STOCK MARKET EFFICIENCY IN DEVELOPING COUNTRIES: A CASE STUDY OF THE NAIROBI STOCK EXCHANGE

by

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TO MY PARENTS

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ABSTRACT

STOCK MARKET EFFICIENCY IN DEVELOPING COUNTRIES: A CASE STUDY OF THE NAIROBI STOCK EXCHANGE

This study extends evidence on the efficiency of stock markets in developing countries using data from the Nairobi Stock Exchange (NSE). Previous evidence from studies on stock markets in developing countries, and NSE in particular, is inconclusive. In many cases, the findings have not supported the random walk hypothesis and are therefore not consistent with efficiency in the weak-form.

The key question investigated is whether successive share price returns on the Nairobi Stock Exchange are independent random variables so that price returns cannot be predicted from historical price returns.

This study uses the traditional random walk methodology of serial correlation and runs tests as applied by Fama (1965), Cooper (1982), and Taylor (1986) rather than the newer methodologies of variance ratios [Lo and MacKinlay (1988)] and of regression [Jegadeesh (1990)]. These techniques are used for reasons of triangulation in research and for their intuitive appeal. They remain appropriate tools for testing the weak-form EMH despite challenge from newer methodologies. In their use, nevertheless, the study recognises and deals with two largely ignored issues in their application to EMH tests in emerging markets: the quality and quantity of data, and the depth of analysis of the market microstructure. The quality and quantity of data are improved through the creation of a computer database. The study then analyses all three price series on the exchange: The Bid, Ask and Transaction prices.

The findings suggests that with proper control over the quality of the data and the use of a larger number of data observations, the random walk model can be a good description of successive price returns in an emerging stock market. This has been shown to hold irrespective of whether bid, ask, or transaction returns are used. This is contrary to most of the earlier evidence that the random walk model does not apply in such markets. The results obtained are therefore consistent with the weak-form of the EMH.

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LIST OF ACRONYMS USED

CIC	Capital Issues Committee
CMA	Capital Market Authority
EMH	Efficient Market Hypothesis
GDP	Gross Domestic Product
IFC	International Finance Corporation
NBFI	Non-Bank Financial Institution
NSE	Nairobi Stock Exchange
P/BV	Price to Book Value
P/E	Price Earnings Ratio
RWH	Random Walk Hypothesis
SCC	Serial Correlation Coefficient

CHAPTER 1

1.1 INTRODUCTION

This chapter provides a discussion of the problem addressed by the study and its importance. It highlights the study's expected contribution and limitations. An outline of the chapters which form part of the study is also included.

1.2 DISCUSSION OF THE PROBLEM

Recently there has been some renewed interest in exploring whether stock market returns are predictable or not [Yong (1987), Fama and French (1988); Lo and MacKinlay (1988); Fuller and Kling (1990); Heaney (1990); Jegadeesh (1990); Schwert (1990); Sy (1990)]. The issue is investigated within the framework of the Efficient Market Hypothesis (EMH). According to Fama (1976) the theory of the EMH of financial markets holds that the security prices tend to fluctuate randomly around their intrinsic values, return quickly towards equilibrium, and fully reflect the latest information available. This means that in such markets investment strategies based on past information cannot consistently earn positive abnormal returns over extended periods of time.

Following Fama (1970), the EMH is categorised into three major levels depending on the type of information assumed to be used by the market in setting prices. These are:

(i) Weak-form efficiency:

The weak-form of the EMH states that the sequence of past price returns contains no information about future price returns. Successive price returns are random and no trading strategies based on a study of past prices can yield abnormal returns.

(ii) Semi-strong form efficiency:

The semi-strong form of the EMH states that the security prices fully reflect all available public information. Under the semi-strong form of the EMH no trading strategies based upon the release of any publicly available information, for example, accounting earnings, will enable an investor to generate abnormal returns except by chance. The basic conclusion being that, if the market is semi-strong efficient, then it will instantaneously impound all information as it becomes publicly available into security prices.

(iii) Strong-form efficiency:

The strong-form of the EMH states that the security prices reflects all the information available both public and private at each point in time. The consequence of it is that no investor, even where such investor has inside information, may be able to device trading strategies based on such information to consistently earn abnormal returns.

The levels of efficiency are nested. Strong-form efficiency implies semi-strong form efficiency, and semi-strong efficiency in turn implies weak-form market efficiency.

The concept of efficient securities markets has gained prominence in both the academic and business world of today. The concept is now supported by empirical evidence from many of the world's markets. Today, it is not only widely accepted by academicians but it also permeates investment practice and Government policy towards the security markets [Brealey and Myers (1984, p.281)]. Fundamentally, the role of an efficient stock market has been expounded by Stiglitz (1981). As he points out:

> **"There is a general consensus that when financial markets are very competitive and efficient, prices quickly reflect all the available information. There is also a widespread belief that competitive and efficient markets enable the efficient allocation of scarce capital among alternative investment opportunities" (p.235).**

The role of the capital market expounded by Stiglitz is consistent with Fama (1970), who specifies:

> **"The primary role of the capital market is allocation of ownership of the economy's capital stock. In general terms, the ideal is a market in which prices provide accurate signals for resource allocation: that is, a market in which firms can make production-investment decisions, and investors can choose among the securities that represents ownership of firm's activities under the assumption that security prices at any time "fully reflect" all available information" (p.383).**

There is consensus among academicians that capital markets in developed countries, for example, USA, Britain and Japan, nearly achieve these objectives because they are efficient at operation and information levels. This is supported by a tremendous amount of research evidence [Ross and Westerfield (1988); Stiglitz (1981); Fama (1970)].

The consensus seems to break down when the debate is extended to stock markets of developing countries. There are those who believe that these markets are not efficient because of their operating characteristics and the nature of the investors [Drake (1977, 1985); Samuels (1981); Kitchen (1986)]. At the operational level the markets are argued to be inefficient because of:

- small size, resulting in them being "thin" with an inadequate number of traders to ensure competition and insufficient securities to enable them to hold diversified portfolios of their choosing.

- inadequate market regulation and standards of disclosure by companies

- poor communications so that some investors have an advantage over others.

- significant costs of obtaining investment information.

- a lack of competent analysts and professional advisers, resulting in differing expectations about the performance of securities.

- significant transactions costs which may deter small investors, thereby limiting the number of market participants and restricting the market to infrequent large bargains.

At the investor level it is argued that most of them are naive and cannot correctly interpret the information they receive [Samuels (1981)]. Most of the investors are also said to take the view that the market is inefficient and therefore an unreliable price setter, i.e. the prices shown do not reflect fundamental values. [Developing countries denote countries of Africa (except South Africa), the Middle East, Asia (except Japan, Australia, and New Zealand), and Latin America [Root (1984, p.366)]. In this study the term will be used in the context of only those countries that have stock markets].

It is difficult to test for operating efficiency although one may look at features which seem to support its existence. Evidence from tests of the EMH is used to infer on the level of technical organisation and operating efficiency. Beaver (1981, p.168) argues that there is no direct or simple relationship between the "greater" market efficiency and "improved" allocation of resources. Hence, a distinction must be made between operating efficiency and the EMH. They are distinct concepts and the relationship between them has not been rigorously derived. An efficient market does not imply that investors will necessarily perceive it to be efficient. There may be widespread perception of market inefficiency even though the security prices fully reflect published information. Keane (1983) holds the view that reasons given for inefficiency are merely speculative opinions and that the issues can only be addressed empirically. In the finance literature, efficiency refers to efficiency with respect to information. A market is efficient with respect to a particular set of information. A market where prices quickly reflect all available information is efficient. The Efficient Markets Hypothesis (EMH) maintains that the total market is quite sophisticated in the way it digests all available information and arrives at equilibrium security prices.

If one agrees with the view that the stock markets are at present one of the best barometers for indicating changes in economic activity then we may expect, other things held constant, that the imperfections in the economy will be reflected by imperfections in the stock markets. The stock market will not respond in an instantaneous and unbiased manner to changes in economic activity [Joutz (1988)]. Price returns in an efficient market are independent over time. Inefficiency will be reflected in non-randomness of price returns.

Considerable research energy has been expended in empirical tests of the EMH. A rejection of the EMH may have the implication that the market is not a reliable price setter and that it often, and sometimes significantly, misinterprets the economic signals it receives. Researchers have obtained substantial evidence in support of the EMH. This evidence has been found for varying time periods, different markets, and when using newer methodologies which are claimed to be superior than those used previously [Ball and Kothari (1989); Dyckman and Morse (1986); Foster (1986); Watts and Zimmerman (1986); Keane (1983)]. Some studies claim nevertheless to have found evidence not consistent with the EMH [Jegadeesh (1990); Rendleman et al (1982);

Charest (1978); Jensen (1978)]. These studies have, either through self-criticism or critical evaluation by other researchers, been found to be deficient in methodology and their conclusions have therefore been suspect. The overwhelming evidence available in support of the EMH has persuaded researchers to conclude that it holds for stock markets of developed countries [especially the New York, London and Tokyo markets]. This belief in the EMH has opened research in many new areas. The extension of the EMH to market-based research in accounting and other fields has provided more evidence in its support. Research based on the validity of the EMH continues, especially on the applicability of new return generation models [Jegadeesh (1990); Lo and MacKinlay (1988)].

EMH tests have been given some attention in the studies of stock markets in developing countries [Sharma and Kennedy (1977); Gandhi, Saunders and Woodward (1980); Cooper (1982); Parkinson (1984, 1987); Yong (1987)]. The conclusions of the studies have been mixed, some supporting the EMH and others not in support. There has been empirical evidence which tends to support those who believe that the share pricing systems of stock markets in developing countries are not consistent with efficiency [Parkinson (1987)]. There is also rapidly accumulating evidence which supports the efficiency of emerging markets at the weak-form level [Barnes (1986)]. Existing evidence on emerging markets is inadequate to make valid conclusions on the EMH and therefore the weak-form efficiency of stock markets in developing countries.

1.3 **THE CURRENT STUDY**

It is the uncertainty regarding the efficiency of securities markets in developing countries that motivates this study. In contrast to existing evidence and conclusions of markets studies in developing countries do exploitable inefficiencies exist in emerging stock markets? The study is targeted on the Nairobi Stock Exchange (NSE) in Kenya, a developing country. Parkinson (1984), found evidence which cast doubt on the EMH as a reasonable description of the operations of the NSE. This study aims to seek further evidence on weak-form efficiency in this market.

1.4 **SIGNIFICANCE OF THE PROBLEM**

Researchers in developed countries (e.g. USA., Britain and Japan) use stock exchanges in such countries to carry out higher level research that requires the basic assumption of market efficiency. The assumption that markets are efficient in developing countries - and specifically in Kenya - cannot be made in the absence of evidence.

There are particular problems that arise when the stock market is not efficient. The cost and availability of finance may largely be a function of the efficiency of the securities market [Samuels (1981)]. The need to extend the studies on the efficiency of the securities market in developing countries therefore becomes obvious and observable. This is especially so in countries where either such studies have not been undertaken, or the results of existing studies are inconclusive.

