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INFORMATION AND COMMUNICATION TECHNOLOGIES DIFFUSION AND ECONOMIC GROWTH: THE GHANAIAN SITUATION

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Abstract
In this paper, Loglet analysis and growth accounting framework have been employed to investigate the rate of diffusion of information and communication technologies (ICT) and the contribution of ICT capital to GDP growth in Ghana over the period 1999-2004. The Loglet analysis indicates that the rate of diffusion of both fixed line and mobile phone services has been phenomenal. For example, Growth Time which is the time required for the trajectory to grow from 10% to 90% of saturation level is 2.5 years for both fixed line and mobile phone services. That of Internet services is 2 years. It has however, been observed that the effect of ICT capital on growth was not significant even though it was positive.

1. The Background

This paper attempts to establish the extent to which Ghana has advanced with regards to the diffusion of information and communication technologies (ICT) and what ICT contribution to GDP growth has been. Studies have underscored the importance of ICT for enhancing the competitiveness of enterprises. Many businesses even in developing countries have Internet access and use it to communicate with suppliers and customers, to search for business information and to showcase their products. These activities require affordable, high-quality access to the Internet and ICT products and services. The economic impact of ICT has been identified as closely linked to the extent to which different ICT technologies have diffused within and across economies. This is partly because ICT is a network technology; the more people and firms that use the network, the more benefits it generates. The diffusion of ICT currently differs considerably between countries, since some countries have invested more or have started earlier to invest in ICT than other countries.

Created from what was then called Coast and the territory of Togoland, Ghana was the first country in sub-Saharan to gain independence in 1957. As of 2022, the country has been home to home to over 30 million people. Despite some economic progress that Ghana has experienced in the last two and half decades, the country continues to face considerable challenges in building the necessary entrepreneurial and innovation capabilities, developing domestic and international trade capacities. Statistics show that 75 per cent of businesses in Ghana fail within the first three years. Those businesses that are able to exceed three years do not go beyond 10 years of operation. "Small businesses constitute over 90 percent of all businesses in the country and the rate of failure is not acceptable."(According to Ministry for Business Development, 2017). ICT

could be crucial in building the capacity of not only small businesses but also all aspects of the economy.

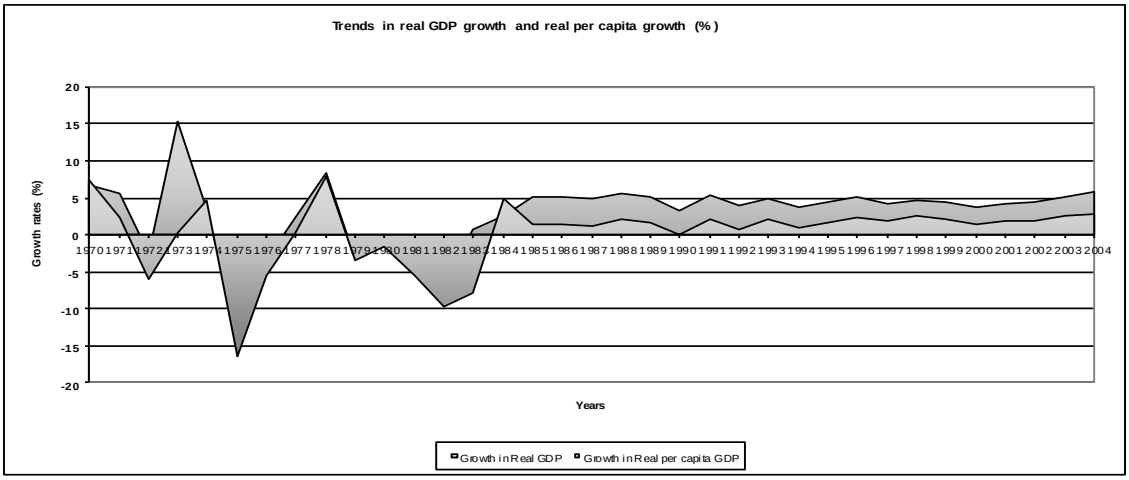
This study therefore, attempts to establish the rate of diffusion of ICT in the country and its role in bringing about economic growth much desired not only to make Ghana a upper middle income country but also to reduce poverty. The data are taken from Institute of Statistical, Social and Economic Research (ISSER) of University of Ghana, Ghana Statistical Service and Ministry of Communication to ascertain the rate of ICT diffusion and how long it will take for these technologies to get to their saturation points in Ghana.

This paper has been organized into ten main sections. The first up to the fourth section touch on the background of the study, the research issue, objectives of the study and the hypothesis. The fifth section is on the theoretical and empirical literature review. The sixth explains the methodology used. Limitations of the model, analysis of results, conclusion and policy recommendation form sections seven up to ten respectively.

