THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ON ECONOMIC GROWTH IN SOUTH AFRICA: ANALYSIS OF EVIDENCE

MC BREITENBACH, OA ADERIBIGBE & D MUZUNGU [1]

ICT has, over the last 20 years especially, had a profound impact on the way citizens of the world live and do. It has done away with typists, telegraph operators, and many other traditional jobs. It is even starting to eliminate the postman's job. One can hardly imagine a world without a cell phone, television or the Internet. There is today, in the modern sector of every economy not a firm without a budget for ICT expenditure. Yet, there is still little effort made to date, to identify, measure, document and analyse the ICT sector's profound impact on the economy.

The impact of ICT on economic growth and development has however, attracted the attention of researchers. Studies were conducted in Taiwan (Wang, 1999), China (Meng & Li, 2002), United States (US), the Organisation for Economic Cooperation and Development (OECD) countries (Colecchia & Schreyer, 2002), Britain (Dolton & Makepeace, 2004) and the Asian region (Jussawalla, 1999), to determine the role played by the ICT sector on economic growth.

No evidence was found that a similar study was conducted for South Africa. This paper analyses the impact of the ICT sector on economic growth for the South African economy. The paper is divided in three parts. The first part of the paper provides a background to the ICT sector. Part two of the paper gives a brief summary of the literature reviewed in respect of this paper and part three gives an outline of the model used in this study, together with the results.

[1] Associate Professor, Assistant Lecturer and Masters Student, Department of Economics, University of Pretoria, Mamelodi Campus

1. BACKGROUND

According to Avgerou (2001), ICT is an absolute necessity for taking part in today's global economy and as such the role of ICT in the emerging global market cannot be overemphasised. ICT has also been credited with the potential to integrate world economies thus demolishing the barriers created by time and distance. It equally makes easier the trade in goods and services and encourages investment as well as the creation of new sectors of enterprise, new revenue streams and ultimately new jobs (Carayannis & Popescu, 2005).

Meng & Li (2002) maintain that the role of the ICT industry in developing countries is far from clear. This, they reason, might be due the fact that developing countries are short of capital investment and knowledge and they thus lag far behind in ICT-industry development and diffusion in comparison to the industrialised nations.

This late adoption of ICT however, might translate into a competitive advantage for the developing countries, as they have the opportunity to learn from the experience of the developed countries and at the same time adopt the latest generation technologies. The obvious benefit of this is that they need not incur the learning and experimentation cost that typically characterised the adoption of new technologies by the early adopters (Wong, 2002).

The new economy

The adoption of ICT and the consequent increased productivity and economic growth induced by it has been described as the dawn of the new economy. The astounding high rate of productivity in the US, which occurred at the same with the rapid diffusion and production of ICT directly led to the term *new economy* (Daveri & Silva, 2004).

In a broader sense the term would describe everything that is recent and new in the economy. It would imply that the old economic rules like the limits of maximum production capacity and the traditional trade off between inflation and employment would be invalid as a result of efficiency arising from the adoption of ICT. The major

driving force of this new economy has been described as ICT (van Ark, 2002; Meng & Li, 2002).

Components of ICT

Cohen *et al.* (2002) describe ICT "as a collection of technologies and applications which enable electronic processing, storing and transfer of information to a wide variety of users or clients". These technologies and applications are further broadly classified into three categories on the basis of their use, *viz.* (1) computing; (2) communication; and (3) internet – enabled communication and computing (Quibria *et al.*, 2003).

Central to the ICT are the communication processes and infrastructures. The communication processes can either be one-way or two-way. In one-way communication the information is disseminated to the receiver who does not have the opportunity to respond immediately. Examples of this include radio and television. Two-way communication allows for feedback between the sender and the receiver of information. The devices for this include telephones, telegraphs, faxes and pagers.

Relatively recent communication technology like the Internet consists of a number of sub-networks that are connected to each other through which electronic communications are transmitted (Foros *et al.,* 2005). The Internet represents the convergence of computing and communications, and forms the backbone of a knowledge-based economy and information society.

