

# **CAPITAL MARKET GROWTH AND INFORMATION TECHNOLOGY: EMPIRICAL EVIDENCE FROM NIGERIA**

**Chinedu B. Ezirim**  
**Rose Uyoyou Adebajo**  
**University of Port Harcourt, Nigeria**

**Uchenna Elike**  
**Alabama A & M University, Normal**

**Michael I. Muoghalu**  
**Pittsburg State University, Kansas**

## ***ABSTRACT***

*This paper utilizes the modified Gompertz technology diffusion model to investigate the effects of information and technology on the growth and development of capital market in Nigeria. The results reveal that growth in market capitalization is affected by the level of interaction between stockbrokers and investors brought about by ICT in the form of internet access, telephone (mainlines and mobile) as well as access to the websites of stockbrokers. Growth in the total volume and value of shares traded is significantly affected by communication technology (telephones). The number of securities listed on the Stock Exchange as well as the growth in federal and state government bonds does not appear to have any significant relationship with the adoption of information and communication technology. Private debt stock appears to have been significantly affected by information and communications technology especially in respect of increase in the number of stockbrokers and access to ICT. Generally, Information Technology has contributed to growth of the Nigerian Capital Market, with the effect mostly seen in the availability of information to investors and the improvements in the trading patterns of the Nigeria Stock Exchange.*

## **INTRODUCTION**

The effect of information and communication technology (ICT) on the growth and development of capital markets has been a subject of debate in recent times. A school of thought led by authors like Shiller (1989), Summers (1988), Porteba and Summers (1988) would argue that capital markets have become excessively volatile since the adoption of computer assisted trading strategies as the latter increase short-term price volatility and risks. They also argue that very few investors have access to online trading systems. Few actually own computers and have easy access to the Central Securities Clearing System (CSCS). Many investor, they claimed, do not have access to a system that sends orders to stockbrokers for automated execution. They also contend that ICT driven capital market operations are fraught with fraud and manipulation, which mostly affect individual investors. A case in point relates to the sale of shares without authorization of the stockholders, a practice that is given impetus by greed and dishonesty of some market participants. They further argued that surveillance problems and the lack of proper enforcement of penalties by the legal system make the adoption of a fast-paced ICT system dangerous to investors.

The second school of thought, which includes authors like Fama (1990, 1991), Fama and French (1988), on the other hand, argued that information technology have made capital markets more efficient as attendant stock prices now reflect important information and investors perception of stocks more swiftly. In their contention, ICT has made the Capital market more efficient by providing all participants with faster and more effective means of exchanging information. They maintained that new products and instruments have been made readily available as a result of the advent of sophisticated ICT. Evidently, capital markets can be more resilient, possess greater depth and breadth with the intervention of ICT.

It must be observed that the premises of the above theorizing are capital markets in developed countries. Would their arguments hold true for the Less Developed Countries (LDC)? Which school of thought would appropriately explain the experiences of the LDCs? Perhaps the critical questions that need to be addressed would include: Has the adoption of information technology had a positive or negative impact on the Nigerian Capital Market? Has ICT transformed the way business is conducted on the Exchange? Has ICT benefited the Nigerian investor? The plethora of research questions can go on and on. However, this paper seeks to ascertain how the adoption of information technology has impacted on stock market development indicators and the way business is conducted on the Nigerian Stock Exchange. A possible area of future research would relate to the benefits of ICT adoption by the capital market to the Nigerian (individual) investor, which is not presently covered in this paper.

This paper adopts an internal influence model with the population of interest being participants in the Nigerian Stock Exchange (NSE). Samaddar et al (2002) studied internal influence models (Gompertz, logistic and exponential models) and found that the Gompertz model best characterized current and future ICT growth/diffusion. The aim of this paper is not to investigate the innovations but to ascertain the impact of ICT innovations on trends in the stock exchange development indicators. The next section provides a brief overview of technology diffusion theory and an examination of previous literature. Section 3 reviews the Nigerian Capital Market development indicators while section 4 outlines the methodology employed. Section 5 presents a discussion on the empirical results, section 6 concludes and section 7 outlines recommendations that would increase the potential ability of the Nigerian Capital Market to utilize new information and technology innovations.

## **LITERATURE REVIEW**

This section starts with conceptual clarifications of some important terms implicated in the topic. Such terms include diffusion, information diffusion model, capital market peculiarities and information and communication technology.

Rogers (1995, 2003) defines diffusion as a 'process in which an innovation is communicated through certain channels over time among the members of a social system'. Simply, diffusion is the way a given information and technology innovation spreads amongst a given population. Traditionally, there are two widely used diffusion models – the internal influence model and the external influence model. The former assumes that there is a given level of interaction among the subjects of the given population such that knowledge of the innovation is disseminated through the interaction channels to the entire population. This model is represented by an S curve (Mahajan & Peterson, 1985) and it captures the slow beginning (low awareness), rapid expansion and the leveling off as it spreads throughout the population. The

external influence model presumes little or no interaction between members of the population and therefore the transmission mechanism is exogenous to the given population.

The current stock of finance and economics literature on the diffusion of ICT have focused on the impact of stock market financing (as opposed to bank financing) on ICT growth and development as well as the determinants of ICT development (Saint-Paul, 1992, Black & Gibson, 1998, Allen & Gale, 1999). This probably accounts for the dearth of literature on the impact of ICT diffusion on stock exchange development indicators. Several researchers have examined the benefits of adoption of ICT in developing as well as developed capital markets. Such studies agree that ICT makes capital markets more efficient for example Mahonney (1997) describes the securities markets as where information technology innovations often lead to changes in the way securities transactions are negotiated, executed, cleared and settled.

