ICT INNOVATION, ADOPTION AND DIFFUSION: AN EXPLORATORY ANALYSIS ON USAGE PATTERNS FOR ECONOMIC PRODUCTIVITY

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Abstract

The rapid development of information and communication technologies (ICT) has prompted many nations, developed and developing, to devote scarce resources to building impressive physical infrastructure and formulating a range of ICT policies in the hope that such moves would enhance economic development. Most governments in developing countries, including that of Malaysia, tend to hold a firm belief that huge investments in ICT will result in immediate and long term economic payoffs, although a large body of academic literature is ambiguous concerning the economic impact of ICT innovation, adoption and diffusion across the various sectors of the economy. The paper argues that the effective innovation, adoption and diffusion of ICT application for economic productivity is dependent on a number of key factors including pattern of usage, economic and political stability of a country.

Abstrak

Pembangunan pesat dalam teknologi komunikasi dan maklumat (TKM) telah menyebabkan banyak negara yang membangun mahupun sedang membangun terpaksa menggunakan sumber yang terhad untuk membangunkan prasarana yang canggih serta menggubalkan pelbagai dasar TKM dengan harapan langkah sedemikian dapat membantu membangunkan ekonomi sesebuah negara. Kebanyakkan kerajaan di negara sedang membangun, termasuk Malaysia mempunyai kepercayaan yang kukuh bahawa pelaburan yang besar dalam TKM akan memberikan pulangan pada masa terdekat dan juga pada masa jangka panjang, walaupun hasil kajian lepas telah menunjukkan pandangan yang berbelah bahagi mengenai hubungan di antara pelaburan dalam TKM dan impak kepada pembangunan ekonomi. Artikel ini mempertikaikan

impak penggunaan TKM ke atas produktiviti dan pembangunan ekonomi yang bergantung rapat dengan faktor-faktor tertentu seperti pola penggunaan TKM serta kestabilan ekonomi dan politik negara.

Keywords: Innovation, Adoption, Diffusion, ICT, Government Policies

Introduction

The study of ICT innovation, adoption and diffusion has generated extensive research in this area. As the knowledge-based economies of most developing countries are increasingly relying on more and better information, the introduction and successful adoption of new ICT technologies has become a critical element in the attempt to enhance the competitiveness of a country's economy (Porter & Millar 1985, Damanpour 1991, Rogers 1995, Drucker 1999).

The advances made in the field of ICT innovation, adoption and diffusion which have been very rapid and significant over the past decades have resulted in the acceptance of the need for policy which recognises the importance of deploying ICT as a means of enhancing economic productivity in both developed and developing countries (Jussawalla 1999:3). The dependence on ICT technologies, specifically computing technology and information services has intensified the development of a new information-based economic sector in the domestic and international market. However, the key question here is how effective and practical are the policies of governments in developed and developing countries in facilitating the adoption and diffusion of ICT to foster economic growth and improve productivity at the various sectors of the local economy? These issues will further be explored in the later parts of the article.

Review of Literature on Innovation

Some of the most important contributions to the field of innovation have been the work of researchers like Rogers (1995), Rogers and Shoemaker (1971) and Rothman (1974) on innovation characteristics. As reviewed by Tornatzky and Klein (1982), ten innovation characteristics have been examined by researchers include: compatibility; relative advantage; complexity; cost; communicability; diversibility; profitability; social approval; trial; and observations. These characteristics represent interactions between the innovation and its context as perceived by the adopting entity. As discussed by Tornatzky and Klein, there is considerable overlap between these characteristics, e.g., between relative advantage and profitability. In general, these characteristics have been treated as independent

variables in studies that relate them to the dependent variables of innovation: adoption and implementation.

In a meta-analysis involving 75 innovation characteristics studies, Tornatzky and Klein (1982:41-44) reported that the first three characteristics - compatibility, relative advantage, and complexity - have been found to consistently influence innovation adoption and/or implementation in a significant number of published studies. According to Rogers and Shoemaker (1971), the compatibility of an innovation is "the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of the receivers". The definition of relative advantage given by Rogers and Shoemaker is "the degree to which an innovation is perceived as being better than the idea it supersedes," and complexity is "the degree to which an innovation is perceived as relatively difficult to understand and use."

