Stock Market Efficiency - An Information System Perspective A Systematic Literature Review

Malithi Thudewatta and Suren Peter
Department of Industrial Management
Faculty of Science
University of Kelaniya
Sri Lanka
malithi.personal@icloud.com,

Abstract

An efficient market provides price discovery and ensures all market participants are ensured a level playing field. The efficiency of stock markets has been studied over many decades, predominantly from a finance theory perspective. The study however, proposes to evaluate the issue of market efficiency from an information system perspective. Information systems play a significant role in providing timely information with the ability to disseminate market information to all stakeholders worldwide, in an instant. After a systematic review of models evaluating performance of information systems throughput, the Information Success model was chosen and then adapted to suit the requirements of the study. Human behavioral components such as herding behavior, intention to utilize information/systems, user satisfaction, and other criteria such as information quality, system quality and service quality which all play a crucial role in making not just information systems efficient but also financial markets efficient, were linked to provide the study's conceptual framework designed to explore the effects of information systems on stock market behavior.

Keywords

Market efficiency, Information System efficiency, Information Success Model

Background

Financial markets play a vital role in the economy facilitating efficient movements of funds through the use of financial instruments. In order to build a strong financial system, having an efficient financial market is of great importance as it encourages more investors to invest in the market as they know that they can take timely decisions at the right time from the available information, as it is an efficient market. Thus, information efficiency in capital markets plays a dominant role in a financial system, (Dedunu, 2017).

Efficient market is where prices fully reflect all the available information at any given point of time. An implication of an efficient market is that no excess returns can be made from this information as it's already reflected in the market price, a random walk of prices and a fair game. Markets which are efficient attract more investors which then results in increased market liquidity. Investors are concerned about market efficiency not only as it can have a huge impact on their wealth but also because an inefficient market forms an unfair stage for investments which discourage people from investing. Thus market efficiency may affect consumption and investment spending and therefore influence overall performance of the economy and the money circulating in the economy, (Arulvel et al, 2011).

Introduction

Efficiency of financial markets is an arena which was heavily studied throughout the years due to its gravity which spread through diverse disciplines, affecting almost everything we do in our lives. Whether markets are efficient or not is a subject which was controversially discussed in the paradigm of finance starting from the 1960s with the emergence of Efficient Market Hypothesis (EMH) by Fama. Along with the birth of the new evolutionary branch of finance, behavioral finance and economics which was first espoused by the Nobel prize winning psychologists Kahneman and Tversky, market efficiency started to evolve in a novel direction taking human

behavioral aspects too, into account. Adaptive Market Hypothesis (AMH), reconciles the Efficient Market Hypothesis in its all states while accounting for behavioral aspects of investors. It states that the investors who fail to survive in the technology bubble leave the market after making substantial losses, which is powerful evidence of what a crucial role technology plays in financial markets even though it's not taken into account in the current state of the art of financial market efficiency (Lo, 2004). The review explores how technological aspects can be embedded to explain market efficiency.

Methodology

A systematic literature review was conducted covering the areas of traditional finance, behavioral finance and information systems efficiency. The systematic literature review for this study was conducted using Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). PRISMA is a widely established approach that is already being utilized in research in several industries such as technology, medicine, tourism among others. The PRISMA checklist was used as a framework for the review process.

- Search Strategy – Electronic libraries were used and a key word based search was done initially. Studies with highest citations were then chosen for further review. The PRISMA flowchart mentioned in the below figure 1 shows the number of studies investigated at each step of the study.