In a study on stock market development in sub-Saharan Africa, Yartey and Adjani (2007) proposed that the adoption of a robust electronic trading system and a central depository system among others are key preconditions for addressing the prevalent problem of liquidity as these stock exchanges seek regional integration.

The paper elucidated some problems peculiar to stock exchanges in Africa, which the adoption of ICT could minimize. First is that only a few stocks are traded on the floor of the market on daily basis and these few stocks account for a large part of the total market capitalization. Secondly, problems of information and disclosure deficiencies abound for most stocks in an environment of inadequate regulatory authorities. Thirdly, the markets are small with few listings, low market capitalization, low liquidity as measured by the turnover ratio and low business volumes. The paper however noted that stock exchanges in Africa were among the best rated for high returns on investment citing the Ghana Stock Exchange as number one in the world in 2004.

Lucas et al (2002) analyzed adoption of ICT in the New York Stock Exchange (NYSE) and concluded that the NYSE invested in ICT to create new resources for advantage and to enhance existing resources. According to the paper, ICT provides for efficient trade executions and adequate trading capacity, ensures a high quality securities market and reduces labour expenses and the demand for physical space. Levine (1991) proposed that stock market liquidity – ability to trade shares easily- which is facilitated by ICT play a key role in economic development.

Clemons and Weber (1990) examined the 1986 Big Bang reforms of the London Stock Exchange and argued that the adoption of ICT and the exchange's new screen based market were a strategic necessity.

The available literature examined suggests that automation of stock exchanges reduce the costs and inefficiencies associated with share trading, increase trading activity and liquidity. Also adoption of ICT speeds up operations and activities of the exchange and reduces costs associated with manual systems. ICT enables the exchanges extend trading days and hours as cumbersome processes are eliminated. It also eliminates the need for intermediation (stockbrokers) as investors can monitor markets and trade online. The Central Securities Clearing System (CSCS) enables shares to exist in electronic form and thus helps eliminate risks of loss, mutilation and theft of certificates as well as reduce errors and delays. Finally, the adoption of ICT would help in the integration of African Stock Exchanges.

On the relationship between capital markets and ICT development in an economy, King and Levine (1993) contend that capital markets facilitate the diversification of ICT risks and therefore positive development of stock markets enhances innovations in ICT. However, Singh et

al (2000) investigated the relationship between ICT and the capital market using multivariate regression analysis on cross sectional data from 63 countries including both emerging and developed economies. They found that stock markets are neither necessary nor sufficient conditions for promoting the development of ICT. The econometric analysis did not reveal any robust systematic relationship between stock market development indicators and ICT development indicators.

Similarly, Yartey (2006) examined the role of financial development and financial structure in explaining cross country diffusion of ICT. The paper found that the structure of a country's capital market does not appear to have any significant relationship with the level of ICT development. Financial development however was found to be an important determinant of ICT development and the paper therefore emphasized the need to develop financial markets in emerging economies. Previous researchers attempted to establish relationships between ICT diffusion in an economy as facilitated by capital markets.

This paper contributes to current literature by examining ICT diffusion in the Nigerian Stock Exchange with a view to ascertaining its impact on the stock market development indicators. The results obtained would answer to a large extent the question of whether the increase experienced in the stock market development indicators can be attributed to the adoption of ICT.

## **THE NIGERIAN CAPITAL MARKET DEVELOPMENT**

### **Historical Background**

The Nigerian Capital Market was established in 1961 to provide and sustain the capital requirements of the Nigerian economy. The mechanism for mobilizing long term funds for investment purposes is the Nigerian Stock Exchange. Between 1961 and 1997, the stock exchange operated a manual call over system with its inherent problems, which could be summarized as undue delays, high risks and manipulations due to long transaction cycles, minimal transparency and therefore a general lack of confidence in the system (NSE, 2006).

Information and communication technology (ICT) transformation in the Nigerian Capital Market began in 1997 with the establishment of the Automated Trading System (ATS). This is a system that enables dealers trade through a network of computers connected to a server using the queuing system. Thus stockbrokers, investors and dealers have equal access to information for purchase and sale of securities and can execute transactions through a network of computers even from remote locations during the Exchange's trading hours. This has enabled more participants to trade daily boosting liquidity and creating opportunities for price discovery. The ATS eliminated price manipulation, which was prevalent during the call over system and also reduced transaction cycles.

In 1999, the Nigerian Stock Exchange introduced a computerized clearing, settlement and delivery system for transactions in listed shares known as the Central Securities Clearing System (CSCS). The CSCS is interfaced with the ATS thereby facilitating a T+3 transaction settlement cycle. In addition, the CSCS is responsible for dematerializing share certificates of quoted companies and storing them in electronic form in a central depository. Other ICT adoptions include the CSCS trade alert, phone-in-service, e-bonus and e-dividend payments.