Framing the application of new ICT as innovation for the key engine of growth for the various sectors of the economy (McFarlan & McKenney 1982; Huff and Munroe 1985) researchers in this field have studied various aspects concerning the adoption and diffusion of ICT, such as modern software practice (Zmud 1982), spreadsheet software (Brancheau & Wetherbe 1990), customer-based inter-organisational systems (Grover 1993), database management systems (Grover & Teng 1992), electronic data interchange (Ramamurthy & Premkumar 1995), and ICT in general (Lai & Guynes 1997). Most of these studies tend to focus on factors and innovation attributes that can predict adoption behaviour, an area that has received focused attention by many researchers in this field (Tornatzky & Klein 1982).

More recently, researchers in the field of ICT adoption and diffusion have attempted to build theories that integrate ICT innovation with the general innovation theories. Swanson's tri-core theory (Swanson 1994), for example, extends Daft's (1978) dual-core theory of technical and administrative innovation in the various sectors of the economy by incorporating several types of ICT innovation which constitute the third core. A recent study by Grover et al. (1997) has provided partial empirical support for Swanson's theory.

A number of studies on modelling diffusion of non-ICT technologies examined more than one innovation (Griliches 1957; Mansfield 1961; Dunne 1994 and Baldwin et al. 1995), however, an equally large number of studies on ICT modelling efforts tend to focus on just a single innovation (Gurbaxani 1990; Loh & Venkatraman 1992; Wang & Kettinger 1995 and Liberatore & Breem 1997). According to Tornatzky and Klein (1982), one important criterion for an "ideal" study on innovation characteristic is to examine more than one innovation, as single innovation studies are

not sufficiently robust to permit generalization to a population of innovations.

While studies in ICT adoption and diffusion have contributed to the understanding of ICT adoption behaviour, previous empirical modelling efforts have shed more light on ICT diffusion patterns. These studies largely provided extensive discussions on the various strategies undertaken to deploy the use of computers and other forms of information and communication technology more effectively across the various sectors. In spite of this, some authors such as Cawson et. al. (1995) have cautioned about the positive assumptions made about the ICT revolution, especially in terms of its market development, as partly reflected in the following arguments:

> "The efforts of US vice-president Al Gore to publicise the opportunities for economic growth afforded by information technology (IT) coincided with some important technological advances, notably in the area of digital compression technologies and telecommunications switching. Suddenly, major deals were being announced between telecoms companies and cable TV operators in the US, the European Union was setting up an expert committee (the Bangemann Committee) to ensure that Europe was not left behind, and Japanese policy-makers were reportedly worried that the Americans had leap-frogged their previous advances in IT. But how does anyone know that these new markets will develop so quickly? What evidence lies behind the view that consumers will be queuing up to get onto the information superhighway? Will 'multimedia' remain as what John Sculley of Apple once called a 'zero-billion-dollar' industry, or will it reach the dizzy forecasts produced by the IT consultants?"
>
> Cawson et. al. (1995, pg.3)

Therefore, one of the main objectives in the study of ICT innovation, adoption and diffusion is to find a common representation of innovation diffusion patterns across a large variety of information technologies. This would be a significant step in understanding the diffusion process common to ICT innovations, as different models imply very different diffusion dynamics. The internal influence model, for example, portrays an imitation and learning dynamic among the society of potential adopters, while the external model depicts a dominating guiding force from outside (Meade & Islam 1998). This would enable researchers in this field of

study to have better knowledge of general ICT diffusion patterns, thus enabling these researchers to prepare themselves to undertake the critical step toward developing a general theory of ICT innovation and diffusion.

To explore this possibility, it is important for researchers in this field to correctly identify different classes of information technologies having similar diffusion patterns in terms of the parameters of their diffusion curves. These parameters are related to critical dimensions of the dynamics of the diffusion process. The coefficient of imitation, for example, pertains to how swiftly an innovation spreads through contacts among potential adopters. If two innovations have similar diffusion patterns and spread among potential adopters with roughly equal speeds, one would anticipate the possibility that they are also similar in terms of innovation characteristics such as relative advantage and complexity. Thus, this tentative classification of information technologies based on their diffusion patterns would provide the empirical data base for addressing a key research objective: to explore the relationships between innovation characteristics of the information technologies and their general diffusion patterns.

