

# **An Impact of ICT on the Growth of Capital Market-Empirical Evidence from Indian Stock Exchange**

Amalendu Bhunia  
Reader in Commerce  
Fakir Chand College, Diamond Harbour  
South 24-Parganas-743331  
West Bengal, India

## **Abstract**

This paper examines the impact of ICT on the growth of the Indian Stock Exchange using a modified version of the Gompertz technology diffusion model introduced by Chow (1983) and consequently reshuffles the model with ICT development turn into the independent variable while stock market growth indicators are the dependent variables. Capital markets have become excessively volatile since the adoption of computer assisted trading strategies as the latter increase short-term price volatility and risks. The data in the present study is obtained from BSE and NSE stock exchanges database, MCX India database, Securities and Exchange Commission and websites of World Development Indicators. In the course of analysis, descriptive statistics and regression model has been designed. The results disclose that selected variables are significantly affected by information and communications technology especially in respect of increase in the number of stockbrokers, investors and access to ICT.

**Keywords:** Indian stock market, ICT, Gompertz diffusion model, growth indicators

## **1. Introduction**

Information and communication technology (ICT) covers any product that will store, retrieve, manipulate, transmit or receive information electronically in a digital form. Capital markets have become excessively volatile since the adoption of computer assisted trading strategies as the latter increase short-term price volatility and risks. Capital market growth in a modern economy hinges on an efficient financial sector that pools domestic capital and assembles foreign capital for productive investments. Inefficiency can considerably cut growth from the levels that might have been possible prearranged suitable policies and market compositions. The global economy has been motivated by a greater assimilation of world markets and an impressive growth of information and communication technologies (ICTs). Interest in the global diffusion of technology has also been increased by the contention that ICT may develop knowledge diffusion through improving communication efficiency and constant permit developing countries to leapfrog traditional methods of increasing productivity (Steinmueller, 2001).

The impact of information and communication technology (ICT) on the growth of capital markets has been a subject of hot topic in modern times. Information and communications technology has turned into the key technology of the past decade. The hurried transmission of the Internet, of mobile telephony and of broadband networks all express how persistent this technology has become. For this purpose, 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 with his computer and accessing into Central Securities Clearing System have access to online trading systems [taken from

Chinedu B. Ezirim et al, 2009]. Many investors claimed that they did not access into automated system for execution. They, furthermore, argue that ICT motivated capital market functions are overburdened with fraud and manipulation that habitually influence human being investors. However, trading with sale of shares without authorization of the stockholders is treated as gluttony and deceit of some market participants. Nonetheless, they further quarreled that supervision dilemmas and improper enforcement of penalties by the legal system compose the adoption of a fast-paced ICT system unsafe to investors. On the contrary, Fama and French (1988) fall out that information technology have made capital markets more efficient as assistant stock prices nowadays reproduce imperative information and investors' awareness of stocks more rapidly. They also recommend that ICT has made the capital market more efficient by providing all participants with quicker and more effective means of exchanging information and new products and instruments have been made readily available as a result of the advent of sophisticated ICT. Obviously, capital markets can be more flexible, acquire superior intensity and wideness with the interference of ICT.

It must be monitored that the grounds of the above-mentioned positing are capital markets in developed countries. Now question obviously arise, would their squabbles hold true for India? The present paper assumes an internal persuade replica with the population of interest being participants in the Indian Stock Exchange. 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 main purpose of the paper is to examine the the impact of ICT innovations on trends in the stock exchange development indicators.