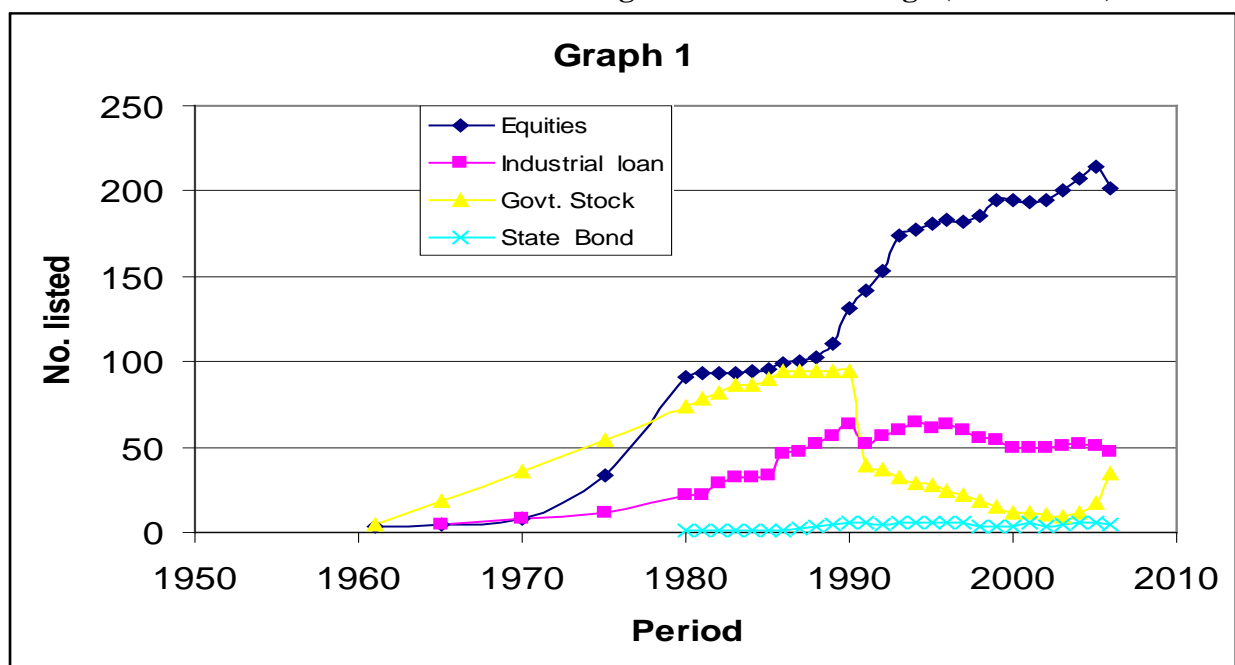
## Capital Market Development Indicators in Nigeria

This paper combines both theoretical and empirical approaches to examine the trends in the stock exchange development indicators. The availability of information on listed companies and the operations of the Capital Market in Nigeria have played significant roles in raising the awareness of Nigerians including individual investors, institutional investors and companies seeking funds in the market. This is evidenced in the tremendous growth in all the development indicators examined. These are measures of Market size and liquidity (Securities Exchange Commission, SEC, 2005).

### Market size

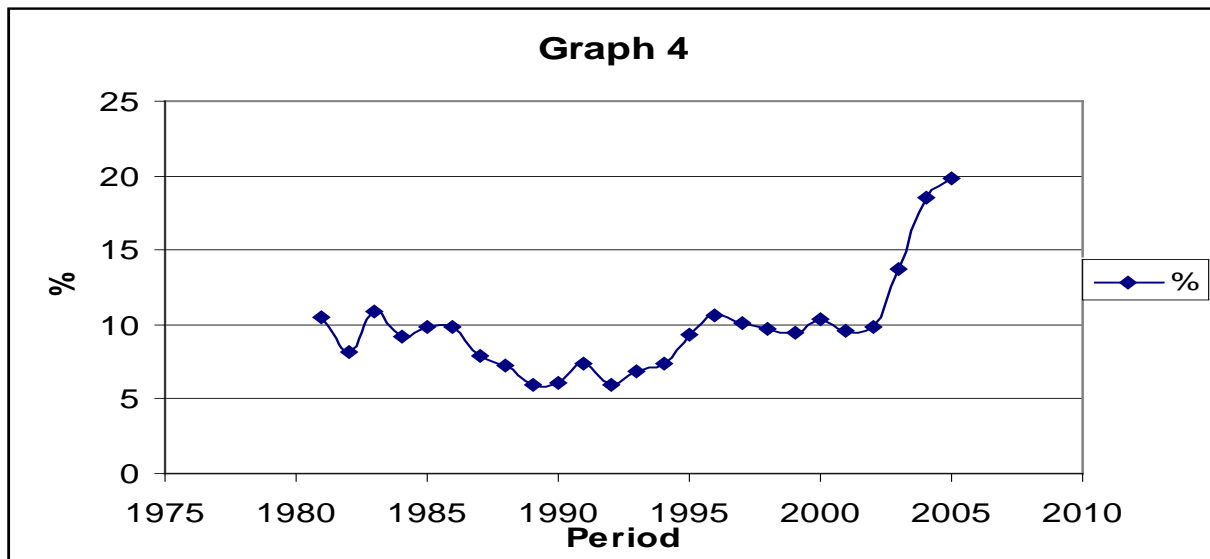
Economic theory postulates that market size is positively correlated with the ability to raise capital and diversify risk. Therefore it follows that the larger the market, the greater its ability to attract capital from surplus sectors of the economy and also the more efficient its ability to diversify risk. Two measures of stock market size considered are the number of listed shares and market capitalization. Figure 1 shows the growth in the number of listed securities on the Nigerian Stock Exchange for the period 1961 – 2006. The Figure reveals that the number of listed shares grew from 8 in 1961 to 288 in 2006 taking into account new listings and de-listed securities. The trend evidences a continued rise in the activities of the market especially in the Equity market mostly powered by Banks, although the debt and bond markets witnessed a steady decline after 1990. The plausible explanation for this increase, other than government policies like the reduced listing requirements for the second tier securities market, is the expansion in availability of information, which has led to increase in investor confidence and transparency in the capital market, all brought about by the adoption of information technology in the Nigerian Stock Exchange.