The substantial improvements in computing power, speed, storage and overall capacity have boosted the development the knowledge-based economy and the information society. This has manifested in the evolution of new applications, including hardware, software and services in diverse areas. These areas include government, e-business, entertainment and the arts, science and medicine and knowledge management and dissemination amongst numerous applications (SAITIS, Undated).

ICT sector in South Africa

The ICT sector in South Africa has continued to attract the interest of the government in view of its widely touted potential to contribute to economic growth and development. Government's interest is also due to the wide implications the lack of access to ICT is regarded as having for productivity and growth of both rich and poor countries (Quibria *et al.,* 2003).

In fostering the development of the ICT sector in South Africa, the government has embarked on various initiatives to stimulate the growth of the sector in collaboration with other stakeholders. One of the earliest initiatives is the South African Information Technology Industry Strategy (SAITIS) project, which attempts to set out an Information and Communications Technology (ICT) Sector Strategy Development Framework for South Africa. The SAITIS project, which was conceived in 1995, has as its main objectives "the bridging of the global development gap and the development of a robust, growing and sustainable ICT sector that would directly support and contribute to sustainable economic growth, social upliftment and empowerment" (SAITIS, Undated).

The South African ICT sector is generally acknowledged as including the following major industries according to SAITIS (undated):

- Manufacturing which is made up of
    - Computer Hardware and
    - Telecommunications Equipment.
- Services which encompasses
    - IT Professional Services (including custom software application development and maintenance);
    - Computer Software (packaged software products – cross industry and vertical market applications);
    - Telecommunications Service

The performance of the ICT sector in South Africa has been quite dramatic. However, its share of the ICT global market between year 2000/2001, is estimated at $US

10 billion, which can be considered small when compared to the global market, estimated to be in excess of $US 2 trillion in extent. (SAITIS, Undated).

The telecommunication sector has contributed hugely to the South African economy. The total revenue generated by the telecommunication sector increased from R7 billion in 1992 to R74 billion in 2002. This translates to an increase in percentage contribution of the sector to GDP from 1.9% to 6% over the same period. The growth in the sector was however, accompanied by high retail prices, job losses and little or no foreign investment (Gilwald & Kane, 2003).

Investment in the telecommunication sector, which has been generally limited to network extension and upgrading, has mainly been financed locally. Investment in the mobile sector is estimated at R 3 700 billion in comparison with a total capital investment of R 3 862 by Telkom for the financial year ending 2004 (Gillwald and Esselaar, 2004).

Despite the increase in investment and number of installed telephone lines, access to the telecommunication services has been hampered by high cost. According to Gillwald & Esselaar (2004), the fixed–line call charges have increased at a Compound Annual Growth Rate (CAGR) exceeding 21% since 1997. One of the fallouts of this is the low level of broadband penetration as a percentage of residential lines at 0.008% compared to an average of 1.96 % for other lower-middle-income countries at the beginning of 2004.

The mobile sector has proven to provide easier access to telecommunications. Within a relatively short period of time the number of mobile subscribers overtook that of fixed lines by a ratio of almost 3 to 1. Figures for February 2003 reveal approximately 14,5 million subscribers to the mobile network (Vodacom, 7.5 million; MTN, 5.22 million; and Cell C, 1 million) in comparison to 4.9 million subscribers to the fixed line network (Gilwald and Kane, 2003). It is estimated that about 46.9% of households in the country have regular access to both fixed and mobile telecommunications (Gillwald and Esselaar, 2004).

Internet penetration in South Africa has not departed from the standard path of technological adoption. Empirical evidence has shown that the adoption of new technology is usually weak at the onset until it reaches a critical mass. This is usually followed by a period of exponential growth and then a slow down as the market reaches the point of saturation. Internet penetration in South Africa, between 2003 and 2004 increased by 6% to an estimated 1.1 million dial-up subscribers (Goldstuck, 2004; Gillwald and Esselaar, 2004).

The key players in the South African telecommunication industry are shown in the following table.