## **2. Review of Literatures**

Many researchers have examined the advantages of taking up of ICT in developing as well as developed capital markets. Mahonney (1997) confirmed that information technology innovations frequently escort to changes in the way securities transactions are negotiated, executed, cleared and settled. Regarding 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 [taken from Chinedu B. Ezirim et al, 2009]. Lucas et al (2002) evaluated espousal of ICT in the New York Stock Exchange and accomplished that the NYSE invested in ICT to generate new resources for improvement and to develop obtainable reserves. From the paper it is apparent that ICT affords for well-organized and satisfactory trading capacity which ensures a high quality securities market and reduces labour expenses. Levine (1991) anticipated that ICT occupy a main responsibility in economic development in terms of stock market liquidity with trade shares. Clemons and Weber (1990) observed support of ICT in the London Stock Exchange and quarreled that the ICT occupy the tactical role for exchange's new screen based market and recommends that computerization of stock exchanges reduce the costs and inefficiencies associated with share trading, increase trading activity and liquidity. Regarding affiliation between capital markets and ICT development in an economy, King and Levine (1993) assert that capital markets unimpeded the diversification of ICT risks and for that reason positive growth of stock markets augment modernizations in ICT. Nevertheless, Singh et al in his study (2000) explored the affiliation between ICT and the capital market using multivariate regression analysis in case of both emerging and developed economies and confirmed that 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. Again, Yartey (2006) observed the role of financial development and financial structure in illumination cross country diffusion of ICT. From the study it is clear that financial structure was not an important indicator for ICT but at the same time financial development was found to be an important determinant of ICT development. The present study adds as a pointer by probing ICT diffusion in the Indian Stock Exchange with the intention of determining its impact on the stock market development indicators.

### 3. Methodology

#### 3.1 The model

The present study analyses the position of information and communication technology on the growth of the Indian 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:

$$\text{Log } \eta_{it} - \text{log } \eta_{it-1} = \theta_i [\text{log } \eta^*_{it} - \text{log } \eta_{it-1}] \quad (1a)$$

Where:

$\eta_{it}$  is ICT use in country I in year t

$\eta^*_{it}$  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. The present paper examines the impact of ICT on the growth of the Indian Stock 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:

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

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 ( $X^*_{it}$ ) can be taken as a function of change in ICT development indicators (Y) and thus express this as:

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

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

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

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:

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

#### 3.2 Data and Variables

Table 1 shows descriptive statistics for the Stock Exchange development indicators. Market capitalization had the highest variability in data with a standard deviation of 819.55.

The dependent variables to be tested for the impact of ICT are the Stock Exchange development indicators 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 ( $\mathcal{D}$ ) and private sector debt ( $\varphi$ ). The data in the present study is obtained from BSE and NSE stock exchanges database, MCX India database, Securities and Exchange Commission and websites of World Development Indicators. The independent variable is ICT development indicators in the Indian 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 ( $\psi$ ). Applying the model in equation (4) to our variables results in the following expressions:

### 3.3 Market Capitalization ( $m$ ) Model

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

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. This paper presumes that the growth in market capitalization is positively correlated with ICT development in the Indian Stock Exchange.

### 3.4 Stock Market Value Traded ( $v$ ) Model

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

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. Stock value traded is expected to be positively related to ICT development.

### 3.5 Stock Market Volume Traded ( $\lambda$ ) Model

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

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.

### 3.6 Turnover ( $\mathcal{H}$ ) Model

$$\Delta \mathcal{H}_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log \mathcal{H}_{it-1} + \epsilon_{it} \quad (8)$$

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. Turnover is expected to be positively related to ICT development.

### 3.7 Number of Securities Listed ( $f$ ) Model

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

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 2001 and 2011 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.

### 3.8 Public Sector Bond ( $\mathcal{D}$ ) Model

$$\Delta \mathcal{D}_{it} = \theta_i \alpha_i + \theta_i \beta_i \log \delta_{it} + \theta_i \beta_i \log \gamma_{it} + \theta_i \beta_i \log \eta_{it} + \theta_i \beta_i \log \psi_{it} - \theta_i \log \mathcal{D}_{it-1} + \epsilon_{it} \quad (10)$$

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 India is small and not actively traded like the equities market. ICT indicators are not expected to affect government bonds significantly.

### 3.9 Private Sector Bond ( $\phi$ ) Model

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

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 India 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.

## 4. Empirical Results and Analysis

The empirical results based on the data available for the period 2001 to March 2011 are presented in table 1 and 2. To test the fitness of the model (Chinedu B. Ezirim et al, 2009), six equations were estimated using the identical explanatory ICT variables for stock market growth indicator. This is supported on the supposition that alike 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.