While researchers in this field of study have examined characteristics of ICT diffusions such as relative advantage and complexity and how they facilitate the adoption of an innovation (Tornatzky & Klein 1982), others have used mathematical models to fit diffusion curves (Kumar & Kumar 1992; Meade & Islam 1998). However, the main focus of this study is to analyse empirical findings in order to undertake the initial step toward linking ICT innovation characteristics to its diffusion patterns.

The facilitation and planning of ICT innovation and adoption is a critical element of managing organizational change in the various sectors of the economy (Souder 1987). In the last quarter of the 20th century, ICT has become the prime driving force for organizational innovation. The latest wave of business innovation, such as business process reengineering (Teng et al. 1994) and electronic commerce, are often enabled by information and communication technologies such as the Intranet, Extranet, telecommunication, and databases (Davenport 1993). By discovering the potential relationships between these information technologies' innovation characteristics and their diffusion patterns, researchers can begin to understand the dynamics of ICT-driven innovations in initiating growth in the economy and be able to plan and manage them more effectively.

Although many countries continue to invest heavily on ICT initiatives in order to achieve economic development, there is a growing belief among scholars in ICT-led development that effective

government policies and planning are the key factors which led to economic growth through the use of ICT. One way that countries have tried to promote greater use of ICT to enhance their economic development is through the formulation of national ICT plans. Apart from Malaysia's MSC, a number of countries have formulated national agenda to facilitate the process of ICT adoption and diffusion. Studies by Choo (1997) for example, have revealed that Singapore's 'IT 2000' represents deliberate attempts by Singapore government to increase government and corporate use of ICT for economic development. Apart from that, the study also showed that 'IT 2000' is aimed at stimulating public interest in ICT, primarily in enhancing its usage and application at the various sectors of the economy.

Similarly, studies by De Long and Summers (1991) have shown that national governments worldwide have increased spending on the development of science and technology parks, such as the Hsinchu Industry and Science Park in Taiwan as incubation sites for highly innovative, technology-intensive companies. Behind these plans is a widely held belief that increased levels of ICT diffusion and use provide opportunities for economic growth. While the effectiveness of such policies is debatable (see for example Pohjola 1998), Kraemer et al. (1992) on the other hand argued for the need to raise the level of ICT spending within countries and stressed the importance of ICT usage in order to contribute to economic growth and development of a country.

Apart from government policies to initiate economic development through ICT diffusion, its ultimate impact on economic development would depend on the extent of ICT usage at the various sectors of the economy. This argument is based on the study conducted by Krugman (1994) who argued that government in certain countries such as Singapore, Sweden, Denmark and Switzerland have undertaken various policies to encourage greater participation among the public sectors to enhance their use of ICT. Krugman argued that it is important for governments to ensure greater usage of ICT in the various sectors of the economy as this would increase productivity which in turn, facilitate the economic development of the country. Issues relating to ICT usage and economic development are explored and discussed in greater depth in the next section as well as other parts of the thesis.

ICT and Economic Productivity

There is a large literature that shows the impact of ICT use, in terms of both significance and implications on the economic productivity of both developed and developing countries. Despite the large

Although Landauer (1995) uses these studies as evidence that investments in ICT are not productive, however it is important to note that these studies were exploratory in nature, lacking a theoretical model necessary for critical analysis. Furthermore, although spending on ICT was rapidly increasing through the 1980s, computer capital represented a very small component of total capital stock during this period. Thus simple correlations, like Roach's, are unlikely to discern any impact of ICT use on productivity over factors such as oil prices, export growth and monetary policy, especially without an appropriate theoretical model.

As more research is conducted, a clearer picture is presented on the relationship between ICT usage and economic productivity. However, it is still likely that while one study shows a negative correlation between total factor productivity and the use of advanced technology such as ICT (Berndt & Morrison 1995), another study may suggest that computer capital does contribute to growth more than ordinary capital (Jorgenson & Stiroh 1995). Part of this is attributed to the difficulty of accurately measuring productivity, which to some extent could result in findings of studies that are not conclusive. As such, apart from *measuring* productivity, this chapter focuses on *analysing* the extent of productivity from ICT use on a number of specific sectors of the economy, such as at the level of the industry and on individual firms. These are discussed extensively in the following sections.