2 The Research Issue

Today, information and communication technology (ICT) plays a critical role in the growth and development of not only developed countries but also developing countries. There is a general recognition that most populous nations are leveraging ICT for socioeconomic advancement through widespread adoption and application across various sectors of their economies (Okinawa and Kyushu, 2000). This indicates that, the rate of diffusion of ICT could be critical in driving accelerated and inclusive growth in developing countries in general and Ghana in particular. Over the years, policy makers and development partners have been pushing for policy initiatives to advance and drive the rate of ICT diffusion in developing countries including Ghana. However, the reality is that, policy initiatives not supported by evidence may not work in the interest of all as data and information on the rate of diffusion and the contribution of ICT to the economic performance of Ghana are scant. This paper therefore sought to ascertain the rate of diffusion of ICT and the contribution of ICT capital to GDP growth in Ghana over the period 1999-2004.

Figure 2.1 Trends in Ghana's real GDP growth and real per capita GDP growth (%)



Source: ISSER, 2005

Figure 2.1 shows the trends in Ghana's real GDP growth and real per capita GDP growth (%) over the 1970 -2004 period.

3 The objectives of the study

The main objective of the study is to use the data from the Ghana Statistical Service, Ministry of Communication, World Development Indicators and the Institute of Statistical, Social and Economic Research (ISSER) to:

- Assess the rate of ICT diffusion in Ghana and
- The contribution of ICT to growth in Ghana from 1999-2004

4 Hypothesis

The study will proceed by assuming that ICT has not been a significant determinant of growth in Ghana over 1999-2000 period. The veracity or otherwise of this statement is to be confirmed or disconfirmed by the empirical results.

5 Brief Summary of Theoretical and Empirical Literature

5.1 Theoretical Issues

Theoretical literature has long recognized the potential for information technology (IT) to contribute to economic growth and development. Kraemer and Dedrick (1994) stated that investments in IT that lead to higher factor productivity and increased competitiveness can have a direct impact on economic growth. Many studies have emphasized that there is a leapfrogging element in the use of ICT (World Bank 1998; and Kenny 1995 and 2000). It is argued in these studies that the use of ICT leads to more effective economic reforms as it enhances public administration's efficiency and reduces bureaucracy. In turn, increased access to information and knowledge would result in higher people's participation and higher human development (Hadden 1996; and UNDP 1993 and 2001).

Literature also acknowledges that the role of ICT in enhancing income and human development through reduction of barriers to knowledge and information asymmetries is yet to be empirically tested using data from developing countries. Some studies caution against the assumption that such linkages would indeed occur in the case of developing countries. For example, Avgerou (1998) and Morales-Gomez and Melesse (1998) argue that the transfer of ICT to developing countries may not contribute to economic development the same way it did in industrial countries, and that it may be best to localize technology and focus on its use in education. Thus, there are ambiguous conclusions concerning the link between ICT use and economic growth in developing countries. The issue of the direction of causality needs to be formally addressed and whether ICT-endowed countries reach high-income levels as a result of higher use of these technologies or was ICT diffusion caused by higher economic growth?

5.2 Some Empirical Issues

Kraemer & Dedrick (1994) carried out cross country study of 12 Asia pacific countries, 1984-90 using simple correlation analysis to establish positive correlation between growth in IT investment and growth in both GDP and productivity. Also, an econometric study of 32 countries by Dewan and Kraemer (1998) found evidence of positive and significant returns to IT capital but only for developed countries. In contrast, for less developed countries, they found evidence of positive and significant returns to non-IT capital. They conclude from this that perhaps less developed countries are unable to achieve high returns on IT investments without complementary investments, especially in telecommunications and education. They further argue that the absence of basic infrastructure and government policy can act as an impediment to the successful implementation of IT. These findings suggest that without a critical mass of resources, both in terms of technological infrastructure and human capabilities, less developed countries face steep barriers to technology payoff.

In a study of IT production and use in East Asia, Dedrick and Kraemer (1998) introduce a framework of IT-led development based on four broad sets of variables, namely environmental factors, industrial policy, industry structure and IT diffusion. This framework indicates how industrial policy, industry structure and environmental factors combine to influence the relationship between IT and economic payoffs. For example, industrial policy can encourage firms to invest in IT by providing financial incentives or by sponsoring R&D activities which directly support the creation of an IT industry. Industrial policy can also improve IT diffusion by attracting overseas investment in high-tech industries.

The empirical evidence by Oliner and Sichel (2000), Pohjola (2001) and Jalava and Pohjola 2002) indicates that ICT diffusion has a significant positive impact albeit to varying degrees on GDP growth. In addition, using neoclassical growth models, some studies have shown that IT investment has greatly contributed to economic growth in the United States (Sichel 1997) and in Finland (Niininen 2001).