Using market capitalization as the dependent variable, the results show that the model captures the diffusion process with an R<sup>2</sup> of 0.80. The number of dealers is positively associated with market capitalization which is significant at 10% with a percentage point increase in the number of dealers' increases market capitalization by 1.02 percentage points. Again, telephone mainline, mobile phone line and dealers with websites are negatively associated with market capitalization which has been insignificant and significant both but internet users are positively associated with market capitalization which is insignificant.

Value traded represents growth in stock market activity and the model shows an R<sup>2</sup> of 0.59 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 Indian 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. 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 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<sup>2</sup> of 0.82.

Analysis of the relationship between government bonds and ICT reveal that the number of stockbrokers is insignificant although with a high coefficient of 12.08 while internet and mobile phone access are insignificant. Telephone mainlines and access to stock-brokers websites is significant although negatively with public bonds. Application of the model reveals that the number of stockbrokers was significant at 1% with a coefficient of 9.01 and t value of 2.27. 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<sup>2</sup> 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 Indian..

## **5. Conclusion**

The present study used a modified Gompertz model to observe the impact of information and communication technology on the growth of the Indian Capital Market. The empirical results disclose that growth in market capitalization is influenced by internet access, telephone, mobile and access to the websites of stockbrokers. Growth in the total value of shares traded is significantly affected by telephones. Growth in the volume of shares traded is related mobile telephony. The number of securities listed on the Stock Exchange does not appear to have any significant relationship with the adoption of ICT. Similarly, growth in public 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 particularly the increase in the number of stockbrokers and access to telephone lines. Lastly, turnover in the market appear to be concerned significantly and positively by access to mobile phone technology. Information Technology has contributed to growth in the Indian Capital Market. The consequence is typically seen in the ease of use of information to investors and the perfections in the trading patterns of the Exchange, as supported in, (Chinedu B. Ezirim et al, 2009).

## **Acknowledgement**

I express my regards to Prof. Ezirim, C.B., Elike, U and Muoghalu, M. I. for his paper “Capital Market Growth and Information Technology: Empirical Evidence From Nigeria” published in *International Journal of Business and Economics Perspectives*, 2009 because the concept and model of their paper have been used in the present paper.

## References

- CBN (2006), "Annual Report and Statement of Account", December 2006, Abuja: CBN Press.
- Charles Amo Yartey (2006), "Financial Development, the Structure of Capital Markets, and the Global Digital Divide", International Monetary Fund, WP/06/258, 1-30.
- Chow, Gregory C., 1983, *Econometrics* (New York: McGraw Hill).
- Clemons, E.K. & Weber, B.W (1990), "London's Big Bang: A Case Study of Information Technology, Competitive Impact and Organizational Change", *Journal of Management Information Systems*, 6(4), 41-60.
- Ezirim, C.B., Elike, U and Muoghalu, M. I. (2009), "Capital Market Growth and Information Technology: Empirical Evidence From Nigeria", *International Journal of Business and Economics Perspectives*, 4(1), 1-18.
- Fama, E. (1991), "Efficient Capital Markets 11", *Journal of Finance*, 575-1617.
- Fama, E., & French, K. (1988), "Dividend Yields and Expected Stock Returns", *Journal of Financial Economics*, 22: 3-25.
- Gatautis, Rimantas (2008), "The Impact of ICT on Public and Private Sectors in Lithuania", *ENGINEERING ECONOMICS*, 4(59), 18-28.
- Lucas, H.C., Oh W., Simon, G., & Weber, B. (2002), "Information Technology and the New York Stock Exchange's Strategic Resources from 1982 -1999", Access from Google Search Engine at [www.rhsmith.umd.edu/ceme](http://www.rhsmith.umd.edu/ceme)
- Levine, R. (1991), "Stock Markets. Growth and Tax Policy", *Journal of Finance*, XLVI, 1445-1465.
- Mahajan, V., & Peterson ,R.A. (1995), "Models for Innovation Diffusion. Newbury Park CA: Sage Publications", *International Journal of Business and Economics Perspectives*, Volume 4, Number 1. 2009,p. 15.
- Ndanusi A.M. (2003), "Country Experience with Capital Market Development: The Nigerian Experience", A paper presented at the Fifty Annual Financial Markets and Development Conference April 2003, Washington D.C.
- Pilat, Dirk (2003), "The economic impacts of ICT on firms and economies", Google Search Engine.
- Porteba J., & Summers, L. (1988), "Mean Reversion in Stock Prices: Evidence & Implications", *Journal of Financial Economics*, 22, pp. 27-59.
- Rogers, E.M. (2003), "Diffusion of Innovations 5th ed", New York: Free Press.
- Samaddar S., Nargundkar, S., & Chatterjee, S. (2002), "E-Market Infrastructure Planning and Internet Growth", *Eight American Conference on Information Systems in SPECS*, 721-728.
- Securities and Exchange Commission. (2008), "Securities and Exchange Commission databank", Access from Google Search Engine at <http://www.databank.sec.gov.ng>
- Securities and Exchange Commission. (1991), "Automation and the Nigerian Capital Market", *Issues in Capital Market Development, Securities Market Journal.*, 1, pp. 73-77.
- Securities and Exchange Commission. (2005), "The Impact of Electronic Technology on the Securities Market in Nigeria", *Issues in Capital Market Development. Securities Market Journal*, 4, 94-99.
- Shiller, R. (1989), "Market Volatility", *Journal of Finance* , 42, pp. 623 – 655.
- Singh A., Singh, A., & Weisse, B. (2000), "Information Technology, Venture Capital and the Stock Market.", A paper prepared as a background paper for the International Labor Organization's World Employment