The carrying out of studies of this type has much support. Wai and Patrick (1973) are of the view that:

> **"the most profitable line of research would be in detailed case studies of capital markets in specific countries" (p.302).**

Cooper (1982) supports the view that even where evidence has been gathered in stock markets in developed countries, for example, USA, Britain and Japan, studies of other stock markets remain necessary. He goes on to explain that:

> **"...stock exchanges are far from homogeneous organisations. They differ from country to country in terms of organisation, ownership, size, legal constraints governing their administration, disclosure of information, investors incentives such as taxation etc., while the willingness and indeed the financial ability of**

the public to invest in shares will vary markedly also" (p.528).

Empirical research also provides safeguards against subjective interpretation. The researcher does not rely on prior beliefs, but collects or generates evidence to support given assertions. The existence of supportive or non-supportive empirical evidence on efficiency in one market is no assurance that it is the same on another market.

Testing the EMH, especially at weak-form level, may seem too obvious to some researchers at present. Recently, however, researchers have shown renewed interest in some of the fundamental findings of weak-form efficiency tests. Ball and Kothari (1989), for example, examine why, in an efficient market, negative serial correlation coefficients seem to occur. Lo and MacKinlay (1988) revisit the random-walk debate in the USA and so does Jegadeesh (1990). Dyckman and Morse (1986) explain that:

> **" each additional test that fails to reject the EMH, provides further evidence that the EMH is a reasonable description of how the securities markets operate (p.9).**

Triangulation is also a very important feature of research.

> **"Triangulation can be theoretical (apply different frameworks to same data) or implemental (using different research methods, different settings, different data, different assumptions, improved decision making techniques and so forth). The extent to which triangulation may produce similar results can be used as a measure of confidence in the findings and validity of underlying theory" [Abdel-khalik and Ajinkya (1979, p.21)].**

Extension of evidence is acceptable in its own right. Keane (1983) says that conclusion of one or two studies should not be interpreted as grounds for slackening the pace or scope of current research activities. He adds:

> **"If anything, they underlie the need for a regular programme of research to serve the dual purpose of providing a continuing attestation of the market's efficiency and of acting as a monitoring process, so that any short-term imperfections that might occasionally surface can quickly be identified and eliminated" (p.157).**

According to Kuhn (1970, p.36) :

> **"Bringing a normal research problem to a conclusion is achieving the anticipated in a new way....."**

1.5 CONTRIBUTION OF THE STUDY

This study is intended to deal comprehensively with weak-form efficiency issues of the Nairobi Stock Exchange. It is intended to:

(i) Provide empirical evidence on the relationships between past and current prices series and also a database on which future empirical work on efficiency can be formulated.

(ii) Give motivation for further research into accounting issues, and to create a database from which such research may be possible. This by itself will break the drought of security market based research in Kenya.

(iii) Draw the attention of policy makers about the existing pricing mechanisms of the exchange. They will hopefully use this knowledge as a basis of making necessary structural reviews of the exchange to increase its importance in capital resources allocation in the Kenyan economy and its expected contribution to economic development.

1.6 STUDY LIMITATIONS AND PROBLEMS.

(a) An exploratory study of this nature is likely to be beset by several problems. The key one amongst them is that of data availability and aggregation. Particular effort is required to ensure the accuracy and reliability of the data used [Yule and Kendall (1965)].

(b) The results of this study depend on the expectations model used. The validity of the results obtained will depend on the extent to which such models properly approximate the true market. Although the models used have been subjected to empirical tests elsewhere, this is no guarantee that they will work in the type of market being studied.

1.7 ORGANISATION OF THE STUDY

This study is organised as follows:

Chapter 2 discusses the nature of capital markets in developing countries. Emphasis is laid on the operating characteristics of these markets and the attention required to increase their level of activity.

In Chapter 3 the structure of the Nairobi Stock Exchange is examined. Unlike previous studies, [Yacout (1981); Niarchos (1972); Parkinson (1984)], which concentrated on individual countries' economies, this chapter is devoted to critical analysis of the nature of the trading activity and price making processes.

Chapter 4 studies the theory underlying weak-form efficiency. The problems inherent in carrying out weak-form studies are also explained.

In Chapter 5 empirical evidence on weak-form efficiency from both developed and emerging exchanges is reviewed.

Chapter 6 looks at the implications on methodology of existing literature and evidence on emerging markets. The research question and hypotheses to be tested are developed.

In Chapter 7 the methods used to obtain data for this research, and the nature of the data itself, are dealt with in detail. Major problems that exists in obtaining data in developing countries are noted. The sample used and the basis of selection are given.

Chapter 8 contains the analysis of the results of the study.

Chapter 9 is a summary of the research activities, findings, and the suggestions for further research.

CHAPTER 2

SECURITIES MARKETS IN DEVELOPING COUNTRIES

2.1 INTRODUCTION

A capital market is a place where buyers and sellers come together to trade in financial assets [Sprecher (1975)]. This term has four different dimensions. These are the securities market, the money market, the primary market and the secondary market.

The securities market is the market in which long term financial assets are traded. Examples of securities' market instrument are preferred and ordinary shares (preferred and common stocks), bonds and debentures.

The money market is the market for trading in short-term instruments, such as Treasury bills, Commercial papers and trade-bills, usually through the banking sector. Due to its nature, it facilitates short-term financing and assures the liquidity of the short-term financial assets. It is also the main focus of Central Bank activities in implementing monetary policy. It is also significant in indicating changes in short-term interest rates, monetary policy and availability of short-term credit. The money market exchanges financial assets representing short-term claims with funds. The importance of the money market arises because it assures borrowers that they can, generally, obtain short-term funds quickly, and assures the lenders that they can convert asset holdings into money [Rose (1988)].

The primary market deals with new issues. Any new issue of shares and bonds is dealt with in the primary securities market. The primary money market is where short-term funds are obtained.

The secondary market provides liquidity for the primary market by providing a readily available market-place for securities. It also facilitates the issuance of new securities. If it does not exist, the issuers of the securities have to seek out a market for their own securities. The secondary securities market is mainly represented by the organised exchange. The secondary money market is where financial assets representing short-term claims are traded.

There exist fundamental relationships between the markets. For example, the interrelationship between the money and securities markets arises because users and suppliers of funds may decide to use any of the markets. A supplier of funds has the option of using the short-term or the long-term market when lending funds. A user of funds has access to both markets, although the market used will depend on the use to which the funds will be put. Long-term financing may call for use of the securities market while short-term financing may demand the use of the money market. The primary market develops to facilitate capital formation. Secondary markets develop for trade in existing securities. This forms the foundation on which many studies of emerging markets link financial development and the stock exchange.

This chapter restricts itself to the securities markets because of its direct relevance to the aims of the research.

2.2 THE ROLE OF SECURITIES MARKETS

Given the relative scarcity of capital and the small volume of savings in most developing countries, the question may be asked whether there is any need for the establishment of securities markets. Drake (1985, p.5) says that:

> **"There are different opinions about how beneficial securities markets are likely to be in practice. Some writers have been inclined to take a rather optimistic view of the role which securities markets might play in expediting economic development. Others have been more pessimistic. There are those, for example, who conclude that a securities market may seriously jeopardise the growth and stability of a country's financial structure, may introduce factors which tend to**

aggregate, if not originate economic fluctuations, and may adversely affect the allocation of savings, reallocation of existing real wealth, redistribution of income and the conduct of monetary policy."

He concludes:

"The question of benefit to economic development is an open one, subject to empirical investigation of past performance and judgment of future prospects in each specific case."

As the level of income, savings and monetisation increases and the structures of the economies change in developing countries, securities markets have started to gain a significant role. In Kenya, for example, the development of a capital market was conditioned by the need for funds in the private sector and the structure of the economy rather than the government need to borrow locally [Arowolo (1971)].

The role of the securities market is that of financial intermediation and capital formation. The market deals with financial assets which are necessary to facilitate the process of wealth and capital accumulation. The most fundamental financial asset is money which is necessary for the development of any form of advanced economic system because it is necessary to facilitate the exchange of economic goods. Other financial assets, such as shares, bonds and debentures are used to aggregate the small pools of savings and channel them into real investment. This channelling is accomplished by financial intermediation. Financial intermediaries are firms whose assets consists almost of financial claims against others. Examples of such financial intermediaries are Banks, Life Insurance Companies, Pension and Provident funds. In financial intermediation savings are gathered from households and the intermediaries invest them in financial assets. The primary securities market plays a key role in this process of financial intermediation.

In summary, a securities market may play the role of:

(a) Providing liquidity to investors by enhancing the marketability of securities through the operation of the exchange. The existence of a market facilitates the purchase and sale of debt instruments and equity securities, particularly through dealings on a stock exchange. A stock exchange not only permits dealings in existing securities (increasing the liquidity of such securities) but also facilitates the issue of new securities to the public [Arowolo (1971)]. This occurs because the exchange provides a continuous market for individual securities issues. A continuous market is predicated on a large volume of sales, a narrow price range between the bid and the asked price and between the previous sale and the sale taking place at the moment. It also depend on the rapid execution of orders. There are also sufficient number of buyers and sellers of the shares of stock of each company traded and a sufficient number of brokers and other members of the exchange transacting orders to assure a broad and active market. The effect of these factors is to improve the liquidity and marketability of the securities that are traded.

(b) The mobilisation of savings to finance new investment. The markets for capital acts as a link between borrowers and savers in the economy. A continuous market for competitively priced securities provides a favourable climate for raising capital. The existence of a ready market to trade in the newly issued securities makes them acceptable to investors.

(c) facilitating wide spread ownership of financial assets thereby reducing the concentration of economic power, income and wealth in the hands of a few. This occurs, for example, where the shares are distributed nationwide ensuring equal participation by all those who desire in the ownership of corporations. The distribution of new issues in Kenya and Nigeria provides good examples [Yacout (1981); World Bank (1987)].

(d) moving business into professional management as well as acting as a stimulus to entrepreneurial capacity. Calamanti (1983) states that besides making better use of latent entrepreneurial capacity, the market would also lead to improved accounting practices, greater profit orientation and more disclosure of information, thus also yielding social benefits. The above is probably made on the assumption that the pressures from the securities markets are able to act effectively on corporate management to make them aware of the need for full information disclosure.

(e) indigenisation and/or privatisation of productive activities. The securities market will be used as a vehicle by which foreign capital can be channelled to the locals without disruption of economic activity since ownership certificates shares can be floated in the primary (new issues) market or existing securities can be disposed-off in the secondary market. Similarly, withdrawal of any one foreign investor may not be readily noticeable.

(f) increasing the volume of foreign investment. It has been identified that one of problems of developing countries is the shortage of capital [Abbott (1985)]. The possibility of using the securities market as a magnet to attract foreign capital and therefore close the capital shortage gap is an important one. Currently, with the debt burden of developing countries becoming unmanageable, a deliberate system of replacing foreign inflows with investment capital rather than debt would be most ideal. The impact of foreign capital flows and the benefits it confers cannot be underestimated [Denison (1980)]. Investing in securities markets other than in one's own country reduces the level of risk because of holding an internationally diversified portfolio [Solnik (1975)]. For example, van Agtmael and Errunza (1982) show that investing in markets of developing countries may offer attractive opportunities for high returns and diversification to investors of developed countries. Investments by foreigners may also be desired because a key problem in developing countries is the inadequacy of foreign reserves. The reserves are necessary to purchase the capital good essential for industrialisation. The foreign funds attracted by the securities market may be used for this purpose.