**Figure 1**  
**Growth of listed securities on the Nigerian Stock Exchange (1961 - 2006)**



The second measure of market size in the Nigerian Capital Market is the value of market capitalization. This is an aggregate value of the total number of issued and paid-up share capital multiplied by the prevailing share price for each company. Table 3 (Appendix) reveals that total market capitalization increased from N5 billion in 1981 to N7.7 trillion in April 2007, out of which equity capitalization amounted to N6.7 trillion and Government securities N1 trillion. This upward trend shows that the market is bullish on the average. The Securities and Exchange Commission explains Market Capitalization as an indicator of investor's perception or assessment of a company and by implication the market as a whole. Therefore, the market capitalization data reveals the increased level of activities and sophistication which can only be brought about by information technology. In particular, the upward swing in the market capitalization can be traced principally to new listings and firmer prices arising from positive market sentiments (Ndanusi, 2003). In addition, a comparison of the market capitalization data to the Gross Domestic Product of the economy reveals an upward trend as shown in Figure 2 (graph 4). Market Capitalization as a percentage of GDP grew from 10.5% in 1981 to 19.8% in 2005 complementing the steady growth trend in the economy as reflected in growth indicators and suggesting rapid stock market growth. This shows that market capitalization is growing faster (in percentage terms) than the Gross Domestic Product.

**Figure 2**  
**Market Capitalization as percentage of Gross Domestic Product**

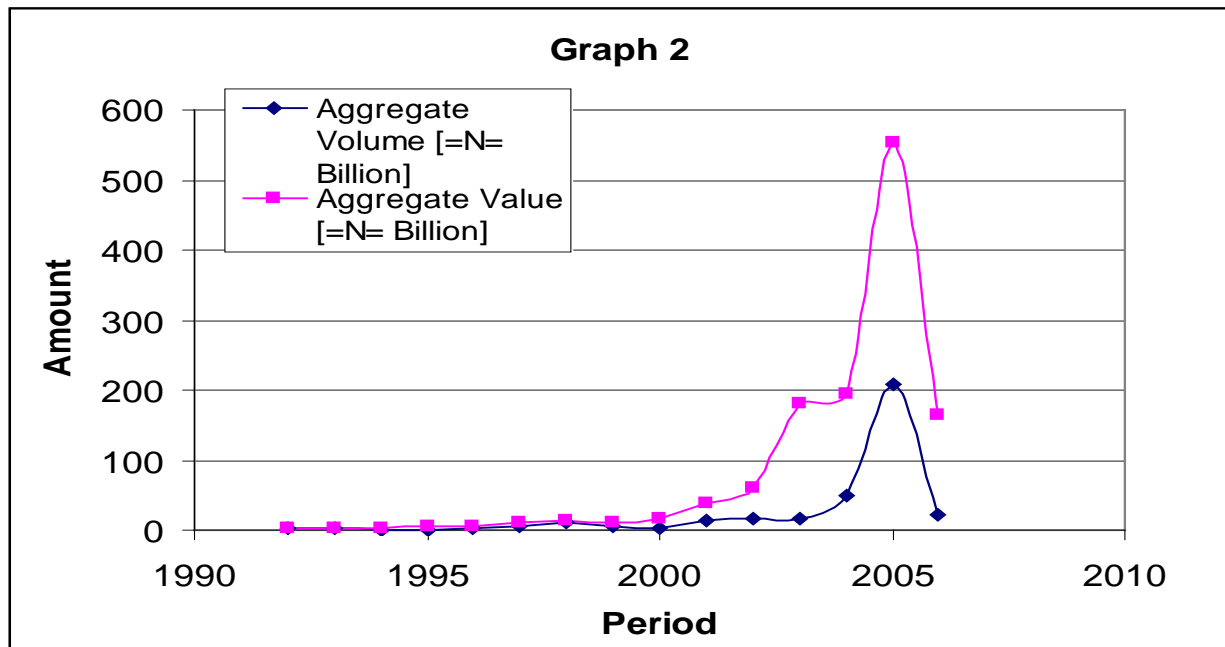


### Liquidity

Liquidity refers to the ability of investors to easily buy and sell shares or in other words the ease of acquiring assets and converting such investments in the stock exchange to cash. Three measures of liquidity considered are total value traded, total volume traded and the All Share Index. The aggregate value of approved new securities grew significantly from N3 billion in 1992 to an all time high of N552.8 billion in 2005 as shown in Figure 3 (graph 2). The decrease in new listings in 2006 was due to new government policies on increase in capital base for companies resulting in mergers and acquisitions.