Lal (2004) conducted firm level study of 51 Indian SMEs using Production Function Framework and he established that labor productivity of advanced ICTs using firms is higher than the rest. This implies that ITC tends to make labour more efficient and thus indirectly affecting productivity growth. Oyelaran-Oyeyinka and Lal, (2005) study on Internet Diffusion in Sub-Saharan Africa, established the importance of telecommunications infrastructure. They found high correlation of telephone density with Internet use, no matter the per capita income level of a country.

6 The Methodology

6.1 Theoretical Framework

This paper uses Loglet analysis (Fri, 1998) and growth accounting framework to assess the rate of diffusion of ICT and its contribution to GDP growth in Ghana.

6.2 Loglet Analysis

Loglet analysis allows for the decomposition of diffusion of ICT into S-shaped logistic components. The study employs the component logistic model, one of two components of Loglet to investigate how autonomous systems such as telephone subscriptions and internet usage exhibit logistic growth. Two main objectives of Loglet analysis are to analyze existing time-series growth data sets in order to decompose the growth process into sub-processes and to elucidate information on carrying capacities and to analyze individual sub-processes in order to determine macro system behavior. At the heart of Loglet analysis is the three-parameter S-shaped logistic growth model. The logistic is attractive for modeling S-shaped growth because it is a parsimonious model where the three parameters (Saturation level, Midpoint and Growth Time) have clear, physical interpretations (Meyer, Yung and Ausubel, 1999).
This follows a form of the logistic equation:

N(t)=K/(1+exp(-a(t-b)) (1)

N(t) is the ICT variable under investigation. The parameter K is the asymptotic limit that the logistic curve approaches for the particular ICT variable. The parameter b specifies the time when the curve reaches 1/2 K, or the midpoint of the growth trajectory. The parameter a is the growth rate parameter that indicates the "width" or "steepness" of the logistic curve. The logistic is symmetric around the midpoint b.

6.3 Growth Accounting Framework

The paper also employs a growth accounting framework to measure the contribution of ICT to economic growth. In this paper we apply the neo-classical growth accounting framework developed originally by Solow (1957). This framework has been extensively applied in other studies on the ICT contribution to growth, such as Oliner and Sichel (2000), Jorgenson and Stiroh (2000), Schreyer (2000), Daveri (2000), among others.

6.3.1 Channels through which ICT affects Growth

Information and communication technology affect output and economic growth in the following three basic ways (Pohjola, 2002):

- The production of ICT goods and services forms part of the total value added generated in an economy.
- The use of ICT capital as an input in the production of all goods and services generates economic growth.
- ICT can enhance economic growth via the contribution of ICT industries to technological change

6.4 Model Specification

We start from a growth accounting function that relates GDP growth rates (Y) to three independent variables namely growth rate of labour force (L), growth rates of ICT capital © and growth rates of non-ICT (K). Following Pohjola (2002), we write the growth equation with the hats indicating growth rates as follows:

$$\hat{Y} = \hat{A} + \alpha_c \hat{C} + \alpha_K \hat{K} + \alpha_l \hat{L} \quad \text{.....2}$$

The only difference between equation 2 and that of Pohjola (2002) is that it excludes human capital (H) and that is supposed to be accounted for by total factor productivity (A).

Empirical growth accounting began with the famous studies of Abramowitz (1956, 1962) and Solow (1957). Their procedure in calculating total factor productivity (A) was to deduct the growth rates of capital and labor (multiplied by their respective factor prices) and ascribing the "residual" to technical progress. In this paper, we are forced to drop human capital because we have only limited data (1999 -2004) and the concern here is to account for the contribution of ICT capital to growth only.

7 The Limitations of the Model

The neoclassical approach is blamed mainly for one of its corollaries, convergence and for the fact that it conceives technical progress as an exogenous factor, Romer (1986, 1994) and Lucas (1988), Pack (1994), Grossman and Helpman (1994). In addition to this, it negates the role of economic policy in the growth process, except transitionally, and while awaiting the achievement of the steady state (Tanzi and Zee, 1996; Fischer, 1993; Easterly and. Rebelo, 1993). In this study, it is no problem because, the aim is to find the contribution of ICT- capital to growth. We thus have two types of capital ICT and non-ICT capital.

8 Data Presentation and Analysis

This section addresses the issues raised earlier beginning with the assessment of the rate of diffusion of ICT in Ghana and then analyze its contribution to economic growth over the period 1999-2004.