2.3 SECURITIES MARKETS AND ECONOMIC DEVELOPMENT

Kitchen (1986) expounds on two hypotheses which can be considered when evaluating securities markets in developing countries. One is the development hypothesis which looks at the financial system as one of the catalysts to economic development. The other is the "Casino Hypothesis" which takes the view that the financial system is irrelevant to economic development. The group holding this view take support from Keynes (1936) assertion that investors' decisions **"can only be taken as a result of animal spirits, of a spontaneous urge to action rather than inaction, and not as the outcome of**

a weighted average of benefits multiplied by quantitative probabilities." This view is now not well founded theoretically.

The development hypothesis tends to dominate current thinking [Drake (1985)]. Its proponents generally agree that developing the financial sector can lead to economic development. Developing countries have centred the effort of development in their financial sectors on an expansion of the range of financial instruments and financial institutions. The types of financial institutions include specialised long-term credit and capital market institutions such as stock exchanges and unit trusts [IFC (1984)]. The range of new instruments encompasses time deposits, negotiable certificates of deposit, corporate stocks, Government equity, futures and options. Financial innovation improves the efficiency of financial intermediation to the extent that they increase the acceptability of financial instruments, lower the costs of financial transactions and expand the flow of financial services [Kitchen (1986)].

The securities market enhances economic growth through

(a) Increasing the aggregate volume of savings

(b) More efficient allocation of the existing stock of tangible wealth

(c) An increase in the aggregate volume of investments and more efficient allocation of savings among potential investment [Calamanti(1983); Abbott(1985)].

These aspects are now examined in some detail.

2.3.1 The effect of securities market on aggregate volume of savings.

To transfer savings from a saver to a user there should be a process through which such savings are to be aggregated and channelled. Without formal institutions, transfer of savings to an investor may be on a person to person basis, but the pool of savings available for investment will be too low. Financial intermediaries develop to play the role of aggregation and distribution of savings. To be effective these institutions must

- provides incentives to save
- Increase volume of investment
- Improve efficiency of investment

Financial intermediaries must motivate savers to save and guarantee them a future return. Goldsmith (1969), for example, finds that the development of financial markets and instruments provides increased opportunities and incentives for savers to save and for investors to invest. This is observed empirically through an increased savings ratio. The role of the market in savings is that of maturity transformation which allows savers to save in short-term instruments and investors to acquire long-term funds. Also the saving role is expanded because the intermediaries undertake the task of risk transfer. Savers are not front-line investors since they do not wish to take the risk. The financial intermediaries themselves will diversify risks by allocating savings to a larger numbers of investors, a feature not available to an individual saver. Because of these two roles, intermediaries play an important function by increasing the mobilisation of savings. This in turn raises the level of investment leading to increase in the level and rate of economic growth [Abbott (1985)]. The stock-exchange, for example, although not directly a savings institution, provides marketability of saving instruments and enables savers to regain liquidity quickly. It also ensures proper management of listed companies thereby increasing savers' confidence.

The markets will also provide greater opportunities for gaining access to credit and an improvement in the technical and economic characteristics of financial assets. Shaw (1973) argues that these are important processes through which the propensity to save may be increased.

It should nevertheless be emphasised that the willingness to save depends on social, cultural, economic and political factors. The opportunity to save in financial assets depends on access to formal financial institutions and the types of financial instruments that these institutions make available to the market.

2.3.2 **Efficient allocation of existing stock of real wealth.**

Calamanti (1983) argues that an efficient financial system may help accelerate economic growth, particularly in developing countries, by reducing the cost of investment capital and also by changing investors beliefs. This in turn changes the nature of investors portfolio holding from only tangible assets (land and buildings mostly) to also diversifying into financial assets.

These changes on portfolio holdings can only occur if there exists a range of financial assets accessible to the investors in developing countries and also change in their beliefs. Currently, for example, it is not unusual to find that the total wealth holdings of an individual in a developing country may be in animals and/or land which by themselves not very productive and do not have spill-over effects.

The provision of financial assets by capital markets offers a chance not only of acquiring new investment but also of risk reduction through diversification. The release of real resources to financial assets increases the production capacity of the economy through such resources being transformed into capital goods. An important argument is that when the capital market acts as a channel for directing investment funds then it will do this efficiently and to the most productive investments.

2.3.3 Increase in the aggregate volume of investment and the allocation of savings.

An efficient securities market may increase the level of investments and improve the allocation of savings. These benefits arise because such markets are likely to have the effect of reducing the cost of funds significantly. This is a consequence of the reduced friction in the financial system.

Similarly, the efficient allocation of resources will increase the average returns that financial assets yields, since it allows proper allocation of investment opportunities to the most productive areas.

2.4 EVOLVING VIABLE SECURITIES MARKETS

Reilly (1979) suggests that the development of a viable securities market depends on:

(1) Timely and accurate information on the price and volume of past transactions and similar information on prevailing supply and demand.

(2) liquidity - a buyer or seller of a security can buy or sell the asset quickly, at a price which is close to the price of previous transactions, assuming no new information has been received. In turn, a liquid market requires continuity, i.e. prices do not change very much from transaction to transaction. Price continuity itself requires depth. There must be many buyers and sellers willing and able to enter the market at prices above and below those prevailing.

(3) Low transaction cost. This 'internal' efficiency means that all aspects of the transaction entail low costs. This includes cost of reaching the market, the actual brokerage cost involved in the transaction, as well as the cost of transferring the asset.

(4) Rapid adjustment of prices to new information. This efficiency ensures that the prevailing price reflects all available information regarding the asset.

The development of a securities market tends to go hand in hand with the existence and/or development of certain key features observed in the securities markets of developed countries. It is not argued here whether they precede capital markets or develop together as such markets develop over time. These features include:

(a) The existence of adequately sized businesses which can issue securities in the primary market and have continued trade in the secondary market. In developed countries the size of entities whose securities are traded world-wide can be readily observed. In the United States, for example, companies such as Exxon, IBM, etc. offer very good examples of the sizes of the entities and the level of securities they offer for public holding.

(b) The growth in the level of domestic savings is important to provide impetus for those savings to be channelled to the capital market. It should be noted that although the level of domestic savings in developing countries has been going up steadily, many households are still only able to sustain savings at very low levels which might not be capable of being re-allocated from the money market to the securities market, i.e. holding in shares and bonds [Calamanti (1983)]. As the level of savings grows we should expect to find an increase in the level of activity in the securities market sector.

(c) a high degree of long-term political and economic stability. This will mean adopting policies which leave the businesses in the economy as much as possible to market forces and create incentives to drive them in that direction.

(d) a well-established legal framework which reliably regulates corporate activities, the ownership and circulation of securities, and relations between issuers of shares and those who subscribe to them.

(e) Adequate level of education (both public and private) necessary to motivate investors in the capital market to understand the relationship between risks and returns of various assets and to remove social bias of predominantly holding one type of asset, for example, land. Education will also persuade the public of the need to appreciate Government policies designed at the initial stages to stimulate capital markets' development and also to see the need for diversification. It should be noted that breaking the barriers of communication in developing countries through education not only enhances economic development but also brings about the desired social changes necessary for effective and efficient markets to exist.

The extent to which these features exist in developing countries is not currently well researched. There are those who argue that these features do not exist in these markets [Drake (1977); Sharma and Kennedy (1977); Samuels (1981); Yacout (1981); Kitchen (1986)], and that, these markets:

- are small, resulting in them being "thin" with an inadequate number of traders to ensure competition, and insufficient securities to enable them to hold a diversified portfolio of their choosing.

- are not properly regulated and have poor standards of disclosure by companies.

- have poor communication systems so that some investors have an advantage over others.

- have significant costs of obtaining information.

- lack competent analysts and professional advisers, resulting in differing expectations about the performance of securities.

- have significant transactions costs which may deter small investors, thereby limiting the number of market participants and restricting the market to infrequent large bargains.

- have investors who are naive and who cannot correctly interpret the information they receive [Samuels (1981)].

Most of the investors are also said to take the view that the market is inefficient and therefore an unreliable price setter.

The above shortcomings are used as a basis for arguing that the stock markets are inefficient at the operating, and as a result at the information, level. There is nevertheless accumulating considerable statistical evidence from the International Finance Corporation (IFC) and other databases on emerging markets which may provide insight into these assertions. The next section examines these shortcomings of the stock markets in developing countries in light of the evidence available.

2.5 EXISTING FEATURES OF EMERGING MARKETS

2.5.1 The World of Emerging Markets.

Exhibit 2.1 shows the World of emerging stock markets as defined by the IFC in 1989. This represents more than 30 markets for which information is now available from the IFC. Most of these markets are to be found in Third world countries. The features discussed in this section relates to these markets. The features discussed are:

- Size of the markets
- Level of Activity of these markets
- Valuation details relating to the markets
- The nature of market information and investor protection available in these markets.

2.5.2 **Size of the Markets**

The size of the market may be defined in terms of capitalisation and the number of securities listed. Table 2.1 reports a summary of these statistics for 1980 and 1989. Columns (3) and (6) show the respective rates of increase/decrease of the capital values and the change in number of listed companies for both the developed and emerging markets over this period.