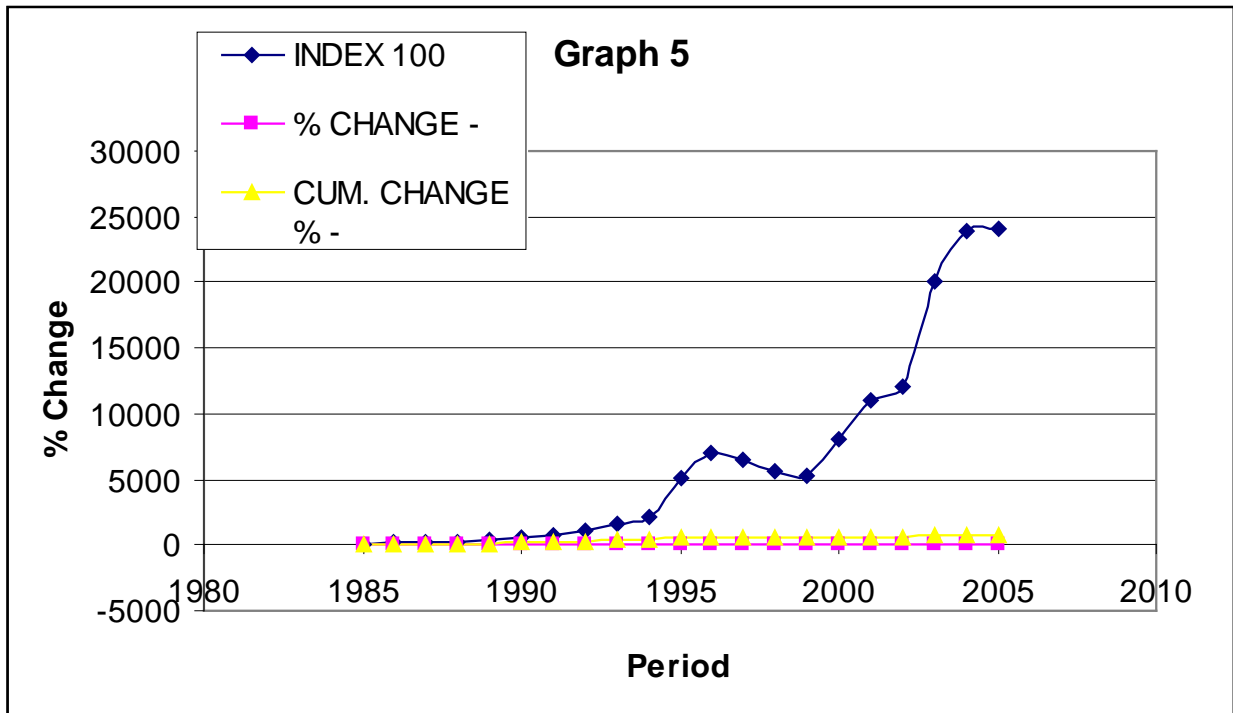
The aggregate volume of new listings also increased remarkably from N1.4 billion in 1992 to a high of N207.1 in 2005. The rapid increase in the value and volume traded is evidence of investors' interest in the market. This paper's position is that the decrease in the values of 2006 will be reversed in 2007 as companies consolidate in line with the new regulations and list supplementary issues and scheme shares on the Exchange. Already the Exchange has witnessed massive over-subscriptions in the shares of companies offered for sale in 2007 such as those of Intercontinental Bank Plc and First Bank Nigeria Plc to mention a few. This again confirms the high level of awareness amongst investors brought about by increased availability of information and trust in the capital market enhanced by information technology.

**Figure 3**  
**Aggregate value and volume of new securities**



Similarly, the Nigerian Stock Exchange All-Share Index shows an upward trend in company prices as revealed in Figure 4 (Graph 5). The market index shows the general behavior of the stock market and it has also been used to show the direction of growth in an economy.

**Figure 4**  
**The NSE All-Share Index percentage change (1984 – 2006)**



## METHODOLOGY

### The model

This paper tests the role of information and communication technology on the growth of the Nigerian Stock Exchange using a modified version of the Gompertz technology diffusion model introduced by Chow (1983). The Gompertz model assumes that over time technology usage tends to an equilibrium level along an S-shaped path and it is given as:

$$\log \eta_{it} - \log \eta_{it-1} = \theta_i [\log \eta_i^* - \log \eta_{it-1}] \quad (1a)$$

Where:

- $\eta_{it}$  is ICT use in country I in year t
- $\eta_i^*$  is post diffusion equilibrium level
- $\theta_i$  is the speed of adjustment

The Gompertz model examines the relationship between ICT as the dependent variable and the factors that impact change in the level of ICT as the independent variables. There is need to adjust this model to fit it to the data and objectives of this study. This paper examines the impact of ICT on the growth of the Nigerian Sock Exchange and therefore rearranges the model such that ICT development becomes the independent variable while stock market growth indicators are the dependent variables. Thus the adjusted model is given as:

$$\log X_{it} - \log X_{it-1} = \theta_i [\log X_i^* - \log X_{it-1}] \quad (1b)$$

Where: X represents the stock exchange growth variables and other variables are as previously defined. The equilibrium level of change in growth in the Exchange ( $X_i^*$ ) can be taken as a function of change in ICT development indicators (Y) and thus express this as:

$$\log X_i^* = \alpha_i + \beta_i \log Y_{it} \quad (2)$$

Substituting and adding an error term, equation (1) can be expressed as:

$$\log X_{it} - \log X_{it-1} = \theta_i \alpha_i + \theta_i \beta_i \log Y_{it} - \theta_i \log X_{it-1} + \varepsilon_{it} \quad (3)$$

Considering that the expression for the dependent variable in equation (3) implies a change in that variable, the equation is thus simplified and expressed as:

$$\Delta X_{it} = \theta_i \alpha_i + \theta_i \beta_i \log Y_{it} - \theta_i \log X_{it-1} + \varepsilon_{it} \quad (4)$$

### The Data and Operational Variables

Table 1 shows summary statistics for the Stock Exchange development indicators. The minimum value of N262 billion for market capitalization was recorded in 1998 while the maximum of N9 trillion was recorded in 2007 showing an increase of more than 97%. Also the number of listed securities rose marginally from a minimum of 258 in 2002 to 301 in 2007. Similarly, the value traded, volume traded and turnover also rose significantly. Market capitalization had the highest variability in data with a standard deviation of 2927.6.