8.1 Assessment of the rate of ICT diffusion in Ghana (1998-2004)

8.1.1 Telephones Services

TABLE 8.1: Distribution of Telephone Subscriptions by Telecom Companies, 1999-2004

Company	Type of Service				Teledensity	
	Fixed line	Payphone	Mobile	Total	2003	2004
Ghana Telecom	313,047	9,933	136,732	459,712	1.8	2.2
Scancom (Spacefon)			630,000	630,000	2.5	3.0
Millicom (Mobitel)			244,000	244,000	0.7	1.2
Kasapa			50,097	50,097	0.2	0.2
Westel	2,603	165		2,768	0.0	0.0
Capital Telecom	500			500	-	0.0
Total	316,150	10,098	1,060,829	1,387,077	5.2	6.6

Source: National Communication Authority (NCA), Accra

In Ghana, teledensity, which is the proportion of phone lines to the total population, has increased remarkably in recent years, from 1.8% at the end of 2002 to about 5.2% by 2003, and then to 6.6% at the end of 2004 (Table 8.1). The increase is due to the expansion of services from three providers, Ghana Telecom, Millicom, and Scancom. The number of phone lines in Ghana more than doubled from about 650,000 in 2002 to over 1,300,000 in 2004 for an estimated population of 20 million.

8.1.1.1 Loglet Analysis of Fixed Line and Mobile Phone Services

In figures 8.1 and 8.2, there has been the decomposition of diffusion of fixed line telephones and mobile phone services into S-shaped logistic components respectively. For fixed line telephone services in figure 8.1, the saturation (K) which is the asymptotic limit is 319311.5, the midpoint (tm) is mid of 2001and Growth Time which is the time required for the trajectory to grow from 10% to 90% of limit K is 2.5 years.