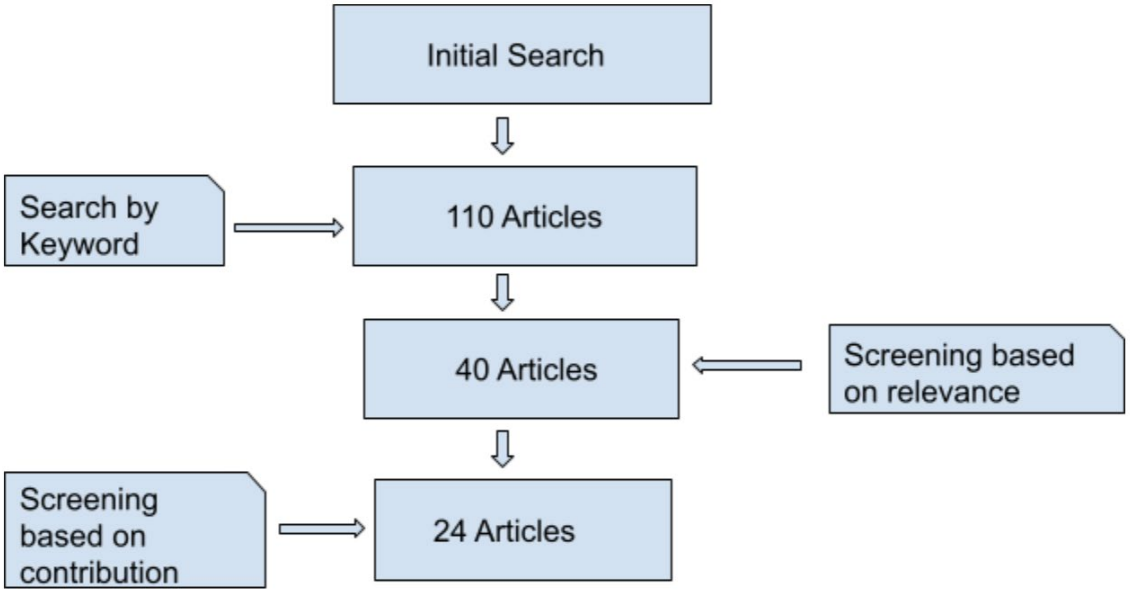

Figure 1 - PRISMA Flowchart

Literature Review

Evolving arena of market efficiency

As per the efficient market hypothesis, an efficient market fully reflects all available information at any point in time from the prices of stocks. The empirical work itself was divided into three main categories depending on the nature of the information subset of interest. They are namely strong form, semi-strong form and weak form tests. Strong-form tests are based on whether individual investors or groups who have monopolistic access to any information relevant for price formation where semi-strong form tests focus on all obviously publicly available information while weak form tests are concerned on information subset of historical price and returns, (Fama, 1970).

The emerging discipline of behavioral economics and finance, however, has challenged this hypothesis, arguing that markets are not rational, but rather driven by fear and greed. Recent cognitive neuroscience research suggests that these two points of view are two sides of the same coin. An army of investors, driven by profit opportunities, seize on even the tiniest informational advantages at their disposal, incorporating their information into market prices which quickly eliminate the profit prospects that originally prompted their transactions. If this happens in

an idealized world of "frictionless" markets and costless trading, prices must always fully represent all available information. As a result, there can be no profits from information-based trading because those profits must have already been made. The most persistent criticism for EMH is that it neglects preferences and behavior of market participants. Investors maximize additive time-separable anticipated utility functions from particular parametric families, such as constant relative risk aversion, according to the standard technique to modeling preferences. But psychologists and experimental economists have highlighted that there are variations from this paradigm. This is in the form of particular biases in investor behavior which is very common when humans make decisions in uncertain conditions which ultimately lead to undesirable outcomes in their investment decisions. Overconfidence, herding behavior, overreaction, loss aversion, psychological accounting are some of the classic examples for those kinds of behavioral biases which bring negative impacts for the investor decision making process. These skeptics of EMH state that investors are not always rational, there can be circumstances where they act irrationally which is predictable and financially destructive (Lo, 2004).

In 1982 the concept of bounded rationality was introduced where instead of optimizing, humans are more likely to choose merely what makes them satisfying, not necessarily optimal [Simon, 1982]. However, this ideology was dismissed due to one criticism, which is “What determines the point at which an individual stops optimizing and reaches a satisfactory solution?”. If such a point can be discovered through the typical cost-benefit analysis, and the context the optimal solution known, it can eliminate the need of satisfying. With that criticism, bounded rationality was dismissed and rational expectations became de facto standard until this criticism was addressed.

The "Adaptive Market Hypothesis" (AMH) is based on an evolutionary perspective to economic interactions as well as new cognitive neuroscience research that is altering and energizing the interface of psychology and economics. It responded to the question of how to determine the point at which an individual stops optimizing and reaches a satisfactory solution through these arguments. Such spots are discovered by trial and error, as well as, of course, natural selection. Individuals make decisions based on previous experiences and their "best estimate" as to what is best, and they learn through obtaining positive or negative feedback from the consequences. They will not learn if they do not receive such encouragement. Individuals build heuristics to tackle diverse economic issues in this way, and as long as the challenges stay stable, the heuristics will eventually adjust to provide roughly optimal answers. If, on the other hand, the environment changes, it should come as no surprise that the old heuristics aren't always appropriate for the new, like the flopping motions of a fish on the land can be observed as strange and ineffective, but under water, the same motions are meaningful (Lo, 2004). To summarize, Adaptive Market Hypothesis challenges the Efficient Market Hypothesis by following basic tenets: People are motivated by their own self-interests, they naturally make mistakes, they adapt and learn from these mistakes, (WWW1).