**Table 1**  
**Summary Statistics on Nigerian Stock Exchange growth indicators**

	Market Capitalization	Listed Securities	Value traded	Volume traded	Turnover	Private debt	Public bonds
<b>Mean</b>	2341.82	272.6	232.9	19.7	0.08	5.38	249.89
<b>Maximum</b>	9467.89	301.0	1075.5	76.74	0.11	11.1	1013.0
<b>Minimum</b>	262.6	258.0	13.57	3.14	0.047	3.10	2.10
<b>Std. Dev</b>	2927.6	14.4	329.7	22.91	0.02	2.82	388.45
<b>Observations</b>	10	10	10	10	10	10	10

The dependent variables to be tested for the impact of ICT are the Stock Exchange development indicators examined earlier and they include: market capitalization (m), stock market value traded (v), stock market volume traded ( $\lambda$ ), turnover ( $\bar{H}$ ), number of securities listed (f), public sector bond (P) and private sector debt ( $\phi$ ). The data for all these variables are obtained from *The Nigerian Stock Exchange Fact-Book 2006* and Securities and Exchange Commission 'Capital Market Bulletin' (various issues). The independent variable is ICT development indicators in the Nigerian Stock Exchange. Four measures are used: number of stockbrokers ( $\delta$ ), number of stockbrokers with functional websites ( $\gamma$ ), total number of internet users ( $\eta$ ), total number of mobile and telephone mainline users ( $\psi$ ). Data for these variables are

obtained from *The Nigerian Communications Commission Website*, primary data collected on stockbrokers' websites and from the World Bank's *World Development Indicators*.

Applying the model in equation (4) to our variables results in the following expressions:

### **Market Capitalization (m) Model**

$$\Delta m_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log m_{it-1} + \varepsilon_{it} \quad (5)$$

Market capitalization is the value of all the listed shares that is number of shares multiplied by price of shares. This is used as a measure of stock market size. Available statistics show that market capitalization as a percentage of GDP in Nigeria has been on the increase from 9.6% in 2001 to 19.8% in 2005. Economic literature agrees that market capitalization is positively correlated to the amount of capital raised and the ability for market participants to diversify risks. However, this paper presumes that the growth in market capitalization is positively correlated with ICT development in the Nigerian Stock Exchange.

### **Stock market value traded (v) Model**

$$\Delta v_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log v_{it-1} + \varepsilon_{it} \quad (6)$$

This measure represents the total shares traded on the stock exchange and it reflects the liquidity of the market. Liquidity here is taken to be the ability of participants to buy and sell shares easily. Access to stock-brokers websites and telephones are presumed to be crucial trade facilitators here. Available data shows that value traded on the Nigerian Stock exchange rose from N13.57 billion in 1998 to over one trillion in July 2007. Stock value traded is expected to be positively related to ICT development.

### **Stock market volume traded ( $\lambda$ ) Model**

$$\Delta \lambda_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log \lambda_{it-1} + \varepsilon_{it} \quad (7)$$

The total volume traded refers to the number of shares exchanged in the course of trading. This value complements value traded in measuring liquidity in the market. As stated in value traded, ease of trading is a crucial factor in determining the volume of daily trades and hence access to the stockbrokers either through their websites via the internet or by telephone plays a major role. Thus stock volume traded is expected to be positively related to ICT development.

### **Turnover (h) Model**

$$\Delta \bar{h}_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log \bar{h}_{it-1} + \varepsilon_{it} \quad (8)$$

The turnover ratio refers to the value of total shares traded divided by market capitalization. This is also a measure of liquidity and it explains the rate at which shares are exchanged. A high turnover ratio implies low transaction costs and vice versa. The data shows that turnover varied

from 0.05 in 1998 to 0.11 in 2007. Turnover is expected to be positively related to ICT development.

### **Number of securities listed (f) Model**

$$\Delta f_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log f_{it-1} + \varepsilon_{it} \quad (9)$$

The number of firms listed is another measure of market size. Statistics show that there has been minimal variation in the number of listed securities between 1998 and 2007 suggesting a limited market. Equation 9 seeks to explain the variability in terms of ICT development and presumes that increase in ICT diffusion, which translates to increased awareness and investor confidence would lead to an increase in the number of listed shares.

### **Public sector bond (P) Model**

$$\Delta P_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log P_{it-1} + \varepsilon_{it} \quad (10)$$

This study includes trading in public sector bonds to capture the extent of government participation in the market. This is regressed on ICT development indicators to ascertain if the adoption of ICT has contributed to the increase in the value of bonds traded on the exchange. The bond market in Nigeria is small and not actively traded like the equities market. ICT indicators are not expected to affect government bonds significantly.

### **Private sector bond ( $\phi$ ) Model**

$$\Delta \phi_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log \phi_{it-1} + \varepsilon_{it} \quad (11)$$

This measure is also examined to ascertain the effect of ICT development on private sector debt in the stock exchange. The private sector debt market in Nigeria is similar to the government bond market in that it is small and not actively traded like the equities market. ICT indicators are not expected to affect private sector bonds significantly.