Figure 8.1

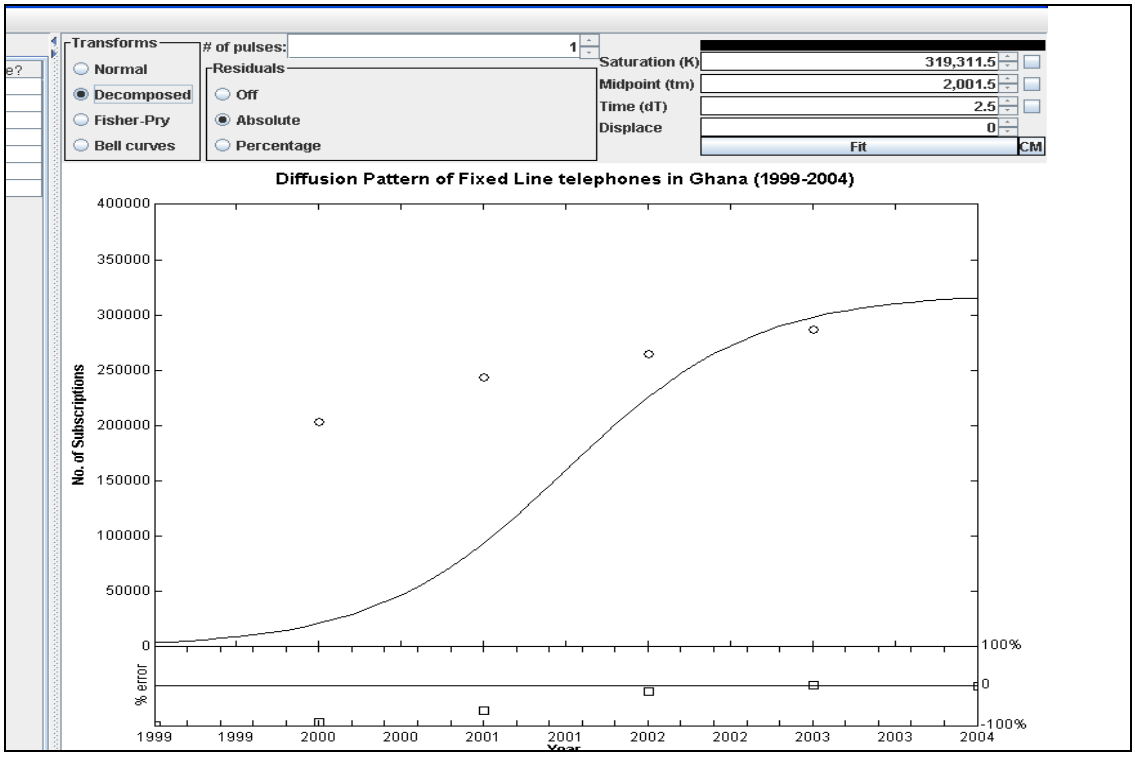


Figure 8.2

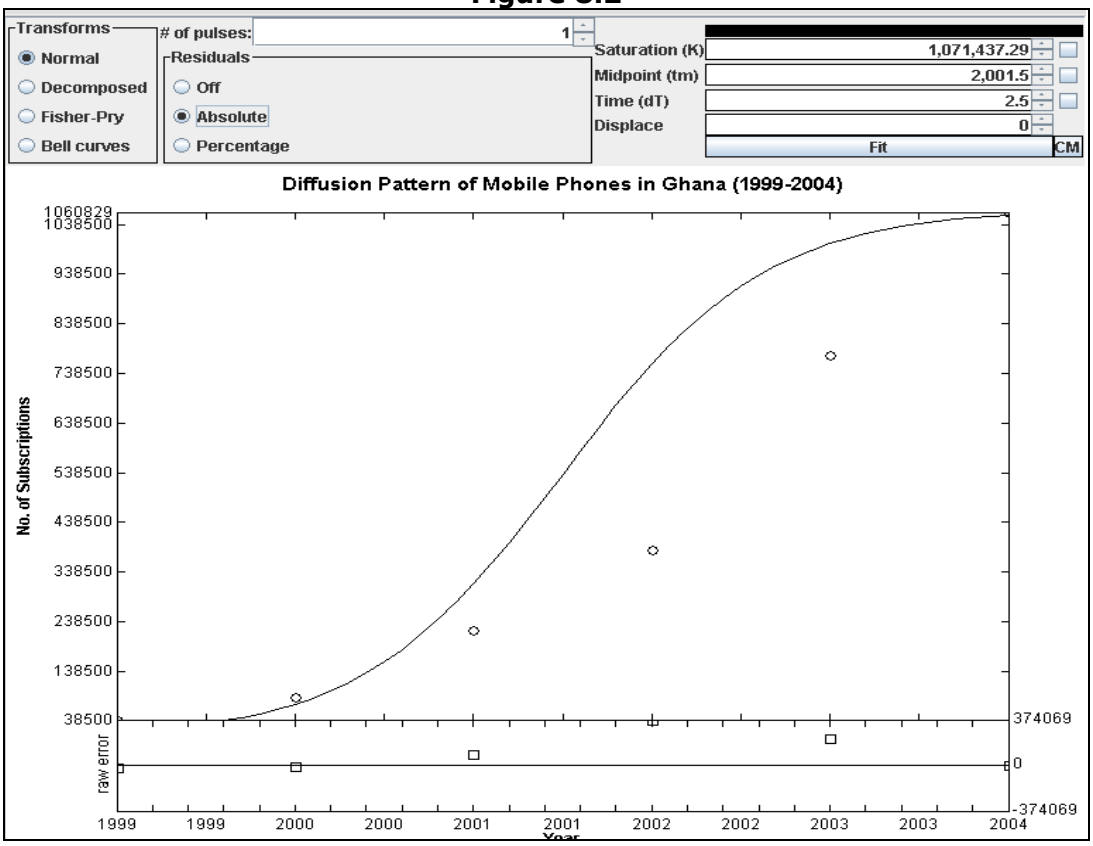


Figure 8.2 shows the rate of diffusion of mobile phone services in Ghana and just like fixed line telephones the saturation (K) which is the asymptotic limit is higher 1,071,437.29, the midpoint (tm) is mid of 2001and Growth Time which is the time required for the trajectory to grow from 10% to 90% of limit K is 2.5 years

8.1.2 Radio Services

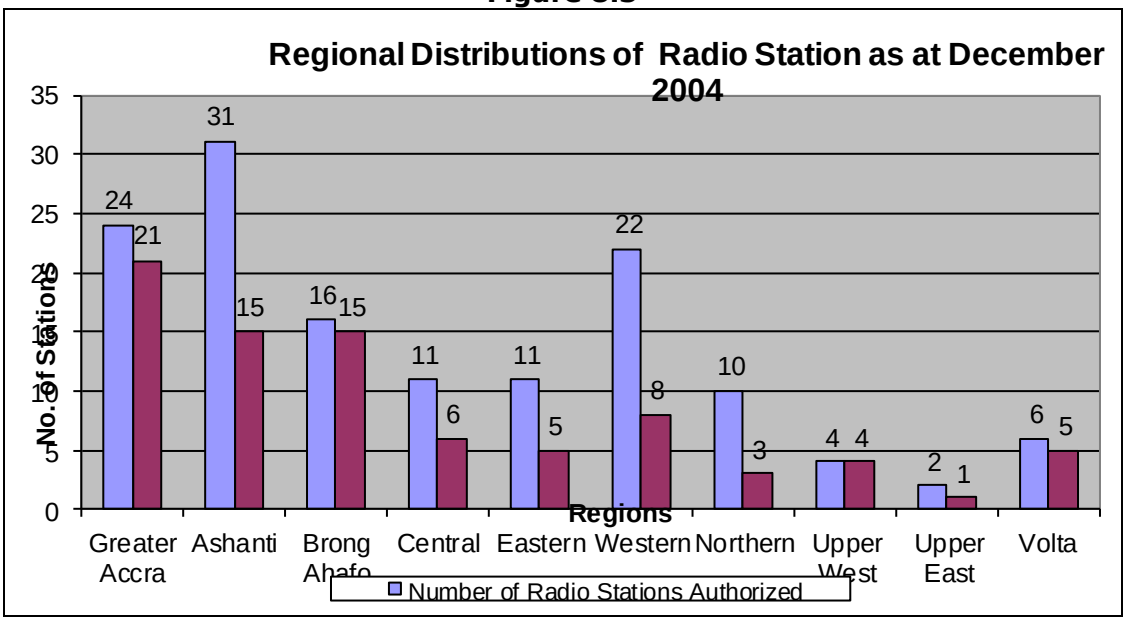
There has been a moderate increase in the number of radio stations in recent years, though they tend to be concentrated in urban centres such as Accra, Kumasi, Sunyani and Sekondi-Takoradi (Table 8.2). It is also worth noting that by the end of 2004, about 40% of the total number of authorized radio stations were not in operation especially in the Ashanti, Western and Northern regions.