Behavioral Biases

Investors are not rational and logical all the time. Investment decisions are not that straight forward and simple as most of us think due to the influences of personality peculiarities, mental mistakes and emotional factors (Baker et al, 2014). There is a great deal of emotional and cognitive factors when it comes to investor decision making (Rehan et al, 2017). A cognitive bias is a heuristic or a rule of thumb which at times distract the investors from sound judgment or rationality. But still there is a debate on whether actually these heuristics are irrational or whether they contribute to useful decisions. Remaining group of biases are more in to emotional nature. Emotional biases come in to play when people make decisions merely based on their feelings not based on facts. As there is no clear boundary to separate the cognitive and emotional biases, the term behavioral biases are used in general for both cognitive and emotional biases (Baker et al, 2014). Among the behavioral biases loss aversion, overconfidence, anchoring, over and under reaction and herd behavior are proven to be ruling most of the decisions made by investors (Chaudhary, 2013). How well investors make their investment decisions, decides to what extent a market is efficient or inefficient. Further, behavioral factors also affect how well investors will utilize their trading Information Systems as well because no matter how well designed trading systems are, if the user is ill-advised from the behavioral biases, achieving a higher level of efficiency in trading using information systems is highly unlikely.

Herding

Herding is discussed in a variety of fields, including neurology, zoology, sociology, psychology, economics, and finance. On a general note in economics and finance, herding refers to the mimicking actions of others by individual investors. For example, someone neglects their own judgment about an investment decision and merely follows the core investors, being over dependent on expert predictions, bunch of investors following the same direction in trading [Spyrou, 2013].

Investor herding is a primary source of speculative bubbles since it implies that investors make identical trading decisions, which can lead to stock prices deviating from their underlying worth.This concept sits on the nexus of traditional and behavioral finance. Herding intensifies volatility, destabilizes financial markets, and makes the financial system more vulnerable [Filip at el, 2015]. Institutional herding has a deep theoretical background that can be classified into five groups.Those are informational cascades, reputational herding, investigative herding, fads and characteristic herding [Sias, 2002]. Instead of responding in accordance with her/his beliefs about information, an individual may opt to emulate the actions of others which basically occurs due to imperfect information. Information cascade is a term used to describe this type of effect. Reputational herding refers to the action of individual investors to imitate the actions of another investor who has already made the decision on a particular investment and implemented it [Rekik et al, 2013]. When institutional investors' information is positively cross-sectionally linked, maybe because they follow the same signals, this is known as investigative herding. Herding among investors can arise from fad too. Lastly, investors may start flocking together due to specific characteristics of the investment portfolio they have invested on [Sias, 2002].

Bikhchandani et al (2001) have stated the difference between intentional herding and false herding in their effort to derive a synopsis about the theoretical and empirical frameworks. Investors' clear aim is to imitate the behavior of other market players and is referred to as intentional herding behavior. False herding, on the other hand, occurs when a group of investors has the same challenges in making an investment decision and, as a result, makes identical trading decisions. Devenow et al, (1996) have identified a contrasting idea to the above. They establish that herding exists in two forms, rational and irrational. An investor is called to be irrational when she/he follows another investor without doing a rational appraisal of his or her own thoughts and an investor is called to be rational when they adopt an optimal solution which might have derived through outside factors. Banerjee [1992] introduced the first ever sequential decision model which establishes that investors who have this behavioral bias of herding, make decisions based on prior actions of other investors. In making that choice their belief is that those prior investors have held important information for an investor who is about to make an investment decision [Filip et al., 2015].