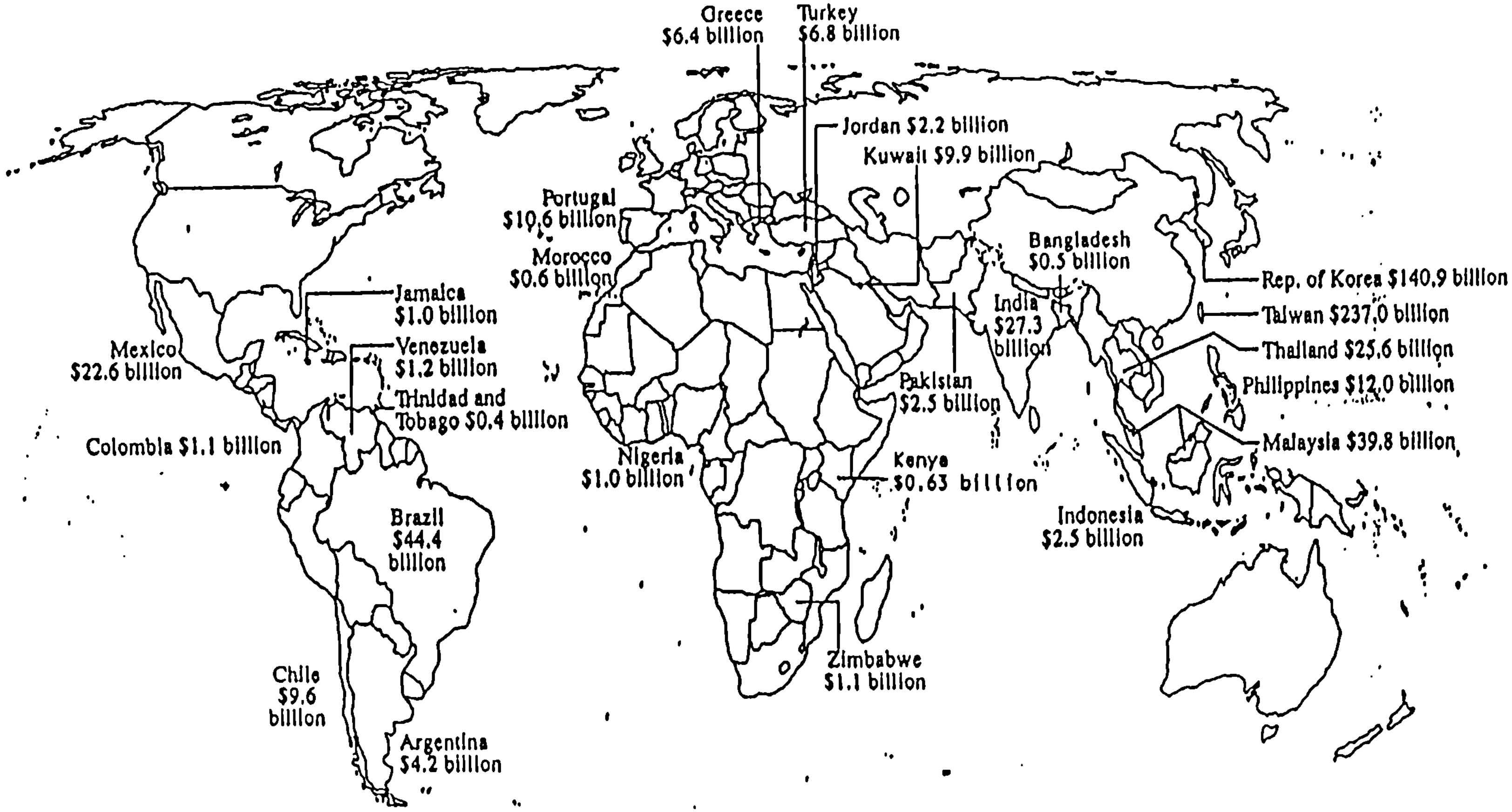
2.5.2.1 **Capitalisation**

Market capitalisation for the emerging markets grew by 6.695 times compared to that of developed markets of 3.183 times between 1980-89. This can be attributed to the significant growth of some individual emerging markets, for example, Portugal; Indonesia; Taiwan; Korea and Thailand. The dominant developed markets like USA; UK; France; West Germany but not Japan registered little growth in value. The emerging exchanges' share of the World's market was small, 3.15% in 1980 and 5.22% in 1989, although there were some slight gains over the developed markets. Examining changes over-time in market capitalisation can give insights into changes in the consensus expectations of the relationship between future and current profitability [Foster (1986, p.74)]. The growth in capitalisation was impressive, suggesting increased investor confidence in emerging markets.

EXHIBIT 2.1

THE WORLD OF EMERGING STOCK MARKETS, 1989

(Market Capitalization in U.S.$)



SOURCE: IFC Emerging Markets Factbook (1990, p.2)

TABLE 2.1 CAPITALISATION AND NUMBER OF LISTED COMPANIES: 1980 - 1989

	CAPITALISATION			NO. LISTED COMPANIES		
COLUMN	(1)	(2)	(3)	(4)	(5)	(6)
MARKET	1980	1989	RATIO	1980	1989	RATIO
AUSTRALIA	59700	136626	1.29	1007	1335	1.33
AUSTRIA	2000	22261	10.13	66	81	1.23
BELGIUM	10000	74596	6.46	225	184	0.82
CANADA	118300	291328	1.46	731	1146	1.57
DENMARK	5400	40152	6.44	218	257	1.18
FINLAND	2759	30652	10.11	48	78	1.63
FRANCE	54600	364841	5.68	586	668	1.14
GERMANY	71700	365176	4.09	459	628	1.37
HONG KONG	39104	77496	0.98	137	284	2.07
ISRAEL	4828	8227	0.70	117	262	2.24
ITALY	25300	169417	5.70	134	217	1.62
JAPAN	379679	4392597	10.57	1402	2019	1.44
LUXEMBOURG	4017	79979	18.91	74	493	6.66
NETHERLANDS	29300	157789	4.39	214	313	1.46
NEW ZEALAND	6161	13487	1.19	237	242	1.02
NORWAY	3190	25285	6.93	117	122	1.04
SOUTH AFRICA	100000	131059	0.31	481	748	1.56
SINGAPORE	24418	35925	0.47	103	136	1.32
SPAIN	16600	122652	6.39	496	423	0.85
SWEDEN	12900	119285	8.25	103	135	1.31
SWITZERLAND	37600	104239	1.77	118	177	1.50
UNITED KINGDOM	205200	826598	3.03	2655	2015	0.76
UNITED STATES	1448120	3505686	1.42	6251	6727	1.08
DEVELOPED MARKETS	2651956	11095353	3.18	15694	18690	1.19
ARGENTINA	3864	4225	0.09	278	178	0.64
BANGLADESH	27	476	16.63	22	116	5.27
BRAZIL	9160	44368	3.84	426	592	1.39
CHILE	9400	9587	0.02	265	213	0.80
COTE D'IVORE	344	437	0.27	193	82	0.42
COLOMBIA	1605	1136	-0.29	13	78	6.00
COSTRA RICA	118	246	1.08	22	24	1.09
EGYPT	246	1760	6.15	62	483	7.79
GREECE	3016	6376	1.11	116	119	1.03
INDIA	7585	27316	2.60	2265	6000	2.65
INDONESIA	63	2514	38.90	6	61	10.17
JAMAICA	54	957	16.72	38	45	1.18
JORDAN	1605	2162	0.35	71	106	1.49
KENYA	18	63	2.50	54	57	1.06
KOREA	3829	140946	35.81	352	626	1.78
KUWAIT	10108	9932	-0.02	55	52	0.95
MALAYSIA	12395	39842	2.21	182	251	1.38
MEXICO	12994	22550	0.74	259	203	0.78
MOROCCO	441	621	0.41	78	71	0.91
NIGERIA	3118	1005	-0.68	90	111	1.23
PAKISTAN	643	2457	2.82	314	440	1.40
PERU	1371	831	-0.39	103	265	2.57
PHILIPPINES	3478	11965	2.44	195	144	0.74
PORTUGAL	191	10618	54.59	25	182	7.28
SRI LANKA	365	471	0.29	171	176	1.03
TAIWAN	6082	237012	37.97	102	181	1.77
THAILAND	1206	25648	20.27	77	175	2.27
TRINIDAD AND TOBAGO	1175	411	-0.65	29	31	1.07
TURKEY	477	6783	13.22	314	50	0.16
URUGUAY	189	24	-0.87	54	39	0.72
VENEZUELA	2657	1156	-0.56	98	60	0.61
ZIMBABWE	1456	1067	-0.27	62	54	0.87
EMERGING MARKETS	86125	611130	6.10	5531	10582	1.91
WORLD	2738081	11706483	3.28	21225	29272	1.38

SOURCE: IFC EMERGING MARKETS FACTBOOK 1990

2.5.2.2 **Listings**

Between 1980 and 1989 the number of listed companies in emerging markets grew by 1.91 times compared to that of developed markets of 1.19 times. There were significant growth in the number of listed companies in some individual emerging markets especially those that also registered material increase in capitalisation.

The emerging exchanges share of the listed companies in World's market was 26.05% in 1980 and 36.15% in 1989, representing some gain of 10% over this period. This gain in the number of listed companies was nevertheless not reflected by an increase in their share of the world's market capitalisation which, as reported above, increased by approximately 2%. The evidence nevertheless indicates that the number of securities in the various markets had increased significantly. The argument that not enough securities are available may only apply in a small minority of cases which cannot be generalised to all emerging markets.

TABLE 2.2 VALUE TRADED 1980 AND 1990

MARKET	1980	1989	RATIO	TURNOVER RATIO 1980	TURNOVER RATIO 1989
AUSTRALIA	9556	44786	3.69	16.01	32.78
AUSTRIA	105	11706	110.49	5.25	52.59
BELGIUM	838	7708	8.20	8.38	10.33
CANADA	28211	70173	1.49	23.85	24.09
DENMARK	58	14463	248.36	1.07	36.02
FINLAND	138	7363	52.36	5.00	24.02
FRANCE	10118	107286	9.60	18.53	29.41
GERMANY	15248	628630	40.23	21.27	172.14
HONG KONG	19226	34584	0.80	49.17	44.63
ISRAEL	2447	3909	0.60	50.68	47.51
ITALY	8574	38926	3.54	33.89	22.98
JAPAN	160931	2800695	16.40	42.39	63.76
LUXEMBOURG	17	186	9.94	0.42	0.23
NETHERLANDS	5099	89848	16.62	17.40	56.94
NEW ZEALAND	653	3027	3.64	10.60	22.44
NORWAY	84	12489	147.68	2.63	49.39
SOUTH AFRICA	5129	7095	0.38	5.13	5.41
SINGAPORE	3654	13711	2.75	14.96	38.17
SPAIN	981	38389	38.13	5.91	31.30
SWEDEN	1796	38389	20.37	13.92	32.18
SWITZERLAND	0		0.00	0.00	0.00
UNITED KINGDOM	35791	17420	-0.51	17.44	2.11
UNITED STATES	409816	320268	-0.22	28.30	9.14
DEVELOPED MARKETS	717662	6288206	7.76	27.06	56.67
ARGENTINA	1089	1916	0.76	28.18	45.35
BANGLADESH	0.4	5	11.50	1.48	1.05
BRAZIL	5313	16762	2.15	58.00	37.78
CHILE	548	866	0.58	5.83	9.03
COTE D'IVORE	187	74	-0.60	54.36	16.93
COLOMBIA	0.2	4	19.00	0.01	0.35
COSTRA RICA	6	9	0.50	5.08	3.66
EGYPT	16	115	6.19	6.50	6.53
GREECE	86	549	5.38	2.85	8.61
INDIA	2760	17362	5.29	36.39	63.56
INDONESIA	9	541	59.11	14.29	21.52
JAMAICA	3	90	29.00	5.56	9.40
JORDAN	139	652	3.69	8.66	30.16
KOREA	1867	121264	63.95	48.76	86.04
KUWAIT	387	1709	3.42	3.83	17.21
MALAYSIA	2572	6888	1.68	20.75	17.29
MEXICO	3262	6232	0.91	25.10	27.64
MOROCCO	10	33	2.30	2.27	5.31
NIGERIA	14	4	-0.71	0.45	0.40
PAKISTAN	180	193	0.07	27.99	7.86
PERU	134	90	-0.33	9.77	10.83
PHILIPPINES	619	2410	2.89	17.80	20.14
PORTUGAL	2	1912	955.00	1.05	18.01
SRI LANKA	3	12	3.00	0.82	2.55
TAIWAN	4503	965840	213.49	74.04	407.51
THAILAND	308	13452	42.68	25.54	52.45
TRINIDAD AND TOBAGO	19	69	2.63	1.62	16.79
TURKEY	10	798	78.80	2.10	11.76
URUGUAY	21	1	-0.95	11.11	4.17
VENEZUELA	60	93	0.55	2.26	8.04
ZIMBABWE	154	36	-0.77	10.58	3.37
EMERGING MARKETS	23672	1159812	48.00	27.49	189.78
WORLD	741334	7448018	9.05	27.07	63.62

SOURCE: IFC EMERGING MARKETS FACTBOOK 1990

2.5.3 **Level of Activity**

The level of activity in the market is best measured by the value of securities traded as well as the relationship between the value traded and capitalisation (turnover). These indicators are reported in Table 2.2. In absolute terms, the amount of value traded is higher for developed countries. When the share turnover is considered there is clear evidence that some emerging markets had very high levels of activity. Taiwan, Korea, Thailand and India, for example, had higher turnover ratios than the developed markets like USA, Japan and UK except Germany. Considered as a whole the turnover ratios for most of the emerging markets were not substantially different from the average for developed markets. One would therefore have difficulty in making a general conclusion that majority of such markets are inactive and investors do not wish to trade. This evidence challenges another myth for developing markets.