TABLE 8.2 Radio Stations as of December, 2004

Region	Number of Radio Stations Authorized	Number of Radio Stations Operational
Greater Accra	24	21
Ashanti	31	15
Brong Ahafo	16	15
Central	11	6
Eastern	11	5
Western	22	8
Northern	10	3
Upper West	4	4
Upper East	2	1
Volta	6	5
Total	**137**	**83**

Source: ISSER, 2005

Figure 8.3



8.1.3 Internet Services

Internet service providers (ISPs) have grown at a slow pace and fewer than half the number of ISPs authorized per year go into operation. Of the 119 ISPs authorized by December 31st 2004 only 18(or about 15%) were in operation (Table 8.2).

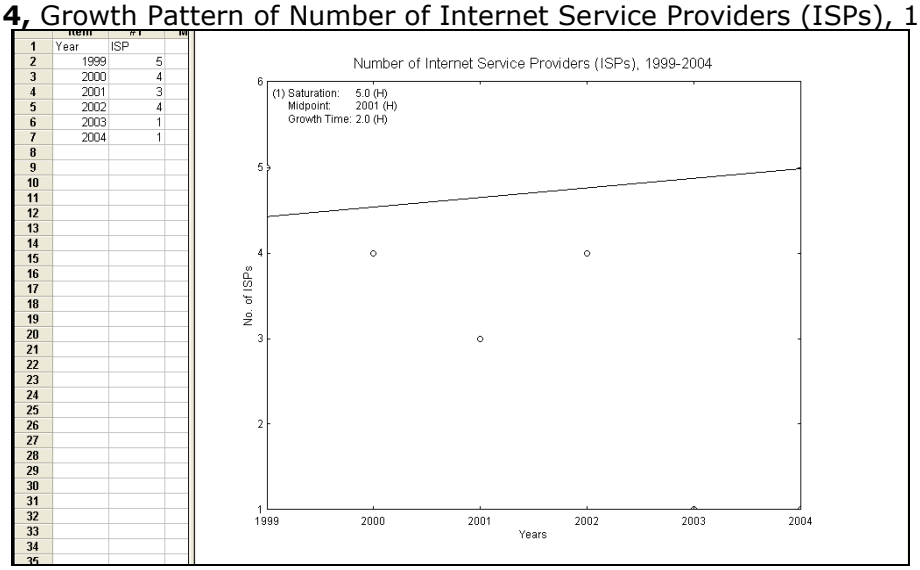
TABLE 8.2 Number of Internet Service Providers (ISP), 1999-2004

Year	ISPs Authorized per year	Operational ISPs
1999	11	5
2000	21	4
2001	26	3
2002	30	4
2003	8	1
2004	23	1
Total	119	18

***Source*:** National Communications Authority

Though awareness of the benefits of ICT is increasing among individuals and businesses, access is limited, personal computers, telecom services and Internet dial-up rates are still somewhat expensive and infrastructure in information and communication is expanding at a sluggish pace.

Figure 8.4, Growth Pattern of Number of Internet Service Providers (ISPs), 1999-2004



	Year	ISP
2	1999	5
3	2000	4
4	2001	3
5	2002	4
6	2003	1
7	2004	1

Figure 8.4 illustrates the growth pattern of Internet Service providers. The saturation (K) which is the asymptotic limit is 5, the midpoint is 2001and Growth Time which is the time required for the trajectory to grow from 10% to 90% of limit K is 2.years. Letter 'H' appeared by the parameters indicates they some parameters have been held constant. The logistic curve indicates faster growth rates of Internet Service providers in Ghana.

Figure 8.5 shows the growth pattern of Internet users in Ghana. Here, the saturation (K) which is the asymptotic limit is 9.2, the midpoint is 2003 and Growth Time which is the time required for the trajectory to grow from 10% to 90% of limit K is 3.9 years. In figure 8.6, it can be seen that for telephone services (Fixed line and mobile phone), there was a sharp rise in 2001, a decline in 2002 and gradual rise in 2003.Population and GDP growth rates showed a steady increase even though, interestingly, GDP growth is ahead of population growth rate, a positive sign for a better future for the economy.