Table 1: Major Telecom Operators

Sector	Number of operators	Dominant operators
Fixed wire telephony	1	Telkom
Cellular	3	MTN, Vodacom, Cell-C
Paging	23	Message link, Paging Plus, Carfone
VANS	25	AT&T, Global Network Services, EDS Africa
Radio trunking	3	FleetCall, One-2-One, Q-trunk
Satellite	4	Orbicom, Sentech, Telkom
Public enterprises	2	Eskom, Transtel
ISP's	60+	DIA, Internet Solutios, M-Web
Wireless data	2	Swiftnet, WBS

Source: Barendse, 2004.

South Africa is widely credited as having a highly developed technology and infrastructure in certain sectors of the ICT industry. However, certain structural distortions within the sector have tended to heighten technological dependency and limit growth opportunities. The computer hardware industry is highly import dependent with little or no hardware components being manufactured locally. Local manufacturing concerns however, has a strong foothold in the production of telecommunication equipment due to a strong support from the state. The introduction of digital technology in place of electromechanical technology, has in recent times has put local manufacturers at a disadvantage (Brenner, 2003).

The software industry in South Africa is also significantly associated with the foreign entities conducting business with locally based firms. Brenner (2003) estimates that 50% of total revenue of software applications sold and distributed in South Africa is for imported packaged software. Though locally based firms dominate the services sector component of the ICT industry many of them are equally associated with foreign firms. It thus follows that more often than not the greater part of the operating system software and application development tools are sourced from foreign firms.

2. LITERATURE REVIEW

In an earlier study, Avegrou (1998) argued that there is not much evidence to indicate that ICT has deterministically led to economic growth in most of the developing countries. Wang (1999), in his study of ICT and economic development in Taiwan, also came to the same conclusion when he argued that the study does not find that IT use presents a direct positive contribution to economic growth.

However, recent studies have indicated that technology and innovation are the main drivers of better economic growth attainment in the most developed countries (Vila, 2005) and that there is a close link between productivity growth and technological progress (Nicoletti & Scarpetta, 2003; Daveri & Silva, 2004).

The opportunities created by general-purpose technologies (GPTs) like the steam engine, electricity and ICT in terms of ancillary investments in new product, processes, and organizational technologies, which would not have existed without the GPTs, often sustain economic growth (Lipsey & Carlaw, 2004). The role played by the steam engine in furthering economic growth in Britain in the early nineteenth century has been widely acknowledged (Crafts, 2004).

Plepys (2002) states that GPTs's contribution to economic growth has been due to improvements in labour, resource and capital productivity, and through organisational and technical innovations. Laursen (2004) however, reasons that the effect of GPTs (which includes transportation and communication technologies, the steam engine and

electricity), might actually have been greater in leading to the establishment of new products and services than to higher productivity.

Experience in Britain revealed that as the rate of growth of investment in ICT rose it became a major stimulant for economic growth and a direct contributor to growth in labour productivity (Dolton & Makepeace, 2004). Studies in the Cambridge sub region of the UK also revealed that there is a link between the existence of a cluster of information communications technology based companies in the sub region and the area's fastest growth rate and the lowest unemployment rate in the eastern region (Jonas & Gibbs, 2003).

Colecchia & Schreyer (2002) in their study of the US and OECD countries found that during the second half of the 1990's, the contribution of ICT to economic growth ranged between 0.3 to 0.9 percentage points per year.

Three main channels of ICT-led economic growth has been identified, *viz*. the effect of productivity growth of ICT-producing firms, the adoption of ICT and its productive use in the other sectors of the economy and the spin-offs from ICT in term of the inventions and innovations that emerge in the wake of ICT diffusion (van Ark, 2002).

Studies have shown that industries that engage in intensive use of ICT tend to have a larger contribution to labour productivity growth than ICT producing industries, most especially in the service industry with their intensive adoption of ICT in their business models (van Ark, 2002; Colecchia & Schreyer, 2002). ICT enhances the capability of firms to transfer, collect and manage a great amount of information. This results in a substantial reduction in costs associated with information gathering and utilisation activities within a firm (Carbonara, 2005; Buiter, 2005; Steenkamp & van der Walt, 2004).