Loss Aversion

Loss aversion is the emotion which drives investors to choose the promising path to avoid possible losses rather choosing a path which can lead to an equivalent gain. People feel the pain from a loss more intensively compared to the happiness they witness from a similar size gain (WWW2). Loss aversion bias has been shown to have a negative impact on business performance in both the public and private sectors. Overconfidence, on the other hand, appears to have a good impact on industrial firm performance but a negative impact on service firm performance. Overconfidence bias appears to be dominating, and as a result, investors may be more overconfident rather than loss-averse. Loss aversion bias has been shown to have a negative impact on business performance in both the public and private sectors. Overconfidence, on the other hand, appears to have a good impact on industrial business performance but a negative impact on service firm performance, according to the data. Overconfidence bias appears to be dominating, according to more solid evidence (Bouteska et al., 2017).

Anchoring

Anchoring is a topic that has been considered as an important part of “dynamic psychology based asset pricing theory (Hirshleifer, 2013). Current body of knowledge in behavioral finance suggests that most individuals do rely on the first piece of information they receive about stocks and there is evidence that people even have reacted and acted upon unrelated data also which had subsequently influenced their investment decisions. Anchoring is slightly more evident in women than in men, with an elasticity of 0.34 against 0.28 for men (Jetter et al., 2016). Empirical results reveals that analysts’ being key market participants, demonstrate the anchoring bias in their forecasts. Analysts make optimistic forecasts when a firm’s performance is below the industry median and vice versa (Cen et al, 2013).

Framing

When people make decisions depending on how information is presented rather than the facts themselves, it is known as framing. People can make different judgments or decisions based on the same data provided in two different ways. In financial decision making, investors may react differently to a given opportunity depending on how it is presented to them in behavioral finance.

Positively and negatively framed information leads to a particular trading pattern, but leaves trading prices and volume unaffected (Kirchler et al., 2010). Framing has an effect on return too. The return projections expressed by investors in the return forecast mode are much greater than those generated for investors in the price forecast mode for upward sloping time series. The return projections made by investors in the return forecast mode are

much lower than those generated for investors in the price forecast mode for downward sloping time series. This is in line with behavioral theories of investor expectation building based on the representativeness heuristic (Glaser et al., 2007). As an investor, it is required to avoid framing bias. Consider rephrasing the facts that reading to see how it affects the conclusion. The idea is to use a logical, thoughtful approach to decision-making rather than a reflexive, impulsive approach.

It is apparent that mere informational efficiency as discussed in the Efficient Market Hypothesis doesn't give a full picture of market efficiency and therefore the need to take into account behavioral aspects of market participants if we are to fully explain the concept. No matter how informationally efficient a market is, psychological phenomena of investors also plays a key role in that.

In this study the main objective is to open up a discussion in the world of finance, that the impacts of technology also should be integrated in the effort of explaining market efficiency. As a preliminary effort we chose Information Systems, more specifically the impact from the trading information systems to market efficiency with the expectation of opening up a new revolutionary aspect to financial market efficiency.

Market Efficiency and Information Systems Efficiency

Trading activities and informational intensity in a trading floor form a fairly complex environment [Weber, 1993]. "Financial markets are probably the most competitive, dynamic and complex of all markets." *[*Almanza et al, 2016*]*. Information technology plays a crucial role in improving the efficiency of trading activities by utilizing its features through real time data services and analytical tools. Advancement in technology has produced this new arena of Financial Engineering which transforms the financial instruments, altered to investor requirements, (Weber, 1993).

The financial world has seen regulatory and market barriers collapsing, automation continuing to restructure trade processes, and cutting the costs of transacting and monitoring financial markets. In financial markets, observers have announced "The End of Geography". Location plays a greatly diminished role in investors' decisions. Global market integration is accelerating, and globalization is no longer merely a buzzword; it has arrived. It is not uncommon to hear of a British broker working with US employees to place orders on Japanese equities. The investor can use a screen-based market to hedge against the risk of adverse changes in currency values or interest rates, such as Globex. Such activities provide benefits through increased investor diversification, lower costs of company funding and increased competition across market participants. Features of the trading systems being used today had been foretold in a landmark paper, "Information Technology in the Major International Financial Markets in the World", (Weber, 1993). These are some interesting predictions that were made which can now be experienced today even on a more improved scale: Information Systems act as an order collector in the process of processing trading instructions, once a trading order is entered to the system order details such as limit price, quantity, time etc are accessible for an investor's management and measurement purpose, price determination is governed by Information Systems which aggregate the information about orders submitted to the stock market, order execution is done by the system and the order confirmation is routed electronically to the users, systems are used to share market information in a wider scale, systems are used for reporting and monitoring purposes of trading activities (Weber, 1993).