Figure 8.5 Growth Pattern of Internet Users in Ghana, 2000-2003

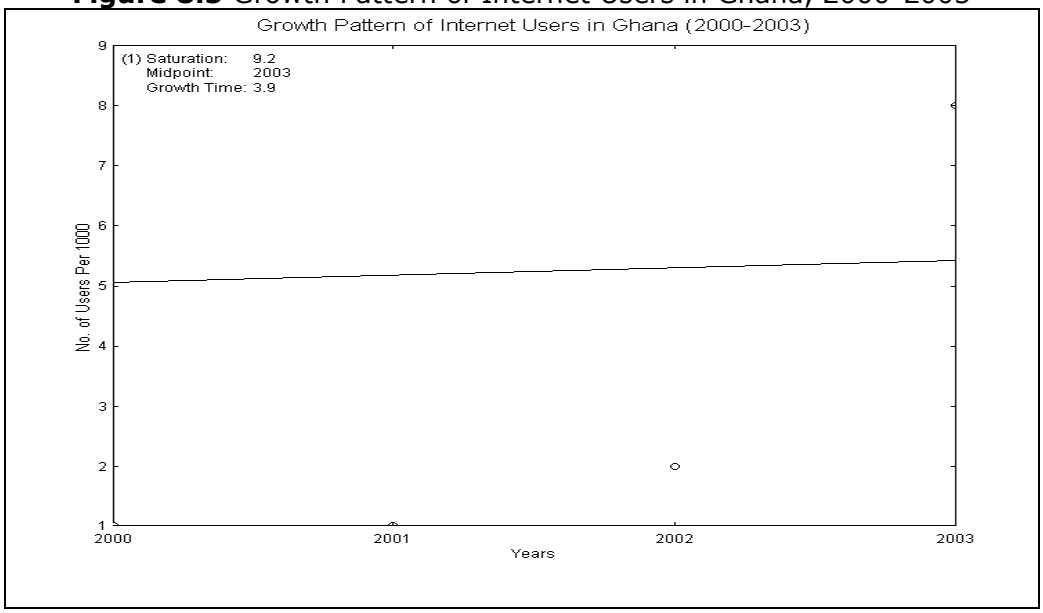
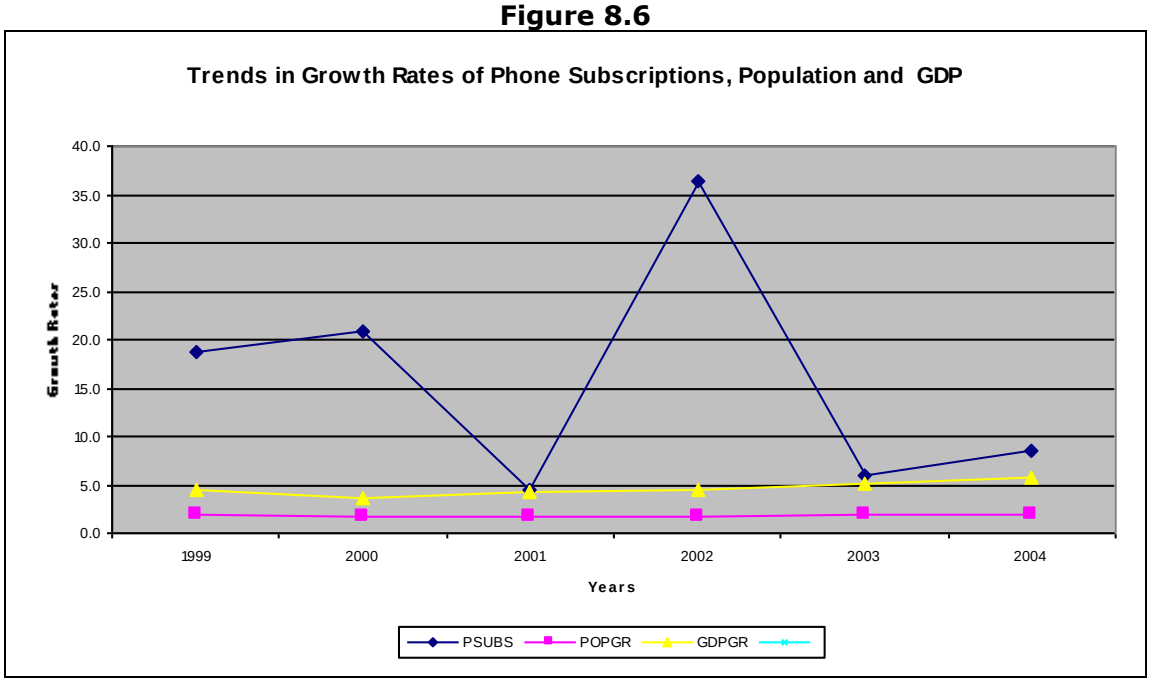