With the adoption of ICT, the individual firm also reaps benefits, which include efficiency and effectiveness (Carayannis & Popescu, 2005). The role of ICTs in particularly facilitating the creation of new business models, improving resource planning

and the design, production, finance, and marketing and sales activities within organisations is equally important (Plepys, 2002).

Notwithstanding the huge prospect of economic growth deriving from ICT, several limitations, which may have a high impact on the economy, have been identified. Plepys (2002) examines the rebound effect in the context of ICT whereby an efficiency in the production process leads to a lower cost per unit and thus increasing the demand for it; the continuous exploitation of new compounds for the manufacturing of semi conductors leading to a huge displacement of materials and waste in the mining process; and huge energy consumption. All these, and the disposal of electronic wastes pose a huge environmental problem.

The unemployment problems that could possibly result from increased efficiency and productivity in the business process has been cited as one of the fallouts and undesirable consequences of the rapid adoption of ICT in the developing countries (Meng & Li, 2002; Gillwald and Esselaar, 2004). It is also believed that ICT adoption may widen the gap between the rich and poor nations and lead to a diversion of resources from other areas, with an adverse development impact (Mansell, 1999).

While it is accepted that the acquisition of necessary technology is crucial for improving productivity, it must also be realised that efficiency would not automatically follow the wholesale acquisition of new technology dependent machineries without the domestic capabilities to generate and manage developments in the technologies (Carayannis & Sagi, 2002).

Measurement problems in the ICT sector

While the role of technology in facilitating economic growth has often been reiterated, the most important issue is to identify the proportion of economic growth, which is due to changes in technology and other sources of growth such as the accumulation of physical and human capital (Lipsey & Carlaw 2004).

Concerns have been raised about the measurement of ICT in terms of its growth and contribution to economic growth. Despite the empirical support for the direct relationship between ICT and economic growth in the US, the measurement methods used in respect of ICT outputs, investments and prices have raised a lot of question (van Ark, 2002).

The methodology for the compilation of the GDP figures also presents a problem. The pertinent question here is whether we treat ICT products as final or intermediate products and imported or domestically produced (Schreyer, 2002).

The compilation of price indices is also tricky in that ICT product models undergo rapid changes. This obviously negates the conditions that a product sample must be representative of the whole product group and at the same time the product sample must be comparable between two time periods (Schreyer 2002).

Pohjola (2002) cautions on the need to control the impact of other factors influencing the adoption of ICT and GDP growth in any attempt to measure and draw conclusions on the causal relationship between both variables.

Analysis of time series

The trend in ICT and development literature to focus on areas of intervention in the development process such as health, education, governance, and socialisation to the neglect of models or approaches that cut across different policy areas have been criticised (James, 2005: Saviotti and Pykka, 2004).

Jalava & Pohjola (2002) argue that it is easy to explain the mechanism underlying the structural transformation of the industrial economy into the new economy on the basis of existing economic theories. However, they emphasise the need to use empirical data to support this.

The SAITIS project group identified several key indicators for measuring progress in achieving the goal of sustainable economic growth. These include the following:

- ICT Sector revenues

- ICT Sector employment
- ICT Sector contribution to GDP
- ICT Sector exports
- ICT Sector R&D expenditures
- Number of ICT SMMEs
- ICT investment as a percentage of GDP
- Overall ICT investment in the economy as a whole

However, as good as the indicators may look, the paucity of data in the sector in South Africa poses a serious problem for the adoption of many of the indicators.

In measuring the contribution of ICT to economic growth in South Africa, this paper takes a cue from an earlier study in China (Meng & Li, 2002) and Taiwan (Wang, 1999). Meng & Li (2002) maintain that the contribution of ICT goods and services to economic growth can be measured according to production as well as from the usage side. In the study, they review the contributions of electronics as a percentage of GDP and the ICT share of the labour force as a percentage of China's non-farm labour force in their measurement of the ICT sector. They also look at ICT investments within the economy.

Wang (1999) in the study of Taiwan identify several variables amongst which are telecommunications infrastructure measured by two indicators *viz*. the main telephone lines per 100 population and ICT sales as a percentage of GDP.