## **ESTIMATION TECHNIQUE AND EMPIRICAL RESULTS**

This study estimates the modified Gompertz ICT diffusion equation using data for the period 1998 to July 2007. The explanatory variables are simultaneously regressed with the dependent variables including a lagged parameter of the dependent variable. This section presents the results of the empirical analysis on the basis of available data for the period 1998 to July 2007. To test the fitness of the model, six equations were estimated using the same explanatory ICT variables for each stock market growth indicator. This is based on the assumption that the same ICT variables are likely to impact on all the stock market development indicators. The results of applying the adjusted Gompertz model to the relationship between the Stock Exchange growth indicators and the measures of ICT adoption are reported in Table 2.

**Table 2**  
**Results of the adjusted Gompertz model showing the relationship between the Stock Exchange growth indicators and the measures of ICT adoption**

	<i>No. of dealers</i>	<i>Internet users</i>	<i>Telephone mainlines</i>	<i>Mobile phone lines</i>	<i>Dealers with websites</i>	<i>R<sup>2</sup></i>
<i>Market capitalization</i>	7.0406 (0.92)***	0.0380 (0.13)	-0.5139 (-0.38)	-0.1412 (-1.02)***	-6.9099 (-0.94)***	0.925
<i>Value traded</i>	-5.4209 (-0.17)	-0.0684 (-0.07)	2.1103 (1.05)***	0.3509 (0.49)	5.1203 (0.17)	0.738
<i>Volume traded</i>	29.5669 (2.126)*	-0.3495 (-0.99)***	-0.8457 (-1.06)***	0.2034 (1.33)***	-31.2912 (-2.17)*	0.981
<i>Listed securities</i>	1.7793 (1.097)***	-0.0395 (-0.61)	-0.1577 (-1.38)***	0.0399 (1.38)***	-1.901 (-1.157)***	0.919
<i>Public bonds</i>	55.5293 (0.84)	-1.2366 (-0.60)	-5.2039 (-1.167)***	0.1299 (0.15)	-60.1275 (-0.87)	0.826
<i>Private debt</i>	38.2513 (5.71)*	-1.1129 (-3.73)*	1.0156 (1.81)**	0.4100 (3.23)*	-41.5663 (-6.18)*	0.996
<i>Turnover</i>	0.1830 (0.03)	-0.1258 (-0.45)	-1.1303 (-1.50)**	0.5113 (2.48)*	-1.1834 (-0.17)	0.947

*T values are in parenthesis, \*, \*\*, \*\*\* Significant at 1%, 5% and 10% respectively.*

Using market capitalization as the dependent variable, the results show that the model captures the diffusion process with an  $R^2$  of 0.925. The number of dealers is positively correlated with market capitalization and is significant at 10%. Specifically, a percentage point increase in the number of dealers increases market capitalization by 7.04 percentage points. Access to internet and telephone mainlines are insignificant while access to mobile phones have a significant although negative relationship with market capitalization. Dealers with websites also showed a significant but negative relationship.

Value traded represents growth in stock market activity and the model shows an  $R^2$  of 0.738 although the lagged dependent value is positive and significant at 0.87 implying that the model is suitable for this relationship. The results show that only access to telephone mainlines is significantly and positively correlated to the value of shares traded on the Nigerian Stock Exchange. The number of dealers, access to internet, mobile phones and dealers' websites are all statistically insignificant. The volume traded refers to the number of shares exchanged during trades. The number of dealers is significant at 2.5% and this demonstrates a strong positive correlation. Specifically, a percentage point increase in the number of stock-brokers increases volume of shares traded by 29.6 percentage points. Similarly, access to mobile phones is significant at 10% showing an increase of 0.2 in volume traded per percentage point increase in the number of mobile phone users. Internet access, telephone mainlines and access to stockbrokers websites are statistically but negatively correlated with volume traded. The number of listed securities fluctuated marginally within the period under review. The results show that the adoption of technology might not have impacted on the number of listed shares as the maximum of 301 is not far from the minimum of 258. The number of stockbrokers as well as access to mobile phones are significant at 10% while access to internet, telephone mainlines and stockbrokers are significant but in a negative manner. The model is appropriate with an  $R^2$  of 0.92.

Analysis of the relationship between federal and state government bonds and ICT reveal that the number of stockbrokers is insignificant although with a high coefficient of 55.5 while

internet and mobile phone access are insignificant. Telephone mainlines and access to stock-brokers websites is significant although negatively with public bonds. Private debt stock increased from N3.1billion in 1998 to N11.1billion in 2005 but reduced to N3.3 billion in 2007. Application of the model reveals that the number of stockbrokers was significant at 1% with a coefficient of 38.25 and t value of 5.71. Similarly, access to telephone mainlines and mobile phones were significant at 5% and 1% respectively while internet access and use of stock-brokers websites were negatively significant.  $R^2$  recorded a value of 0.9957.

Turnover as used in this study refers to the relationship between the value of shares traded and the market capitalization and is used as a measure of liquidity. The relationship between turnover on the one hand and number of stockbrokers, internet access, and access to stock-brokers websites on the other is statistically insignificant while access to mobile telephone is significant at 1%, implying the considerable influence of information technology on capital market development in Nigeria.

### CONCLUDING REMARKS

This study utilized a modified Gompertz model of technology diffusion to examine the impact of information and communication technology on the growth of the Nigerian Capital Market. The results reveal the following important findings: Growth in market capitalization is affected by the level of interaction between stockbrokers and investors brought about by ICT in the form of internet access, telephone (mainlines and mobile) as well as access to the websites of stockbrokers. Growth in the total value of shares traded is significantly affected by communication technology (telephones).