Figure 8.6



8.2 Contribution of ICT to Economic Growth

This part tries to establish ICT contribution to Economic growth in Ghana. Tables 8.3 and 8.4 show the results for a model without ICT capital and that with ICT-capital respectively. Only non-ICT capital appeared to be significant at 10% in table 8.3. This is in line with Dewan and Kraemer (1998) evidence of positive and significant returns to non-IT capital for less developed countries. In Table 8.4 where ICT capital (growth of telephone service) was added, they appear not to have a significant effect on growth over the 1999-2004 period. This is in contrast to what Oliner and Sichel (2000), Pohjola (2001) and Jalava and Pohjola 2002) pointed out that ICT diffusion has a significant positive impact albeit to varying degrees on GDP growth in some developing countries. May be there is a minimal level of ICT that must be attained by Ghana before its effect will become significant.

The hypothesis that ICT has not been a significant determinant of growth in Ghana over 1999-2000 period has been confirmed by this result. Avgerou (1998) and Morales-Gomez and Melesse (1998) argue that the transfer of ICT to developing countries may not contribute to economic development the same way it did in industrial countries, and that it may be best to localize technology and focus on its use in education.

The positive sign of all the variables in the two models indicate that both dependent and independent variables increase and decrease simultaneously over the period under investigation. On the whole, the two models perform quite well as 67% of variation in real GDP growth is explained by the explanatory variables in table 8.3 while 83% of variation in real GDP growth is explained by the explanatory variables in table 8.4 even though the F-statistics in both cases show that the variables were not jointly statically significant. This model appears to be very restricted and no evidenced of even the coefficients adding up to 1.

Table 8.3: Modeling Real GDP Growth by OLS: The present sample is: 1999 - 2004

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	3.409198	4.686630	0.727431	0.5196
Labor Force Growth	0.408488	1.921909	0.212543	0.8453
Non-ICT Capital Growth	0.020298	0.008106	2.503962	0.0874*

* Significant at 10%, R2 = 0.679687, Prob (F-statistic) = 0.181285
Durbin-Watson stat =1.710365

Table 8.4 Modeling Real GDP Growth by OLS: The present sample is: 1999 - 2004

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	2.385469	4.297035	0.555143	0.6346
Labor Force Growth	0.539110	1.735250	0.310682	0.7854
Non-ICT Capital Growth	0.031391	0.011229	2.795495	0.1077
ICT Capital Growth	0.036702	0.028212	1.300957	0.3230

* Significant at 10%, R2 = 0.826505, Prob (F-statistic) = 0.248605
Durbin-Watson stat =1.915099

9 Conclusions

In this paper, Loglet analysis and growth accounting framework has been employed to investigate the extent to which the rate of diffusion of ICT and GDP growth that is empirically observed in Ghana over the 1999-2004 period is due to ICT capital (growth of telephone services). The Loglet analysis indicates that the rate of diffusion of both fixed line and mobile phone services has been phenomenal. For example, Growth Time which is the time required for the trajectory to grow from 10% to 90% of limit K is 2.5 years for both fixed line and mobile phone services. That of Internet Services is 2 years and 3.9 years for internet users. These rates of diffusion are incredibly fast compared to the slower rate of diffusion of most technologies. It has however, been observed that the effect of ICT capital on growth was not significant even though it was positive, an indication of the right sign and direction.

There is no doubt that the use of ICT is perceived by many as a catalyst for economic growth. Since ICT performs important functions such as improving the functioning of markets with regards to what to produce, how to produce, what to sell, how to sell, where to sell, it can have a direct effect on growth. Clearly ICT is indispensable for this function. Also, ICT can play a major role in the area of production and delivery of educational content in Ghana. It is worth noting that the proximate causes of poverty which the government of Ghana wants to reduce can be seen as two gaps: the ideas gap and the objects gap. The objects gap is the lack of physical resources that contributes to persistent poverty. The ideas gap is the lack of know-how about how to make the best use of the resources one has. It is the ideas gap that ICT can most effectively bridge. Given the fast rate of diffusion of ICT in Ghana, its growth effect is yet to be realized.

10 Policy Recommendation

The positive relationship between ICT capital and GDP growth that has been established in this paper tends to suggest that broad based ICT use should be encouraged so as to realize significant benefits at the macro level. For a small country like Ghana, domestic use of ICT is crucial for developing the human capital required for the export market. The government of Ghana's effort to tap the potential of ICT by an Integrated ICT-led Socioeconomic Development Policy and Plan must be encouraged and implemented. It is also important that institutions that encourage the use of ICT domestically should be created so as to instill the culture of ICT usage into both the older and younger generations. The prejudice regarding ICT and economic growth in Ghana is that its use is critical. Whether its contribution to growth is borne out by empirical studies or not is another issue.

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