2.5.4 **Valuation Details**

The valuation ratios are the price/earnings (P/E), price/book-value (P/BV) and dividend yield. The figures for 1988 and 1989 are presented in Table 2.3. The P/E ratios were reasonable for all markets both emerging and developed.

TABLE 2.3 VALUATION RATIOS 1988 TO 1989

	PRICE/ EARNING RATIO THIS YEAR 1989	RELATIVE TO WORLD	LAST YEAR 1988	PRICE/ BV RATIO THIS YEAR 1989	RELATIVE TO WORLD	LAST YEAR 1988	DIVIDENDYIELD THIS YEAR 1989	RELATIVE TO WORLD	LAST YEAR 1988
developed markets									
FRANCE	12.50	0.65	12.60	2.09	0.80	1.82	2.70	1.23	2.80
GERMANY	17.80	0.92	15.60	2.39	0.92	1.89	2.90	1.32	3.60
JAPAN	51.90	2.69	53.80	4.79	1.84	4.79	0.40	0.18	0.50
UNITED KINGDOM	11.70	0.61	10.40	1.95	0.75	1.68	4.50	2.05	5.00
UNITED STATES	14.10	0.73	11.60	2.16	0.83	1.81	3.30	1.50	3.70
emerging markets									
ARGENTINA	22.14	1.15	11.30	1.64	0.63	0.30	4.69	2.13	3.62
BRAZIL	8.30	0.43	7.95	1.34	0.52	0.72	0.66	0.30	1.50
CHILE	5.82	0.30	4.40	1.33	0.51	1.11	9.50	4.32	9.38
COLOMBIA	6.96	0.36	8.75	1.08	0.42	1.59	7.05	3.20	5.93
GREECE	24.30	1.26	10.59	3.12	1.20	2.33	4.62	2.10	5.62
INDIA	18.34	0.95	21.51	3.46	1.33	2.46	1.93	0.88	3.23
JORDAN	14.93	0.77	17.30	1.88	0.72	1.48	2.38	1.08	3.40
KOREA	38.57	2.00	39.51	2.50	0.96	3.34	1.26	0.57	0.54
MALAYSIA	30.75	1.59	24.14	3.34	1.28	2.58	2.19	1.00	2.04
MEXICO	10.66	0.55	5.04	1.03	0.40	0.69	2.10	0.95	3.02
NIGERIA	6.99	0.36	6.07	1.83	0.70	3.46	7.33	3.33	8.96
PAKISTAN	8.44	0.44	9.37	1.80	0.69	1.68	8.26	3.75	7.93
PHILIPPINES	18.50	0.96	9.92	4.35	1.67	2.75	1.10	0.50	2.23
PORTUGAL	21.42	1.11	26.50	3.79	1.46	4.36	1.87	0.85	1.34
TAIWAN	51.17	2.65	40.23	6.55	2.52	4.57	0.58	0.26	0.61
THAILAND	23.07	1.20	12.62	8.06	3.10	3.41	7.94	3.61	4.01
TURKEY	17.64	0.91	2.62	7.18	2.76	1.53	3.61	1.64	11.24
VENEZUELA	6.44	0.33	11.45	1.37	0.53	2.31	2.21	1.00	1.10
ZIMBABWE	7.00	0.36	4.24	1.27	0.49	4.00	9.75	4.43	7.79
WORLD	19.30	1.00	18.10	2.60	1.00	2.41	2.20	1.00	2.40

SOURCE: IFC EMERGING MARKETS FACTBOOK 1990

A majority of emerging markets registered increases in their P/E ratio over those for 1988. The P/BV ratio seems slightly better for emerging markets for 1989. The dividend yields were also higher for the emerging markets. The P/E ratio and the dividend yield gives future value signals to investors. The higher the P/E ratio, the higher the expected future income relative to current income.

Observing the statistics indicate that based on the P/E and dividend ratios investors in emerging markets have good prospects.

2.5.5 **Market Information and Investor Protection**

Table 2.4 shows the type and level of information available to investors in emerging markets. It also shows the extent to which investor protection is provided in each of the markets.

The Table reveals that investors in emerging stock exchanges have reasonable levels of information provided for decision making. Whether the disclosure serves the investors needs is an empirical issue [Wallace (1988)]. Annual, semi-annual and quarterly financial reports are required in many of the cases. Except for Kenya, Pakistan and Zimbabwe, all other markets have international electronic coverage. Information is also available from both local and international analysts. The level of investor protection is considered world class for some exchanges, but is reported to be poor for Taiwan, Greece and Turkey although some of these performed well in the period. The evidence does not at all support the held notion that communication is poor and that disclosure is non-existent. This argument should be discarded.

TABLE 2.4 MARKET INFORMATION AND INVESTOR PROTECTION IN EMERGING MARKETS

							Reporting requirements-timing			
	Share price index (1)	Securities exchange publications (2)	International electronic coverage (3)	Regular publication P/E,yield (4)	Market commentaries in English (5)	Company brokerage reports (6)	Consolidated annual audited (7)	Interim statement (8)	Accounting Standard (9)	Investor Protect (10)
Latin America										
ARGENTINA	X	AQMWD	X	P	-	LR	X	Q	A	AS
BRAZIL	X	AMWD	X	C	LR,IR	LR,IR	X	Q	G	GS
CHILE	X	AMWD	X	C	LR	LR	X	Q	G	GS
COLOMBIA	X	AMWD	X	P	-	LR	X	Q	A	AS
MEXICO	X	AMWD	X	C	LR,IR	LR,IR	X	Q	G	GS
VENEZUELA	X	AMWD	X	P		LR	X	S(BANKS)	A	AS
East Asia										
KOREA	X	AMWD	X	C	LR,IR	LR,IR	X	S	G	GS
PHILIPPINES	X	AMWD	X	C	LR,IR	IR	X	S	G	AS
TAIWAN	X	AMWD	X	C	LR,IR	IR	X	Q	P	PS
South Asia										
INDIA	X	AMWD	X	P	LR	LR	X	S	G	GS
INDONESIA	X	AMD	X	C	LR,IR	LR,IR	X	S	P	AS
MALAYSIA	X	A(M/2)WD	X	C	LR,IR	LR,IR	X	S	G	GS
PAKISTAN	X	AD		P	LR	-	X	S	A	AS
THAILAND	X	AQMWD	X	C	LR,IR	IR	X	Q	A	AS
Europe/Mideast/Africa										
GREECE	X	AMWD	X	P	LR,IR	LR,IR	X	S	P	P
JORDAN	X	AMWD	X	P	LR,IR	LR	X		P	AS
KENYA	X	AMW		P	LR	LR	X	S	A	AS
NIGERIA	X	AWD	X	P	LR,IR	LR	X	Q	A	AS
PORTUGAL	X	AMWD	X	C	LR,IR	LR,IR	X	S	A	AS
TURKEY	X	AMWD	X	P	LR,IR	LR,IR	X	Q	A	PS
ZIMBABWE	X	AWD		P	LR	LR	X	S	A	AS

KEY

Column	Symbols
(1)	X = At least one share price index is calculated; most have several and many have sectorial indexes as well.
(2)	A = Annual; Q = Quarterly; M = Monthly; (M/2) = Biweekly; W = Weekly; D = Daily
(3)	X = Daily coverage of stock market on an international wire service
(4)	P = published; C = Comprehensive and published internationally
(5)&(6)	LR= Prepared by local brokers or analysts; IR = Prepared by international brokers or analysts
(7)	X = Consolidated audited annual accounts required
(8)	Q = Quarterly results must be published; S = Semiannual results must be published
(9)&(10)	G = Good, of internationally acceptable quality; A = Adequate; P = Poor, requires reform S = Functioning Securities Commission or similar government agency concentrating on regulating market activity.

ADOPTED FROM: IFC (1990), EMERGING MARKETS FACTBOOK P.161

The above evidence is a pointer that stock markets in developing countries are moving in the right direction and that their positions have greatly improved over the last 10 years. More still requires to be done.

2.6 DISCUSSION

To improve the emerging markets and help them reach the level of those in developed countries, the factors that hinder the growth of the markets should be identified and dealt with. This section completes the chapter by addressing itself to some of the key problems in such markets and offering suggestions on how these problems may be dealt with. The discussion centres on:

- Financial repression/Financial deepening
- The supply of securities
- The demand for securities
- Government regulation and control

2.6.1 Financial Repression/ Deepening

Financial repression may be defined as a state where, due to either formal (Government) or informal controls, there exist barriers to the development of free securities markets in the economic sense. Following Goldsmith (1969), Shaw (1973), Fry (1982) and Fischer (1989) one may conclude that the key characteristics of financial repression include:

- Existence of controls on interest rates (normally maintained at fixed statutory levels by the Government) which may result in negative real interest rates in the economy.

- Government and other institutional barriers to the entry and development of financial institutions and instruments. This is evidenced by very strict rules for joining stock exchanges or registering financial institutions. These maintain such institutions at the bare minimum and give the existing ones no incentive to innovate new financial instruments

- Formally targeting savings and investments into specified areas of the economy thereby stifling capital available to other high growth innovative projects. In developing countries this is observed by requiring specific deposit/liquidity ratios, investment in treasury bills and demanding fixed percentage investment in certain sectors e.g. agriculture [Fry (1982)]. This has the effect of directing investment funds to inefficient investments. The consequence is to slow down the rate of economic growth and bring down the rate of innovation in the securities market.

- The existence of parallel informal markets of money lenders who can advance funds on a short term basis at very high-levels of interest rates. These markets will not be able to satisfy the demand for funds since they are, by their risky nature, unable to attract any significant deposits from savers.

Financial repression can be dealt with by systematic change of policies to move towards financial deepening. Financial deepening means the accumulation of financial assets at a pace, faster than accumulation of non-financial wealth [Shaw (1973, p.vii)]. The policies adopted which encourage the growth of financial institutions and instruments are:

- Removing the institutionalised barriers of entry into the financial markets. This, for example, calls for more liberal policies on entry into organised markets and the floating of financial institutions. The removal of barriers may call for initial statutory legislation and the synchronising of monetary and fiscal policies [IFC (1984), Fischer (1989)].

- Action on existing interest rate policies. The presumption in financial repression that fixed interest rates may be desirable to move the economy towards higher levels of investment is not well founded [Kitchen (1986, p.80-83)]. This is due to the banking sector sometimes being the only organised financial market. The Government in such a case has no other access to ready borrowing other than the banking system thereby stifling funds available to other borrowers. Financial deepening calls for the liberalisation of interest rates so that an equilibrium can be reached between savings and investment. It is not clear how the market may react to liberal policies on interest rates. It is nevertheless expected that the rates of interest will adjust themselves to match yield on other financial assets such as shares and also match expected returns on retained earnings. The economic power of financial intermediation will be in full play.

