social and cultural Infra-structures and skills required for utilizing ICT's capabilities. Such a large-scale change and reduce in ICT price after privatization requires teams of competent planners and advisors, with the government present at all stages of the privatization. This seems to be currently missing from the current process, where the rate of privatization has garnered more attention than the quality of the process. The government has to increase

access to ICTs, such as make phones, cell phones, computers and internet connectivity more available in rural areas and its extension into underserved areas; enhance people's ICT literacy and skills; and develop ICT applications that can provide much-needed social, economic, and government services to citizens. Promoting the use of ICTs throughout the economy can raise productivity and growth.

Since international trade plays an important role in ICT dispersion and allows domestic producers and costumers to have access to more diverse goods and services with lower prices, policy makers should encourage free trade through decreasing tariffs and eliminating non-tariffs barriers to ICT imports and thereby facilitate ICT development. In addition to, ICTs are often used in the service sector to further differentiate products, removing them even further from the mass production and consumption. For example, in financial services, where the ICTs do support economies of scale in transactions processing they should also permit the creation of many new services[1].

4- Conclusions

An attempt is made to establish a link between ICT sector investment and economic growth and to assess the specific impact on the productivity of the economy through network of 10 industrial sectors. By using improved techniques comprising input and output technique and economic modelling, that results suggested that ICT productivity over a 3 year period has outpaced the economy narrow productivity level. Further more, we found that ICT was a negatively contribute to the performance of economic system as a whole. Indeed the analysis conducted in this paper shows that more industries especially service sector have not been benefited from the incorporation of advances in telecommunications technology which might

1- Of course the proliferation of new services does not tell us about expected gains or losses in productivity. Factors other than ICT productivity that influence productivity in this area include the costs of complements such as the input of skilled labour to explain and sell these services.

have, amongst other things, emanated from the policy of discouraging information investment in their production processes.

This paper shows that Iran government policies on ICT and its investment incentives may have wide reaching consequences for not only the ICT industry but also other industries and the economy. The government has to increase access to ICTs, such as make phones, cell phones, computers and internet connectivity more available in rural areas and its extension into underserved areas; enhance people's ICT literacy and skills; and develop ICT applications that can provide much-needed social, economic, and government services to citizens. Promoting the use of ICTs throughout the economy can raise productivity and growth.

References

1- Albadvi, A., Keramati, A., Assessing the impact of information technology on firm performance considering the role of intervening variables: organizational infrastractures and business process reengineering, International Journal of Production Research, Francis and Taylor publisher, UK (in press).

2- Central Bank of Iran (2004),' SNA93-Tables', National Accounts of Iran.

3- Centre of Statistics and Programmed Implementation (2000), 'Input-Output Transactions Table 2000-01", Government of Iran.

4- Chakravarity S (2005),"Determinants of Cellular Competition in Asia", IIMA Working Papers from Indian Institute of Management Ahmadabad, Research and Publication Department. ideas.repec.org/p/iim/iimawp/2005-06-01.html - 10k.

5- Correa L (2003)," The Economic Impact of Telecommunications Diffusion on UK Productivity Growth', Queen Mary, University of London.

6- Cronin, Franics J and Gold M (1997), ' Telecommunications, Factor Substitution and Economic Growth', Contemporary Economic Policy, Vol XV, pp.21-30.

7- Cronin, Franics J and Gold M, (1997),"The Social Rate of Return from Telecommunications Infrastructure Investment, mimeo.

8- Hosseini Nasab E and Aghaei M (2009),'The Effect of ICT on Economic Growth: Further Evidence', Euro Journals, Issues 5, pp.46-56.

9- Jorgenson, D. W. and Stiroh, K. (1995) "Investment in Computers and U.S. Economic Growth", Economics of Innovation and New Technology, Vol. 34, Number 3, pp. 295-316.

10- Joseph, K. J., 2002. Growth of ICT and ICT for Development: Realities of the Myth of the Indian Experience. UNU/WIDER Discussion Paper No. 2002/78.

11- Kraemer, Kenneth L, and Jason Dedrick (2001), 'Information Technology and Productivity:

12- Moshiri S and Jahangard E (2004), 'ICT and Iran economic growth', Iranian Economic Researches Quarterly. Vol.19, Summer.

13- Norton S.W (1992),'Transaction costs, Telecommunications and the Microeconomic of Macroeconomic Growth', The University of Chicago.

14- Peterson, W (1979),'Total Factor Productivity in the UK: A Disaggregated Analysis in Measurement of Capital", Basingstoke: Macmillan, 212-23.

15- Qiang *C* and Pitt A (2004), 'Contribution of information and Communication Technologies to Growth', World Bank Working Paper No 24.

16- Qiang C, Clarke G, and Halewood N (2006), "China's Information Revolution :Managing the Economic and Social Transformation", World Bank.

17- Results and Implications of Cross-Country Studies', In Matti Pohjola (ed), Information Technology and Economic Development. Oxford: Oxford University Press, pp. 257-279.

18- Röller Lars-Hendrik and Waverman L (2001), 'Telecommunications Infrastructure and Economic Development: A Simultaneous Approach', American Economic Review, Vol. 91, Number 4, PP. 909–23.

19- Steinmueller E and Ines Bastos M (1995),'Information and Communication Technologies: Growth, Competitiveness and Policy for Developing Nations', UNU/INTECH Discussion Paper No.9511.

20- Wong P.K(2002),' ICT production and diffusion in Asia Digital dividends or digital divide?', Information Economics and Policy, Volume 14, Number 2, pp.167-187.