Gomber et al (2018) states that the interdisciplinary space of the Fintech revolution is taken over by the technology transformation of banking, securities trading, and other financial services which encompasses new service visions and client centricity, with promising cost-control and profitability prospects, which also concludes the impact of technology to the world of financial instruments.

Now it's very clear that there is an overlap between financial markets and information systems. Thus we can understand that how well the information system is utilized can have an immense impact on how well functioning or malfunctioning a financial market is. Let's deep dive into the previous work on efficiency of Information Systems.

DeLone et al, (2016) conclude in their study that system quality, information quality, service quality, intention to use, use, user satisfaction and net impacts, as individual success variables in measuring the efficiency of information systems. Systems quality is the desirable characteristics of an information system. Information quality is the desirable characteristics of the system outputs. Service quality is the quality of the support users receive from the organization's information systems. Use is defined as the degree and manner in which users utilize the capabilities of an information system. User satisfaction is the level of user satisfaction with a system's output. "With increased use of a system, problems come to light and possible improvements are recognized, leading to

requests for changes and updates to the system, which is commonly called "maintenance". To capture this feedback arrows are extended from "Use" and "User satisfaction" towards service quality, systems quality and information quality as depicted in the figure attached below.

Results and Discussion

From the systematic review of literature, the Information Success Model was selected as the foundation of the conceptual model and then behavioral biases' impact included together with aspects of informational efficiency, through the construct of information quality as seen in Figure 2.

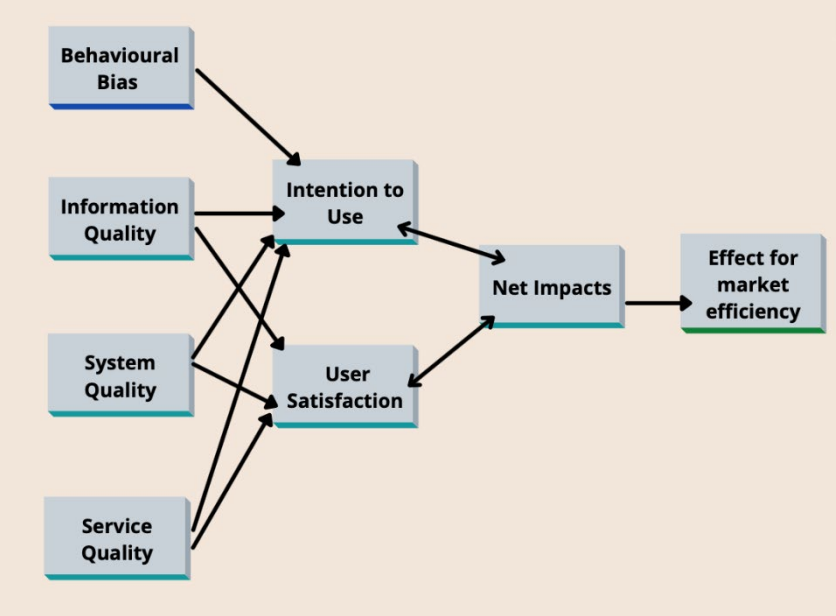

Figure 2 - Conceptual Diagram

Conclusion

Plenty of research has been centered around the discipline of capital market efficiency, but this has been predominantly from a finance theory perspective. Thus, there is a clear vacuum in the current body of knowledge especially in this era where technology plays a crucial role in the functioning of financial markets. The study directly address his research gap, bridging the traditional finance theories to one of the most predominant aspects of technology to capital markets, the influence of trading information systems efficiency, to derive a much more complete view of market efficiency. This is study is just a much-needed initiation for start evolving the market efficiency in a new revolutionary branch, taking technological aspects too into account at its infancy stage.