- Removing institutional targeting of savings and investments. This means that markets would be free to exercise discretion on where to seek savings and where to direct investments. One hypothesised effect of such a policy change is that it will be possible for markets to make funds available for highly innovative projects which will play a major role in economic development.

2.6.2 The Supply of Securities

It cannot be continuously assumed that the size or number of entities in developing countries are themselves a hindrance to the growth of a capital market through the non-issue of securities since they do readily fit into the structure of the economies where they operate. It can only be argued that the owners are unwilling to issue financial instruments because, for example, of fear of dilution, loss of control, disclosure of private information to competitors, of the fear that improved disclosure may lead to an increased tax burden, and because the government may artificially fix issue prices [Calamanti (1983)].

Perhaps, the issue of financial repression discussed earlier make the banks identify only existing businesses as the only ones worth the risk thereby offering them a guaranteed credit line in the forms of permanent overdrafts and other loans. Such businesses will have access to cheap credit, interest rates having been artificially suppressed. This itself will ensure that they do not issue securities which, under such conditions, may be more costly than bank credit.

Calamanti (1983) gives a good account of the policy measures of intervention necessary to increase the supply of securities. He identifies these as:

(i) **Coercion:**

- Here companies are automatically listed on the exchange when they fulfil certain criteria, e.g. when they reach a certain asset base or turnover or other measure that policy makers may consider appropriate. Listing goes with the requirement that a specific percentage of shares must be issued to the public.

Another coercive means of expanding corporate share issues would be to impose limits on borrowing from banks or other financial intermediaries. These limits could be based on compliance with debt/equity ratios in the borrower company or a limitation on the maximum indirect credit limit [Calamanti (1983, p.67); Drake (1977, p.84)]. This kind of measure not only makes the issue of shares necessary, but may also encourage issues in the bond market.

Another means has been to require foreign firms to issue fixed percentages of equity to locals. For example the rule has been in existence in Nigeria and India, where foreigners cannot invest in certain industries, or can only own part of others [Odife (1984)]. Given the shortage of foreign reserves in developing countries this may not be particularly appealing, even at a policy level, unless such foreign resources are targeted to only specific areas of investment.

Coercive measures are not themselves acceptable under conditions of economic liberty, but where voluntary action by the companies is not forthcoming then such measures could be used as a last resort.

(ii) **Tax incentives and/or penalties**

This calls for the use of fiscal policies to motivate private companies to go public. The objective is both to encourage companies to issue shares and investors to buy such shares once issued. This is achieved by penalising companies which remain private. It can also be achieved by tax discrimination with regards to dividend versus other investment income [World Bank (1987)]. For example, discriminating measures might be extended to:

- suspending tax on capital gains derived from share ownership.
- differential tax rates between private and listed public companies.
- preferential treatment of dividend income by taxing at lower rates than other investment income.
- changing practices where interest on loan capital is tax deductible, whereas dividend payouts are not, resulting in double-taxation of dividends.
- exempting companies which go public from tax for a number of years.
- allowing share issue costs to be tax deductible.
- suspending stamp duty on issue and transfer of shares.

2.6.3 Demand for Securities

Parkinson (1984) and Drake (1985) conclude that the past beliefs of inadequate demand for securities in developing countries tend not to exist any more. The issue is not of demand but one of not having adequate securities in the market in the first place. Drake (1985) proposes that the increase in demand arises from:

- Speculative interest and

- The unsatisfied portfolio needs of financial institutions.

The financial markets in developing countries are to be found in urban centres which are well served by modern communication facilities. This implies that the demand for securities in developing countries tends to be centred on elite institutions and investors only commonly found in urban centres [Yacout (1981)]. This in effect means that the small savers in the rural areas tend not to have access or not to understand the importance of investment in securities. Encouraging demand for securities among the small savers in rural areas may itself require not only education based policies (see section 2.4 above) but also a concerted effort to show such potential investors that financial assets are as valuable as tangible assets such as land and buildings.

The other is the slow growth of pension and unit trust funds through which savers can invest in markets for the future. Measures aimed at encouraging the growth of both individual and institutional demand for securities are necessary. For example, in Kenya institutional investors acquire shares and forget that they have them in their portfolio, resulting in such shares not being traded in the market [IFC (1984)]. They should not only acquire but also trade in the securities acquired. If the activity of the stock exchanges is to be increased, the growth of pension funds and unit trusts should be encouraged.

The demand for shares will of course also reflect the level of confidence that investors have in the market in the first place. The expectation of good performance and professional management of portfolios without shoddy dealing give rise to a belief that even a piece of paper can represent real wealth. The Government and other bodies must have a way of regulating the securities market in order to establish and maintain public confidence.

2.6.4 **Regulation and control**

The confidence of investors in securities markets depends on how well such markets are perceived to operate. It is discouraging where the investors feel that the markets can easily be manipulated or that insider trading, preferential treatment or outright theft is possible in the market. The level of protection can only be afforded through regulation in the initial stages of development. Excess regulation may nevertheless lead to financial repression and may be costly to the public and to the market in the long-run. The level of regulation will take the form of statutory legislation and development of disclosure rules by accounting bodies. The argument that investors in securities markets of developing countries do not have adequate information [Samuels (1981)] arise because of inadequacy and weaknesses in existing regulations. Improving existing regulations can overcome these shortcomings.

The role of accounting numbers in such markets is very important. Accounting bodies (where they exist) should not only follow the statutory requirements, but also attempt to set out standards by which companies can disclose information through financial statements. The effect of adequate accounting disclosure is to reduce access costs of information to investors.

2.7 CONCLUSION

We have seen in section 2.5 that securities markets in developing countries have progressed steadily over the years. The institutions of existing markets should be improved and efficient information flows to such markets established. As a result of improved operational efficiency then it can be expected that the securities market will play a greater role in the economic development of the countries by ensuring the allocation of resources to the best available alternatives. Hopefully, when the development of efficient securities markets has been achieved, such markets will play a significant role in the internationalisation of markets, and ensure freer flow of funds between developed and developing countries.

CHAPTER 3

THE NAIROBI STOCK EXCHANGE.

3.1 INTRODUCTION

The Nairobi Stock Exchange (NSE) is Kenya's only securities market and one of the eight exchanges in Africa. The other stock exchanges are in Egypt, Morocco, Ivory Coast, Nigeria, Tunisia, Zimbabwe and South Africa. It is one of the only two such exchanges within the Preferential Trade Area of East and Central African states. The other exchange is the one at Harare, Zimbabwe. The NSE acts as an agency or medium for promoting and facilitating contacts between buyers and sellers of securities. It also provides a forum for the listing (not trading) of Government Securities. This Chapter describes the NSE as a formal background to the issues and the data dealt with in the study. The chapter is organised in four parts. Part 1 gives a review of the background of the exchange. The historical part is only briefly treated because detailed reviews are available in Lomas (1961) and Munga (1974). Part 2 reports the economic and operating features of this exchange. Part 3 presents a detailed account of the organisation of trading. In Part 4 suggestions for improving the securities market in Kenya are discussed.

PART 1:

3.2 GENERAL BACKGROUND OF THE EXCHANGE

3.2.1 Brief history of the Nairobi Stock Exchange

The NSE was formally started by six brokers in 1954. There existed trade in securities before this time, at least for some twenty years previously, but trade was informal. In the early stages, the Government and the brokers had particular interest in forming a viable stock exchange. The Government saw the exchange as a medium for raising finances for its programmes locally. The brokers viewed the exchange as an organisation for raising funds for the expansion of the private enterprises. The brokers felt that there should be as little Government involvement as possible and their views prevailed. As a result, the exchange was formed outside Government control in line with the London Stock Exchange as it then was [Loxley (1969)]. The direct interest of the Government on the exchange gradually subsided and the exchange was left entirely in the hands of private brokers.

3.2.2 Objectives of the exchange

The stated objectives of the exchange are:

(a) To improve the facilities available to the public for the purchase and sale of shares and the investment of money.

(b) To regulate the dealings of members with their clients and with non-members engaged in stockbroking activities.

(c) To standardise, from time to time review, and if necessary or desirable increase or decrease charges to be made by members for services rendered to their clients, or modify the method or methods of assessing or calculating such charges.

(d) To correlate the stockbroking activities of members and facilitate the exchange of information to their mutual advantage and for the benefit of their clients and to offer advantage and facilities, for the information of the public, or lists of prices dealt in by members.

(e) To co-operate with Associations of Stockbrokers and Stock Exchanges in other countries and places and to obtain and make available to members information and facilities likely to be of advantage to them or to their clients.

(f) To investigate, resolve, decide, deal with and take steps to enforce its decisions and awards relating to, any irregularities or alleged irregularities in the dealings of members with their clients, non-members engaged in stockbroking activities, any differences or disputes between members and non-members and any complaints made against members by other members or any other parties if such differences, disputes or complaints relate to or touch on the stockbroking business or activities of such members (NSE Rules, p.2).

3.2.3 The Committee of the exchange

To achieve the above objectives the exchange has organised itself into a committee. This committee is responsible for the administration of the Exchange. As a private members organisation, the NSE is registered under the Societies Act. The members of the Committee are the individual firms or companies engaged in stockbroking in Kenya. To facilitate efficient administration, the Committee elects a Chairman and a Secretary from among its members. These office bearers are to execute all the administrative functions of the stock exchange.

3.2.4 The brokers

There are currently six brokers operating in the NSE. These brokers are:

1) Francis Thuo & Partners Ltd. P.O.Box 46524 Nairobi Kenya.

2) Dyer & Blair Ltd. P.O.Box 45396 Nairobi Kenya.

3) Chandulal Shah. P.O.Box 14686 Nairobi Kenya.

4) Francis Drummond & Company Ltd. P.O.Box 45465 Nairobi Kenya.

5) Nyaga Stockbrokers Ltd. P.O.Box 41868 Nairobi Kenya.

6) Ngenye Kariuki and Company. P.O.Box 12185 Nairobi Kenya.

In the advanced stock markets brokers do not deal with each other directly but through intermediaries, for example, jobbers and specialists who deal in certain types of shares. At the NSE the brokers deal with each other directly. The brokers are also jobbers. The brokers do not specialise in specific types of shares or business and are assumed to be conversant with a variety of shares and business. The brokers in practice form a small elite group with wide unchallenged power over such fundamental issues as membership of the exchange, the shares to be quoted, the terms and conditions upon which quotations will be accepted.

Applications for membership of the exchange are from individuals only. The qualifications and requirements for such membership are:

(a) The applicant shall have a reasonable level of education preferably School Certificate and above.

Although not essential, professional qualifications of a financial nature or a degree in economics or commerce would be an advantage.

(b) The applicant shall have had at least three years working experience at a senior level with a registered member of Nairobi Stock Exchange or any other recognised stock exchange.

(c) The applicant shall not conduct any business until appropriate Government Licences such as Authorised Depository, Trade Licence, Principal Licence, etc. are obtained.

(d) Before confirmation of the full membership, the applicant will be subject to a probationary period of at least one year. During probationary period:-

(i) The applicant shall deposit with the Stock Exchange a sum of K.Shs. 50,000/-. This deposit shall be refundable without interest on expiry of the probationary period.
(ii) Business accounts shall be settled within two working days after good delivery.