3. MODELLING FRAMEWORK

3.1 Empirical framework

The data

The data used in this study consist of 22 observations for the period of 1975 to 2002. The ICT variables used here is the telephone mainlines (per 1, 000 people) and the gross domestic product at constant 2000 prices. GDP is taken as the dependant variable and the number of Telkom Mainlines as explanatory variable. The number of Telkom

Mainlines is used as the Proxy for ICT. Here the focus is on the examination of the casual relationship between the ICT and GDP.

Model

The casual relationship between the likely interdependent variables of ICT and GDP is studied using the times series. A simplified model is used for this purpose:

$\ln GDP_t = \alpha + \beta \ln TELML_t + \mu_t$

Where $\ln GDP_t$ is the GDP

$\ln TELML_t$ the Telcom mainlines per 1,000 people, and

μ_t the stochastic term

3.2 Empirical Results and Discussions

The output

Dependent Variable: LNGDP				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTELML	0.384375	0.036793	10.44683	0.0000
C	11.84051	0.160879	73.59889	0.0000
R-squared	0.807602	Mean dependent var		13.51679
Adjusted R-squared	0.800202	S.D. dependent var		0.137494
S.E. of regression	0.061458	Akaike info criterion		-2.672178
Sum squared resid	0.098204	Schwarz criterion		-2.577020
Log likelihood	39.41049	F-statistic		109.1363
Durbin-Watson stat	0.774266	Prob(F-statistic)		0.000000

According to the results, all the coefficients are statistically significant (p-value< 0.05). The F-statistic is 109.1363 (p-value = 0.0000) is significant and indicate that the model is overall a good fit to the data. The high Adjusted R-squared (0.80) indicate that 80% of the variation in the GDP is described by the variation in the explanatory variable. A 1% rise in the Telecom mainlines will increase the GDP by 4%.

Fig. 1. Actual fitted graph

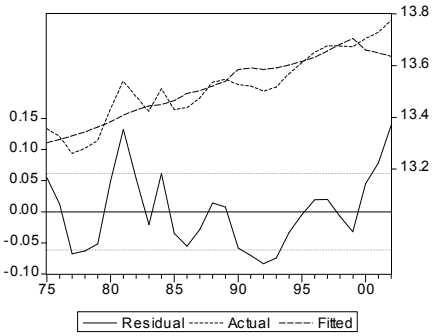
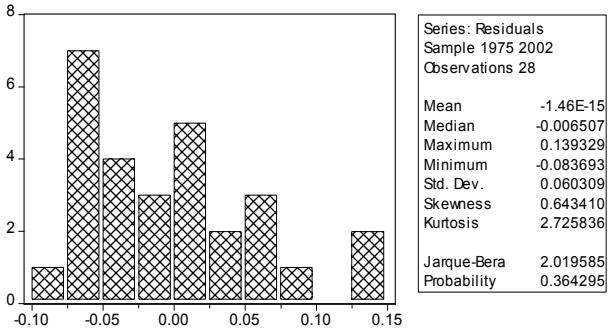


Fig. 2. Normality test



H_0: errors are normally distributed

H_1: errors are not normally distributed

JB is 2.01 (p-value = 0.36) is compare to the critical value $\chi^2(2) = 5.99$. The null hypothesis will be rejected if the JB statistic = 2.01 > the critical value of 5.99. Thus we cannot reject the null hypothesis. We can conclude that the errors are normally distributed.

Stability test (visual test)

Fig. 3. CUSUM simple

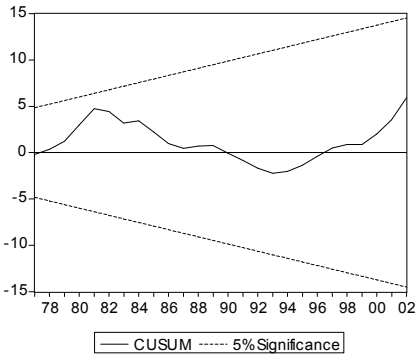
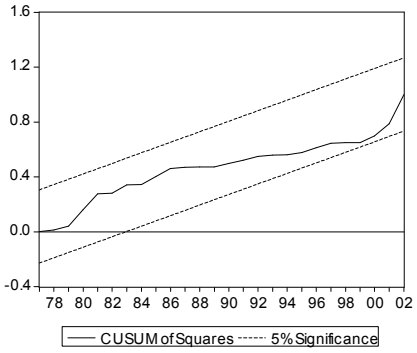


Fig. 4. CUSUM square



Based on these two tests there are indications that the parameters might be very stable. The two tests give the same results. In order to confirm this result, the Ramsey Test was further conducted to determine the stability of the residuals for us to gauge the stability of the parameters.