Growth in the volume of shares traded arises from the interaction between stockbrokers and investors mainly via mobile telephony. The number of securities listed on the Stock Exchange does not appear to have any significant relationship with the adoption of information and communication technology. Similarly, growth in federal and state government bonds has not been significantly affected by information and communications technology. Private debt stock appears to have been significantly affected by information and communications technology especially the increase in the number of stockbrokers and access to telephone lines. Lastly, turnover in the market seem to be affected significantly and positively by access to mobile phone technology. Information Technology has contributed to growth in the Nigerian Capital Market. The effect is mostly seen in the availability of information to investors and the improvements in the trading patterns of the Exchange. The results call for further advances in information technology that could help to broaden and deepen the market thus improving its effectiveness and efficiency.

In spite of the phenomenal growth recorded in the Nigerian Capital Market as reflected in aggregates such as market capitalization and value of transactions, the market is still relatively thin compared to other more developed markets. This reveals that there is great potential for further growth. First, the continued expansion of the internet creates opportunities for innovation in financial services, thus the regulators of the Nigerian Capital Market should seek to expand and deepen the market by introducing new products such as derivatives like option and futures trading. In addition, online trading by investors directly through the internet or mobile phones should be explored rather than the present system of passing all trades through stockbrokers creating unnecessary delays and inappropriate pricing of securities.

Secondly, companies listed on the Stock Exchange should be mandated to provide timely electronic information on their operations such as quarterly and annual financial statements on their websites thus making them available to all investors. This would enable the market learn, absorb and act on information quickly leading to market efficiency and precise pricing of securities. Thirdly, companies should be encouraged to hold electronic annual meetings and thus conduct on-line voting which would provide a wider sector of investors the chance to participate in the affairs of their companies. In recent times, some listed companies have used the internet to disseminate offer for sale/subscriptions of shares forms and prospectuses. This is quite commendable. However, companies can go a step further to allow investors purchase such shares through the internet rather than traditional modes.

The transaction cycle of three days should be reviewed and made instantaneous. This is possible using information technology to integrate the databases of players in the financial system. A one day transaction cycle for instance would eliminate the risk of default on trades. Wallman (1998) posits that ownership transfer of securities could be reflected only in the records of the depository (that is the Central Securities Clearing System) and settlement done through electronic banking. Lastly, the Capital Market regulators especially the Securities and Exchange Commission should be more open to innovations and be flexible without jeopardizing the interest and protection of investors as well as the efficiency of the market. The Commission needs to encourage more companies to list in the market so as to expand it and give investors more choices of where to invest. The recent incidents of massive over-subscriptions of offers attest to the fact that the Nigerian investor desires more depth in the market.

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***About the Authors:***

**Chinedu B. Ezirim** is a Professor of Finance, University of Port Harcourt, Nigeria. He is a member of the Academic Board of the European Business Competence License that sits in Germany and Austria. He has published several articles in International Journals and presented papers in many International Conferences.

**Michael I. Muoghalu** is a University Professor of Finance and MBA Program Director of the College of Business, Pittsburg State University, Kansas.- He has published several articles in International Journals and presented papers in many International Conferences.

**Uchenna Elike** is a Professor of Economics and Finance and MBA Program Director of the College of Business, Alabama A & M University, Alabama. He has published several articles in International Journals and presented papers in many International Conferences.

**Rose Uyoyou Adebajo** is a Lecturer in the Department of Finance and Banking and also a Ph.D (Finance) Candidate of the University of Port Harcourt. She has some articles in national and international Journals to her credit.

## APPENDIX

### Time Series Data

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<b>MKT CAP</b>	262.6	300	472.3	662.6	763.9	1356	2112	2900	5121	9467.9
<b>VALUE</b>	13.57	14.03	28.2	57.6	60.3	120.7	225.8	262.9	470.3	1075.5
<b>VOLUME</b>	3.14	3.97	5.0	5.9	6.6	13.3	19.21	26.7	36.5	76.7
<b>TURNOVER</b>	0.05	0.05	0.06	0.09	0.08	0.09	0.11	0.09	0.09	0.11
<b>FIRMS</b>	264	268	260	261	258	265	276	285	288	301
<b>PUBLIC</b>	2.7	2.4	2.1	8.3	12.7	25.2	178.1	365.5	888.9	1013
<b>PRIVATE</b>	3.1	3.1	4.1	5.8	3.5	8.4	7.9	11.1	3.5	3.3
<b>DEALERS</b>	124	162	187	226	226	240	229	239	239	164
<b>WEBSITES</b>	NA	NA	130	158	158	162	160	167	167	115
<b>MAINLINES</b>	NA	450000	553374	600321	702000	888534	1027519	1223258	1687972	2391442
<b>MOBILE</b>	0.0	0.0	35000	266461	1569050	3149472	9174209	18587000	32322202	49057883
<b>INTERNET</b>	0.0	0.0	107194	153350	420000	1613258	1769661	2654492	4247186	6370780
<b>INDEX</b>	5672.7	5266.4	8111	10963.1	12137.7	20128.9	23844.5	24085.8	27880.5	NA

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#### ***About the Author:***

**Venkareddy Chennareddy** obtained M.A in Economics, M.Sc in Statistics, from Andhra University, India, Ph.D in an Economics area from Michigan State University, U.S.A. He worked in several institutions such as University of Wisconsin at Platteville, Saginaw Valley State University, Michigan, Tennessee Valley Authority, Southern Research Institute, and the U.S.A Federal Government. He presented many papers in professional conferences, published articles in the conference proceedings issues, journals, and published chapters in books. He chaired many sessions in conferences and served as a discussant of presented papers.