Besides the above, the members of the exchange shall pay the following costs for membership (NSE RULES 58 & 102)

(a) Members

1. Entrance Fee	Shs. 2,500.00
2. Annual Subscription Fee (payable half yearly)	Shs. 4,000.00

(b) Registered Agents

1. Entrance Fee	Shs. 1,000.00
2. Annual Fee	Shs. 800.00

The Committee of the exchange is not bound to accept any application for membership or to give reasons for refusing such application. According to existing stock exchange rules, no appeal is available on the decision of the Committee. This has been one of the most controversial rules of the exchange. It has been felt that such a rule was devised to maintain the status quo of the existing brokers. The Capital Markets Act (1989) erodes this power of the Committee.

3.2.5 **Conduct of brokers**

The exchange sets out the various rules to be followed by its members in dealing amongst themselves and with outsiders. The most important of the rules can be summarised as:

(i) No partnership in brokerage is allowed between a broker and a non-broker unless authorised by the

Committee.

(ii) The brokers are to charge the standardised brokerage rates laid down from time to time by the Committee.

(iii) The brokers shall keep or cause to be kept proper books of accounts in which shall be entered full particulars of their dealings and transactions.

(iv) No fictitious transactions shall be made by or between members.

3.2.6 Disciplinary provisions

Any member who does not charge fees in accordance with the rules can be fined.

The Committee may either suspend or revoke membership for any irregularities, non-conformity with the ethics, code and conduct of stockbroking business, and non-observance of the Rules and Regulations of the Exchange.

3.2.7 The Government's regulation of the exchange

The Government through direct and indirect means participates in the operations of the market. For example, Government agencies regulate financial institutions to provide a secure financial system and to promote competition. In Kenya this can be seen to be through legislation and/or activity. Government agencies have responsibility for implementation of monetary, fiscal, and debt management policies in the interest of economic stabilisation. Monetary policy is concerned with changing the growth rate of the money supply and the terms and conditions of credit. Fiscal policy is concerned with taxes and expenditure of government. Debts management policy is concerned with the impact of the Government's debt-issue decisions on the financial markets.

In carrying out those policy programmes, Government agencies exercise tremendous influence on the cost and availability of credit, an influence felt throughout the entire structure of financial markets and institutions. The direct influence on the exchange is felt through the CAPITAL MARKETS AUTHORITY (CMA) from 1989 and previously by its predecessor THE CAPITAL ISSUES COMMITTEE (CIC).

3.2.7.1 **The Capital Issues Committee (CIC)**

Up to late 1988, the CIC was the most influential body with respect to share issues in Kenya. The CIC was initially set up within the Treasury in 1971 to monitor and control the issue of securities. At that time its stated aims were to prevent economically harmful capital outflows from Kenya. The setting up of this committee followed disinvestment by foreign companies which had been urged to go public to allow local ownership of shares. These companies would repatriate all the receipts of all new issue to their home countries. The CIC was set up to authorise among other things, the size, timing and pricing of any new issues of securities, the capitalisation of reserves and the transfer of securities by publicly quoted companies.

The CIC was heavily criticised as being an obstacle to flotation of companies on the Nairobi Stock Exchange. Swainson (1980) contended that the CIC was an effective control measure for preventing the buying of local firms by foreign firms, and as a consequence a hindrance to external capital inflows. Langdon (1978) in his review of foreign subsidiaries suggested that the CIC did not represent an important control on the flotation or growth of the multinational sector. The IFC (1984) report on capital markets in Kenya was of the view that, in real terms, the CIC provided the most severe supply side restriction on the stock exchange. The World Bank (1987) Report on Kenya's Industrial Sector stated:

> **" Such extensive powers (of the CIC) are unusual even in countries, such as the United Kingdom, that have had in the past similar Committees regulating new issues. In such countries, pricing (if not timing) has virtually been decided privately between the firm and its underwriters."**

We do not know whether the evidence available vindicates the CIC or the multinational subsidiaries. The facts are that the CIC process has been reputedly so slow and time consuming that one issue - Barclays Bank's - was nearly six years in process before conclusion. It should also be noted that between 1980 and 1988 there have only been three public issues and one private placing. This has not been an encouraging sign for a market expected to mobilise savings and channel funds to important areas of investment.

The sharp criticism of the World Bank and the International Finance Corporation (IFC) led to the Kenyan Government's decision to enact the Capital Markets Authority Act and set up the Capital Markets Authority in 1989.

3.2.7.2 The Capital Markets Authority (CMA)

There have been suggestions over several years that the Government makes a move towards injecting "life" into the capital market in Kenya. The CMA was the body formed to oversee this task. The formation of CMA came as a result of recommendations made to the Government by the International Finance Corporation. The Authority is managed by a council of eleven members appointed by the Government. There are no specific requirement for appointment of a stock exchange member, and on this basis it is supposed to be independent from the exchange.

The CMA was formed to promote and maintain an effective and efficient securities market through:

(a) the development of all aspects of the capital markets with particular emphasis on the removal of impediments to, and the creation of incentives for, the longer-term investments in productive enterprises.

(b) the creation, maintenance and regulation, through implementation of a system in which the market participants are self-regulatory to the maximum practicable extent, of a market in which securities can be issued and traded in an orderly, fair and efficient manner.

(c) the protection of investor interests.

(d) the operation of a compensation fund to protect investors from financial loss arising from the failure of a licensed broker or dealer to meet his contractual obligations.

The establishment of the Authority is supposed to have significant impact on the operations of the exchange because:

(a) it will reduce the powers of the Committee of the exchange. It will establish conditions for, and approve an entity to operate as, a securities exchange. In addition it will be within its powers to grant a licence to any person to operate as a broker. This was a function of the Committee of the exchange. Aggrieved parties will have recourse to appeal to it from the exchange. No such facility was in existence before.

(b) it will have the responsibility for making rules regarding the listing of securities on the exchange.

(c) it will regulate disclosure of security transactions by brokers and dealers and the security exchange.

(d) it requires the proper maintenance of books, records, accounts and the audit of such books and records of any licensed broker.

The enactment of the security market law was a very important step in the provision of responsible stock market services in Kenya and for the protection of the investor.

3.2.8 The role of the financial sector in the exchange

The process of accumulating and channelling savings into real investment is performed by financial intermediaries. The assets of these firms consist of financial claims against others. Examples of such financial intermediaries are banks, life insurance companies, pension and provident funds. In financial intermediation, savings are gathered from households and the intermediaries invest them in financial assets such as shares, bonds, debentures and mortgages. This section examines the nature of the financial sector and its role in the exchange.

The financial sector is made up of

3.2.8.1 **Commercial banks**

The country had by 1989, 24 banks with 217 full branches, 70 sub-branches and many agencies and mobile units. In Kenya, the role of the Government in the drawing of bank credit has increased over time. The Government's share of bank credit has continued to increase, for example, from 2.9% in 1980 to 8.4% in 1985. This resulted from forced bank lending to the Government through it demanding a given liquid asset ratio and purchase of treasury bills. This action has tended to produce a crowding-out effect on the credit available to the private sector.

The commercial banks in Kenya have come to play a new role in the issue of new shares. The last four new issues have been greatly supported by the banking sector. The banks have acted as collecting agents and have also in some cases advanced funds to their customers for purchase of the shares. The shares purchased are then used as collateral for those advances. This has also changed the hitherto unacceptable system where banks did not attach value to share certificates. This share purchase support scheme is probably one of the reasons new issues have been over-subscribed.

Changes in the regulation of bank lending may have important implications for the exchange. In 1989, the

Central Bank changed the rules to allow commercial banks to extend term loans to over three years. Previously banks were restricted to term loans of 3 years maximum. The reason is that, currently, the banks tend to favour lending through rolling overdrafts to well-established private and public companies. This has to do with risk management of bank funds. The opening of long-term lending means that the banks can make long-term lending to such companies. These same companies will not find it necessary to go public or to offer new securities to the public. This will result in a very reduced level of activity on the exchange's new issues market.

The new conditions may also make banks favour major companies at the expense of small enterprises, which would then face severe credit rationing. It might be argued that this will provide motivation for small enterprises to seek funds through the exchange operations. In any case companies complaining of a credit squeeze by the Government or the banks should exercise their right to float equity or debt on the exchange. As will be discussed later, the current state of the exchange does not make it easy for small companies to make public issues.

Although the major banks do hold some equity in publicly quoted companies as part of their portfolio, the extent to which they invest on the exchange is not known. There has been great reluctance to disclose the nature and extent of the holding. The extent of their trading on the exchange is also unknown. The level of intermediation between the banks and the exchange remains undocumented.

3.2.8.2 **Non-bank financial institutions (NBFIs)**

There were 54 operational NBFIs with 94 branches operating in urban areas. The formal role of NBFIs is collecting savings and channelling these savings into long-term investments. Their importance was recognised in the direct competition they offered from the early 1980s' to the banking sector which hitherto had been operating as an oligopoly. The main distinction between them and the banks was that they were allowed to charge higher lending rates than the banks. Consequently they were able to offer higher rates to savers.

Even though the NBFIs grew tremendously in the 1980's, they did not seem to have had any significant impact on the operations of the stock exchange. By 1986, serious management problems had already been noted with respect to some of the NBFIs. These problems cumulated to the September 1986 bank crisis in Kenya. The underlying reason was that the NBFIs which collapsed did not make sound fund-channelling decisions. Their capital bases were weak and management poor. In the publicly available list of portfolio holdings of the collapsed NBFIs, none had made any investment in quoted securities. In future, NBFIs may be expected to specialise in long-term finance and hold long-term based portfolios. A consequence of this would be their increased participation on the exchange.

3.2.8.3 Development banks

The role of development banks is that of providing long-term finance through arranging local and international loans for major industrial undertakings. There are at present four development banks concerned with industrial finance in Kenya. It is expected that given the constraints on commercial banks and the weaknesses of the NBFIs, the development banks offer an alternative to industrial finance. It is true that the development banks play a key role in providing long term finance to industry [World Bank (1987)]. The reasons for this have been:

(a) The formal restrictions on the commercial banking sector
(b) The inability and unwillingness of the NBFIs.
(c) The non-activity and lack of dynamism of the stock market.

The funds available to these development banks are limited. This means that they are constrained in their industrial lending. The problem of constrained funds of the development banks may be resulting from their use of the stock exchange. No notable attempts have been made by these banks to raise funds through the organised exchange either by way of debt instruments or equity issues [World

Bank (1987)]. Their role in the exchange remains remote. One of them, Industrial and Commercial Development Corporation (ICDC), nevertheless, did float a public company in 1978 through its subsidiary, ICDC Investment Limited. It may be argued that the objectives of the issue was not to raise finance through the organised exchange but to fulfil a social objective in its original charter, that of distributing its share ownership nationally.

3.2.8.4 Insurance companies

Kenya had a total of 39 locally incorporated insurance companies by the end of 1988. Since the role of insurance companies is to manage risk over long-term periods, we should expect particular interest in long-term investments, especially those offered by the exchange. There is scarce information on the level of investment of life and non-life insurance companies. Their investments have been observed to be of short-term nature. The World Bank (1987) report on industrial development in Kenya states that life-insurers argue that their investments are biased towards the short -term because of:

(a) Very high interest rates paid by NBFIs
(b) restriction on lending to, and investing in, non-publicly quoted companies; and
(c) the absence of any new supply of publicly-traded equities and bonds.