ICT Usage Patterns Within Firms in the 1980s and 1990s

A number of studies address the demand and application of ICT among establishments across the various sectors of industry. These studies, which were mostly conducted in the 1980s and 1990s, explored the relationship between ICT usage and productivity. The first set of studies, conducted in the 1980s, seemed to suggest no connection between ICT investment and productivity at the level of the firm, industry or the economy (see, for example Roach, 1987, 1989, 1991; and Strassman, 1990).

Consistent with these, other studies conducted in the 1980s and early 1990s on service-related industry, such as banks and insurance companies showed weak or non-existent links between ICT and productivity (Franke 1987, Strassman 1990, Alpar & Kim 1991, Harris & Katz 1991). A number of reasons can be advanced for this, the main one being the infancy of the technology, resulting in lack of adequate knowledge to enable users to fully exploit the applications associated with the technology. However, the trend is now changing with the banking and finance sector being one of the highest users of ICT in the industrial sectors across both developed and developing

nations (Roach 1987, 1989, 1991, 8MP:364; Gordon 2000:55-58; Pohjola 2003:16).

In contrast to the studies conducted in the 1980s and early 1990s, findings from the second set of studies, conducted mainly in the mid through late 1990s and early 2000 tend to suggest otherwise (see, for example Brynjolfsson and Hitt 1995, 1996, 1998; Brynjolfsson 1996; Bresnahan 1999; Bosworth & Triplett 2000; Jorgenson & Stiroh 2000; Oliner & Sichel 2000; Jorgenson 2001). These studies not only revealed positive and significant impacts from ICT investments across establishments in the industrial sectors, but also suggest that the economic boom and surge in productivity in the late 1990s was largely due to heavy investment in ICT among establishments.

Most of these studies seem to indicate that output growth in firms, industries and the economy may arise from increases in input levels, improvement in the quality of inputs and from growth in the productivity of inputs. This shows that the use of ICT-enabled applications can benefit firms and establishments across the industrial sectors in two ways. Firstly, labour productivity can increase when workers are provided with ICT-enabled applications to enable them to get their tasks done more effectively. For example, a cashier at a retail chain store using a computer-based information system such as a scanner can process a transaction in less time compared to those using the conventional method of using the cash register or calculator.

Secondly, technical progress in the production process or in the quality of output can increase the level of output without additional investment in input, a process labelled as multifactor productivity (MFP). An increase in MFP means that for a fixed level and quality of inputs, a firm, industry or economy is achieving higher levels of output. This form of productivity improvement is of great importance because firstly, it reflects the growth of the organisation through the effective utilisation of ICT-enabled applications and secondly, it underlines the demand for ICT at the firm/industry level.

ICT Usage and Economic Productivity

At the Industrial Level

Extensive discussions on the use of ICT and its significance at the industry level have been documented in the research undertaken by Roach (1987, 1989, 1991). In his studies, the author argued that ICT is an effective substitute for labour in most manufacturing industries but has been associated with the growth in white-collar employment in services, especially finance. He also attributed this to relatively keener competitive pressures in manufacturing and foresees a period of belt-tightening and restructuring in services as they begin to face international competition.

However, studies of manufacturing also found evidence that computers may not necessarily increase productivity. For example, Berndt and Morrison's (1995) study indicate no financial gains from using ICT at the industry level. In their study, they analyzed a broader data set from the U.S. Bureau of Economic Analysis (BEA) that encompasses the whole U.S. manufacturing sector. Their findings were consistent with their earlier study (Morrison & Berndt 1991) which examined a series of parameterized models of production at the level of the industry.

In this study, they found evidence that every dollar spent on ICT delivered, on average, only about $0.80 of value on the margin, indicating a general over investment in ICT. In the later aspects of their study, Berndt and Morrison (1995) examined broad correlations of ICT investment with labour productivity and multifactor productivity. This approach did not find a significant difference between the productivity of ICT capital and other types of capital for a majority of the 20 industry categories examined. Instead, they did, however find that investment in ICT was correlated with increased demand for skilled labour.

Similarly, Siegel and Griliches (1992) used industry and establishment data from a variety of sources to examine several possible biases in conventional productivity estimates. They found a positive simple correlation between an industry's level of investment in computers and its multifactor productivity growth in the 1980s. They did not however, examine more structural approaches, in part because of troubling concerns about the reliability of the data and government measurement techniques. Their findings contrast with those of Berndt and Morrison (1995), which however, also document positive correlations between ICT capital and some measures of economic performance in the specifications where cross-sectional effects were emphasized.