Report 2000-2001.

Summers, L. (1988), "Does the Stock Market rationally reflect fundamental values?", *Journal of Finance*, 41, pp. 591-601.

Wallman, S.M.H. (1998), "Information Technology and the Securities Market", *The Brookings Review*, 16(1), pp. 26-29.

Yartey, C. A. (2006), "Financial Development the Structure of Capital Markets and the Global Digital Divide", IMF working paper wp/06/258.16 *International Journal of Business and Economics Perspectives* Volume 4. Number 1. 2009

Yartey, C. A., & Adjani, C. K. (2007), "Stock Market Development in Sub-Saharan Africa: Critical Issues and Challenges", IMF Working Paper Series WP/07/209.

**Table 1: Descriptive Statistics on Indian Exchange growth indicators**

	Market capitalization	Listed securities	Value traded	Volume traded	Turnover	Public debt	Public bonds
Mean	769.17	61.61	58.24	4.08	0.012	0.93	60.73
S.D.	819.55	2.07	65.44	0.51	0.004	0.41	66.57
Observation	2	2	2	2	2	2	2

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

	No. of Dealers	Internet Users	Telephone Mainlines	Mobile Phone Lines	Dealers with Websites	R <sup>2</sup>
Market Capitalization	1.0214 (0.66)***	0.0006 (0.08)	-0.0084 (-0.15)	-0.0086 (-0.34)***	-1.0207 (-0.21)***	0.80
Value Traded	-0.1925 (-0.16)	-0.0132 (-0.02)	0.9881 (0.67)***	0.1085 (0.08)	1.0002 (0.03)	0.59
Volume Traded	2.5614 (0.89)*	-0.1909 (-0.13)***	-0.0687 (-0.42)***	0.0105 (0.71)***	-5.0802 (-0.96)*	0.86
Listed Securities	0.3799 (0.23)**	-0.0048 (-0.18)	-0.0204 (-0.64)***	0.0102 (0.56)***	-0.8832 (-0.67)**	0.82
Public Bonds	12.0758 (0.49)	-0.8401 (-0.16)	-1.0351 (-0.03)***	0.0206 (0.01)	-9.2557 (-0.38)	0.63
Public Debt	9.0121 (2.27)*	-0.0064 (-1.06)*	0.0882 (0.86)**	0.1244 (0.98)*	-2.1166 (-1.95)*	0.91
Turnover	0.1004 (0.001)	-0.0027 (-0.11)	-0.1004 (-0.91)**	0.0749 (0.91)*	-0.2051 (-0.02)	0.88