References

WWW2, https://www.schwabassetmanagement.com/content/loss-aversion-bias updated on 03/11/2021

WWW1, https://www.investopedia.com/terms/a/adaptive-market-hypothesis.asp updated on 02/08/2019

Ahmed Bouteska, Boutheina Regaieg, Loss aversion, overconfidence of investors and their impact on market performance evidence from the US stock markets, *Journal of Economics, Finance and Administrative Science,* 2018

Peter Gomber, Robert J. Kauffman, Chris Parker & Bruce W. Weber, Special Issue: Financial Information Systems and the Fintech Revolution, *Journal of Management Information Systems*, pp. 12-18, 2018

Harshani Dedunu, Weak form Efficiency of the Sri Lankan Stock Market From 2010-2014, *IOSR Journal of Economics and Finance*, Volume 8, Issue 3 Ver. II , PP 75 - 81, 2017

Raja Rehan, Imran Umer, Behavioural Biases and Investor Decisions, *Market Forces*, Volume 12, 2017

Alma Lilia Garcia Almanza, Serafín Martínez Jaramillo,Edward Tsang, *Using Genetic Programming Systems as Early Warning to Prevent Bank Failure*, 2016

DeLone and McLean, Information Systems Success Measurement, *Foundations and Trends in Information Systems*, Volume 2, Issue 1, 2016

Michael Jetter, Jay K.Walker, Anchoring in Financial Decision Making- Evidence from the Field, *IZA, 2016*

Angela Filip, MirunaPochea, Andreea Pece, The Herding Behaviour of Investors in the CEE Stocks Markets, *Procedia Economics and Finance*, Volume 32, pp. 307 - 315, 2015

H. Kent Baker, Victor Ricciardi, How Biases Affect Investor Behavior, *The European Financial Management*, 2014

A. K Chaudhary, Impact of Behavioral Finance in Investment Decision and Strategies-A Fresh Approach. *International Journal of Management Research and Business Strategy*, *2* (2), 85-92, 2013.

Ling Cen, Gilles Hilary and John Wei, Role of Anchoring Bias in the Equity Market: Evidence from Analysts' Earnings Forecasts and Stock Returns, *The Journal of Financial and Quantitative Analysis*, Vol. 48, No. 1 pp. 47-76 , 2013

Rekik, Yosra, Determinants of Individual Investors' Behaviors: Evidence from Tunisian Stock Market. *IOSR Journal of Business and Management,*2013

Spyros Spyrou , Herding in financial markets: a review of the literature, *Review of behavioural finance*, volume 5, issue 2, 2013

K.K Arulvel, S. Balaputhiran ,S. Ramesh & B.Nimalathasan , Market Efficiency or Not: A Study of Emerging Market of Colombo Stock Exchange (CSE) in Sri Lanka, *International Conference on Leading beyond the Horizon*, 2011

Markus Glaser, Thomas Langer, Jens Reynders, Martin Weber, Framing Effects in Stock Market Forecasts: The Difference Between Asking for Prices and Asking for Returns, *Review of Finance*, Volume 11, Issue 2 , Pages 325–357, 2007

Erich Kirchler, Boris Maciejovsky & Martin Weber , Framing Effects, Selective Information, and Market Behavior: An Experimental Analysis, *Journal of Behavioral Finance*, 90-100, 2005

Andrew Lo, *The Adaptive Markets Hypothesis: Market Efficiency from an Evolutionary Perspective*, 2004

Richard W. Sias, *Institutional Herding*, 2002

Andrea Devenow, Ivo Welch, Rational Herding in Financial Economics, European Economic Review, Vol.40, issue 3-5, pp. 603-615, 1996

Bruce W. Weber, *Information Technology in major financial markets*, 1993

F Fama, , Efficient Capital Markets, *The Journal of Finance*, Vol. 25, pp. 383-417, 1970

Simon.H , A Behavioral Model of Rational Choice, *Quarterly Journal of Economics*, 1955

Biographies

Suren Peter obtained his Doctorate from Maastricht School of Management, Netherland, Currently he serves as the Head of the Department of Industrial Management at University of Kelaniya Sri Lanka. He holds BSc in Industrial Management from the University of Kelaniya Sri Lanka, MSM from Georgia Institute of Technology, USA. His research interests cover the arenas of investor behavior, financial market behavior and privatization. He currently serves as director in a number of corporates in the country.

Malithi Thudewatta is a final year undergraduate at the Department of Industrial Management of University of Kelaniya, Sri Lanka who is reading for her BSc (Hons) in Management and Information Technology, specializing Business Systems Engineering. In addition, she is a student of the professional body, CIMA (Chartered Institute of Management Accountants) and she is reading for Diploma in Management Accounting (CIMA Dip in MA). She is currently completing her final year undergraduate research in the area of Efficiency of Financial Markets and the impact of Information Systems Utilization with regards to Market Efficiency.