At the Firm Level

A number of studies have also been found examining the relationship between firms' ICT investment and their performance. Interestingly, studies that have used larger and more recent datasets have found evidence that ICT positively affects firm's performance. Most of these studies analyse ICT application within the following two sectors – service and manufacturing. While the findings of these studies on the service sectors often show weak effects of ICT use, the findings on the manufacturing sectors on the other hand, generally indicate stronger effects of ICT use. In order to analyse these issues in greater depth, a more comprehensive analysis will need to be given on these sectors. These are discussed in the sections that follow, which provide comparative analysis of productivity and ICT usage between these sectors.

At the Service Sector Level

Several studies have examined the impact of ICT on the performance of the service sector, most notably in the financial sector. For example, Parsons et al. (1990) studied the production function of banking services in Canada and although they found that the impact of ICT on multifactor productivity was quite low between 1974 and 1987, they believed that the growth in ICT use will be greatly enhanced in the future. Similarly, Franke (1987) found that ICT was associated with a sharp drop in capital productivity and stagnation in labour productivity, but remained optimistic about the potential of ICT.

Strassman (1985) reports disappointing evidence in several studies. In particular, he found no correlation between ICT and return on investment in a sample of 38 service sector firms. The findings of his study indicate that while some top performers invest heavily in ICT, others do not. This led him to conclude in his later book (1990) that there is no relation between spending for computers, profits and productivity.

Harris and Katz (1991) examined data on the insurance industry from the Life Office Management Association Information Processing Database and found positive but sometimes weak relationships between ICT expense ratios and various performance ratios. Similarly, Alpar and Kim (1991) studied 759 banks and found that a 10 percent increase in ICT capital is associated with a 1.9 percent decrease in total costs. A number of other related studies on the impact of ICT in initiating productivity in the service sector of the economy have also been documented. These include studies by Weitzendorf and Wigand (1991) which developed a model of information use in two service firms and found an association between ICT investment and increased economies of scope.

Diewert and Smith (1994) provide an interesting case study of a large Canadian retail distribution firm. They found that the firm experienced an astounding 9.4 per cent quarterly multifactor productivity growth, for six consecutive quarters starting at the second quarter of 1988. They argued that "these large productivity gains are made possible by the computer revolution which allows a firm to track accurately its purchase and sales of inventory items and to use the latest computer software to minimize inventory holding costs".

Despite this, it is worth noting that measurement problems are more acute in services than in manufacturing, partly because many service transactions are highly personalised in nature and therefore not amenable to statistical aggregation. Even when data are abundant, classifications sometimes seem arbitrary. For instance, in accordance with one standard approach, Parsons et al. (1990) treat *time* deposits as inputs into the banking production function and

demand deposits as outputs. The logic for such decisions is sometimes weak, and therefore subtle changes in deposit patterns or classification standards can have disproportionate impacts.

The importance of variables other than ICT is also particularly apparent in some of the studies on the service sectors. In particular, researchers and consultants have increasingly emphasized the need to reengineer work when introducing major ICT investments. As Wilson (1995) suggests, it would be interesting to know whether reengineering efforts are the main explanation for Brynjolfsson and Hitt's (1993, 1995) findings that ICT is correlated with increased output. A recent survey found that, in fact, firms that had reengineered were significantly more productive than their competitors (Brynjolfsson, 1994).

At the Manufacturing Sector Level

A significantly large body of literature comprises firm-level studies of ICT productivity in the manufacturing sector. Again, these studies show mixed findings in terms of the relationship between ICT use and productivity in the manufacturing sector. For example, the study by Loveman (1994) provided some of the first econometric evidence of an ICT productivity shortfall in the manufacturing sector when he examined data from 60 business units using the Management Productivity and Information Technology (MPIT) subset of the Profit Impact of Market Strategy (PIMS) database. The author also estimated that the contribution of ICT capital to final output was approximately zero over his 5-year period of study. His findings were fairly robust to a number of variations on his basic formulation.

Barua et al. (1991) traced Loveman's results back a step by looking at the effects of ICT on intermediate variables such as capacity utilization, inventory turnover, quality, relative price, and new product introduction. Using the same data set, they found that ICT was positively related to three of these five intermediate measures, but that the effect was generally too small to measurably affect final output. Dudley and Lasserre (1989) also found econometric support for the notion that better communication and information reduce the need for inventories, without explicitly relating this to bottom-line performance measures. Using a different data set, Weill (1992) disaggregated ICT by use, and found that significant productivity could be attributed to transactional types of information technology (e.g., data processing), but was unable to identify gains associated with strategic systems (e.g., sales support) or informational investments (e.g., email infrastructure).