H_0: Stable regression

H_1: Not stable regression

$\alpha = 0.05$

The log likelihood ratio statistic = 0.33 with p-value = 0.56.

Table 3. Ramsey Test

Ramsey RESET Test:

F-statistic	0.298544		0.589640
		Probability	
Log likelihood ratio	0.332389		0.564256
		Probability	

Table 4. White test

White Heteroskedasticity Test:

F-statistic	13.93418		0.000086
		Probability	
Obs*R-squared	14.75957		0.000624
		Probability	

4. CONCLUSIONS

The main objective of the study was to examine if there exists any evidence of a positive relationship between ICT and the GDP. Within the limitation presented by time and absence of a comprehensive database, the research finding is in line with earlier empirical works by Dolton & Makepeace (2004) and Jonas & Gibbs (2003) which suggested a positive relationship between ICT and economic growth.

Considering the substantial contribution of the ICT sector to economic growth and the magnitude of the growth in the industry it is very important that further studies be conducted to determine the contributions of the ICT at the component level. This may also require further to studies to determine the appropriateness or otherwise of establishing a separate category for the ICT sector in the national accounting system.

All be it, the finding of this study provides a platform for further research into the relationship between ICT and economic growth with a broader variable proxies for the ICT sector being adopted.

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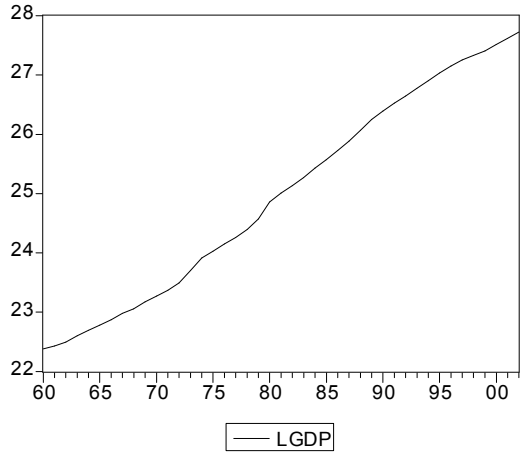
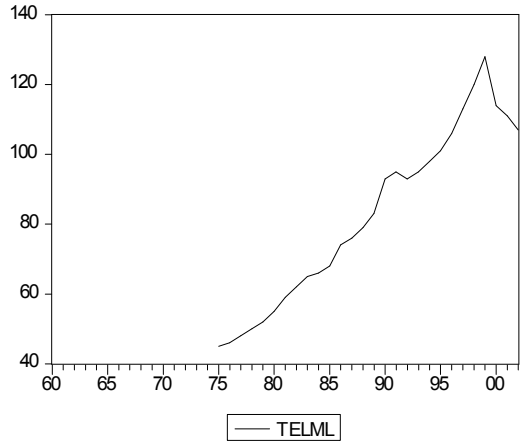
Lgdp line graph



Telml line graph



Arch test

ARCH Test:

F-statistic	1.296578		0.265634
		Probability	
Obs*R-squared	1.331261		0.248581
		Probability	

Lm test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	9.791509		0.000778
		Probability	
Obs*R-squared	12.58115		0.001854
		Probability	

White test

White Heteroskedasticity Test:

F-statistic	13.93418		0.000086
		Probability	
Obs*R-squared	14.75957		0.000624

Probability

Reset test

Ramsey RESET Test:			
F-statistic	29.91148		0.000011
		Probability	
Log likelihood ratio	22.03171		0.000003
		Probability	