In a series of study utilizing large firm-level surveys by International Data Group (IDG), Brynjolfsson and Hitt (1993) reported that ICT use improves productivity. The findings of their study

indicate that while gross marginal product of non-computer capital ranges from 4.14 per cent to 6.86 per cent, computer capital on the other hand averages 56 per cent – 68 per cent. Their point estimates of gross marginal products indicate that at the margin computer capital generates 10 times more output than other capital of equal value. The results of their study are similar to those of Brynjolfsson and Hitt (1995), which revealed that up to half of the excess returns imputed to the use of ICT application could be attributed to firm-specific effects.

Research in manufacturing generally finds higher returns to ICT investment than in the services, probably because of better measurement. Most of this research tends to use data from IDG, which is among the largest data sets used in this research area. Indeed, Brynjolfsson and Hitt (1993) attribute the statistical significance of their findings partly to the large size of the IDG data set, which enables them to more precisely estimate returns for all factors. Using comprehensive surveys of the UK engineering industry undertaken in 1981, 1986, and 1993, Kwon and Stoneman (1995) also find that the use of computers and numerical control machines has increased output and productivity.

Conclusion

The review of the literature clearly reveals mixed findings concerning the relationship between ICT investments and increases in economic productivity. Most of these studies were conducted in the 1980s and 1990s and although the findings of the studies undertaken in the 1990s seemed to indicate a more positive relationship between ICT investments and economic productivity, the pattern varied across countries and across sectors. This can be attributed to a number of reasons, including economic and political.

In terms of economic, the review of the literature clearly revealed that countries which are more developed and advanced with strong financial stability have the capacity to exploit and use ICT applications more extensively. To a large extent, the adoption and diffusion of ICT across these countries, which include the United States and more developed countries across the OECD regions have shown positive results in terms of using computers and other forms of ICT applications to enhance their economic development. Part of this is attributed to the level of ICT usage, where in this case computers and other forms of ICT applications are used more extensively to perform higher level activities such as automation, product design, and research and development particularly in the manufacturing sector.

On the contrary, the study also shows that developing countries with weak financial and economic stability are unable to

exploit the use of ICT for economic development as extensively, thus revealing the existence of a weak relationship between ICT investments and economic productivity. To a large extent, Malaysia can be classified under this category, where due to the lack of financial resources and technological know-how, the formulation and implementation of ICT policies in Malaysia is mostly centred on the lower level usage of computers and other forms of ICT applications. This by itself does not justify the heavy government investments to establish its ICT initiatives, nor does it justify the assumptions made by the Malaysian government that heavy investments in ICT will indeed result in economic productivity.

In terms of political, the review of the literature also shows that strong government involvement does contribute significantly to a more effective policy design and implementation and this obviously could lead to a positive link between ICT diffusion and economic productivity. In spite of this, it is obvious that strong government involvement is more effective in smaller countries such as Singapore, where the coordination and implementation of ICT policies is less intense and is more manageable compared to larger countries with greater difficulties in communication such as Malaysia.

This therefore suggests that although strong government interventions may result in a more productive usage of ICT applications, however, developing countries such as Malaysia are still experiencing coordination problems due to the large size of the country. Furthermore, the study has also shown that a large percentage of the country is still underdeveloped, therefore attempts undertaken by the government to promote the extensive usage of computers and other forms of ICT applications for economic development is not feasible, especially since computers are still viewed as a strange object among a large percentage of the rural communities.

Therefore as a summary, although the formulation and implementation of the government's ICT policies have indeed resulted in a significant increase in the uptake of computers and other forms of ICT applications across the various sectors, however, the findings of the study did not reveal any significant evidence to indicate that this can be used as a strong indication to show its positive link to the economic development of the country. More work will need to be done to strategically diffuse ICT adoption and application patterns across the various sectors of the economy.

Note

1 Willcocks & Lester (1999) defined 'ICT Productivity Paradox' as "the concept that, despite massive investments by companies and organisations worldwide in their ICT systems, there still seems to be little pay-off"

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