The observation that insurance companies would wish to invest in quoted securities is interesting, and suggests that the insurance companies have a major role to play in a revitalised stock exchange system. The Insurance Act imposes formal directions into which investments should be put. It provides for at least 20% of the investment to be put in quoted securities. There is also a provision that requires increased local ownership of all foreign controlled insurance companies. It requires 51% local ownership of such companies. This may revitalise the stock exchange's new issue market by having such companies make public offers of equity shares. We are unable now to determine the effectiveness of the insurance companies in financial intermediation and their level of activity on the organised exchange. The only evidence is circumstantial and may be inferred by examining the investment account in published annual accounts of the insurance companies. We do, of course, believe that they are probably the most active single group of institutional investors but the Exchange did not have published evidence on their level of participation.

The above discussion shows that the level of participation of the financial sector in the exchange is at a very low level. This does not augur well for the stock exchange's development in the future, unless increased participation by this sector is forthcoming.

PART 2:

3.3 ECONOMIC AND OPERATING FEATURES OF THE NAIROBI STOCK EXCHANGE

3.3.1 The Activity Of The NSE

The NSE deals in three types of securities. These are ordinary shares, preference shares and debentures. The listing of a security qualifies it for trading on the exchange. Government securities are, however, listed but not traded. Their trading is managed by the Central Bank, and distribution is done through the help of one of the six brokers who at that time is the Government broker. In discussing the performance of the NSE, Government securities will be omitted because their activity is not within the organised exchange. The statistics of the exchange are given in Table 3.1.

3.3.2 Size of the Markets

The size of the market may be defined in terms of capitalisation and the number of securities listed. Table 3.1 reports the summary statistics for 1979 to 1989.

TABLE 3.1: THE NAIROBI STOCK EXCHANGE STATISTICS

(currency amount in Millions)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
A. Number of listed companies											
Nairobi Stock Exchange	54	54	55	54	54	54	54	53	53	55	57
B. Market Capitalisation											
1) In Shillings	137	134	226	404	546	721	624	698	757	852	1296
2) In USA dollars	20	18	25	37	41	50	38	43	46	48	63
3) Percentage change		-10.0	38.9	48.0	10.8	22.0	-24.0	13.2	7.0	4.3	31.3
C. Valuation Indicators											
1) NSE Index (Jan 1966=100)	416.3	378.3	350.4	349.8	382.7	386.4	421.1	506.0	735.3	858.6	
2) Change in Index (%)		-10.0	-7.4	-0.2	9.4	1.0	9.0	20.2	45.3	16.8	
3) P/E ratio	6.1	5.0	9.4	7.7	1.5	1.5	6.8	3.5	10.4	7.0	11.5
4) Dividend yield (%)	7.4	6.6	4.7	7.1	4.5	6.8	5.5	5.0	5.1	8.4	10.1
D. Economic Data											
1) Gross Domestic Product(GDP)	$7023	6949	5882	5446	5545	5564	6037	7268	8011	8940	
2) Growth GDP		-1.1	-15.4	-7.4	1.8	0.3	8.5	20.4	10.2	11.6	
3) Growth GDP(constant prices)	4.3	3.3	5.5	2.3	2.3	0.7	4.9	5.5	4.8	5.2	

SOURCES: Nairobi Stock Exchange

Company Accounts- Various issues

IFC statistics 1990

Kenya Economic Survey - Various issues

3.3.2.1 **Capitalisation**

Market capitalisation for the NSE grew by 2.5 times compared to the growth of all emerging markets of 6.695 times and that of developed markets of 3.183 times between 1980-89. This can attributed to the low growth in value of quoted companies in the agricultural sector. This growth was nevertheless reasonable considering that, like many other African countries, Kenya was experiencing difficulties in its internal structures and external debt management, which also affected the generation of wealth. From 1986 the increase in growth can be attributed to increased investor confidence in the market following the Government's announcement of its intention to revitalise the stock exchange. During that year there was also a declared intention by at least three companies to go public, and this was given wide publicity by the national media.

3.3.2.2 **Listings**

The number of securities listed has remained constant over the period 1979 to 1988. The lowest number listed was in 1986 when one company was reprivatised. Two listings in 1988 increased the number to 55. The shares listed are from different industrial groupings, utilities, and financial institutions. The types of the listed securities were:

Ordinary Shares

At the end of 1988 there were 52 ordinary shares listed. For the period 1979 to 1988, 4 shares were delisted: 3 were delisted because of company failure and one company became private. During the same period, four new ordinary equities were listed. All four new ordinary share listings were financial institutions: two banks, one NBFI, and one insurance company. The current legal requirements are that the shares must be denominated in par values, which have no relationship with the market price. Any special features such as special rights, restrictions, and class of the shares must be disclosed.

Preference Shares

The number of listed preference shares remained constant throughout the period 1979 to 1988. Two issues were delisted with the failures of the issuing companies. One preference share was issued by an industrial company within this period. The nature of the preference shares is always disclosed, for example, whether the shares are redeemable and if so, when, cumulative or non-cumulative, their convertibility, and the coupon rate of dividend and any special rights.

Loan Stock

Two loan stock issues had been continuously listed for the entire study period. There were no new issues. These were the only loan stocks available for trading. Other loan stocks listed were for local authorities and the Government, but they were not available for trading.

3.3.3 Trading Volume (Turnover).

The level of activity in the market is best measured by the value of securities traded and the relationship between the value traded and capitalisation (turnover). No official statistics are available on trading volume. The last official figures available were in 1979 when 5,496 trades were concluded. The number of shares that changed hands or the nature of the investors who dealt in the transactions in that year was not available. The volume of trading cannot as for now be determined until the exchange starts to report it again formally.

3.3.4 Valuation Details

The valuation ratios are the price/earning and dividend yield. The figures for 1979 to 1989 are presented in Table 3.1. The P/E ratios and dividend yields were similar to those of other emerging markets. The dividend yield was stable over the period which was good for investors relying on dividend income. The P/E ratio and the dividend yield gives future value signals to investors. The higher the P/E ratio, the higher the expected future income relative to current income [Foster (1986)]. It may be concluded from the ratios that the NSE shows reasonable prospects.

3.3.5 The Nairobi Stock Exchange Index

The NSE-Index enjoys extensive coverage in the public media in Kenya as a barometer that monitors changes in the economy.

3.3.5.1 Computation

The computation of the weekly index is at present done by the broking firm of Dyer and Blair. They took up the exercise in 1968. The original index (then known as the East African Industrial Share Index) was done by T.L. Champion. The base of the current index is January 1966.

The NSE index is unweighted. An arbitrary figure of K£2000 is assumed to be invested equally at K£100 except for Kenya Breweries and Kenya Power which are allocated K£250 each. The index is constructed using the formula:

$$I_c = \frac{\sum_{i=1}^{n} (SP)\ (B)}{2} \qquad (1)$$

Where:

I_c = Ordinary share price index in the current week

n = Number of companies (17 companies currently).

S = Number of shares outstanding for each company

P = Middle market price for the ordinary shares of each company in the current week.

B = The base index as at 3rd October 1968 = 170.86

3.3.5.2 **Composition**

The companies whose shares are used for the computation of the index are:

1. B.A.T. (K) Ltd.
2. Brooke Bond
3. Car and General
4. Consolidated Holdings
5. C.M.C. Holdings
6. Diamond Trust of Kenya
7. E.A. Portland Cement
8. Elliot Bakeries
9. Jubilee Insurance

10. Kakuzi Ltd.
11. Kenya Breweries
12. Kenya National Mills
13. Kenya Power and Lighting.
14. Barclays Bank
15. Motor Mart and Exchange
16. National Industrial Credit
17. Sasini Tea and Coffee Ltd.

3.3.5.3 **Movement in the NSE-Index**

The year-end index and the changes in the index are given in Table 3.1. The index has increased considerably over the 10 years from 416.3 in 1979 to 858.6 in 1988. The percentage changes from year to year were erratic. Negative changes were recorded for 1980 and 1981 reflecting the impact of the oil crisis on the economy. Improved performance of the economy and the easing of the oil pressure on the industrial sector are reflected in the index between 1986 and 1988. The percentage changes in the index compares well to those of the Gross Domestic Product shown at the bottom of Table 3.1.

3.3.6 Information Reporting By Quoted Companies

3.3.6.1 Reporting Requirements of the Stock Exchange

The stock exchange has its own rules for reporting by quoted companies. It requires that during the continuance of its quotation the company will:

(a) Present half yearly interim statements, the Chairman's Annual Report and Accounts to the Nairobi Stock Exchange immediately these have been approved by the Directors.

(b) Notify announcement of dividends, rights and bonus issues at least three weeks before the closing of the register.

(c) Notify any sale or purchase of assets which could materially alter the company's business or capital structure.

These provisions have to be complied with. Any company that fails to comply with them will have trading in its shares suspended.

3.3.6.2 The Companies Act

The Companies Act makes it mandatory for all registered companies to produce annual accounts. It also prescribes the minimum amount of disclosure that must be made by companies in those accounts. The accounts must be audited before publication.

3.3.6.3 **Other issues in reporting**

The nature of financial reporting by Kenyan quoted companies is a research issue in its own right but it suffices to say here that public companies are required to follow Kenyan Accounting standards in the formulation of their reporting. Where standards have not been formulated, the current rules by the Institute of Certified Public Accountants of Kenya are that International Accounting Standards should be adopted.

There has also been increased attention by the public media on the activities of companies in Kenya. The companies also do from time to time make public disclosure of activities and events which they consider to be of importance. One may argue, a priori, that the level of reporting by companies is reasonable.

3.3.7 **Fiscal Environment Of The Exchange**

The levels of taxation have been argued to affect the demand and supply of securities on exchanges [Calamanti (1983), Kitchen (1986)]. This section examines the fiscal environment of the NSE. Exchange related taxes are:

(a) **on transactions**

Transactions on the exchange are subject to stamp duty. The current rate is at 0.5% of the value of the transaction in the security. The tax is payable by the person to whom the security is transferred.

(b) **on income from listed securities**

The dividend received from quoted securities is considered to be income chargeable to tax in Kenya in the hands of the recipient. The tax rates differ depending on whether the recipient is an individual or company.

An individual will have dividend income added to his other income and taxed at the individual rate of tax whose maximum currently stands at 45%.

A company will have the dividend treated as corporate income and taxed at 45%. The dividend may nevertheless be exempt from tax if the company owns 12.5% or more of the shares or voting power of the dividend issuing company.

Similarly, dividend income (unless exempt from tax) is subject to with-holding tax of 15%. The tax is deducted by the issuing company before making the dividend payments to its shareholders. The withholding tax on interest is 10%. This means that interest has a more favourable tax treatment than dividends.

(c) **on quoted companies**

The profit of quoted companies is subject to tax at 45%. This is the same tax rate charged to all companies, both private and public. It should be recalled from above that the dividend received or paid out by such companies is also subject to tax. This represents double taxation of dividends and is arguably one of the main issues hindering the development of the capital markets [IFC (1984)].

(d) **tax treatment of certain expenditure of raising capital.**

There are certain costs incurred in raising capital which are not tax deductible. The costs of raising share capital and of issuing debentures, for example, are not tax deductible.

An effect of the current tax regime is that no tax advantages are gained by a company going public.

3.3.8 The Demand For Securities

Demand for securities in Kenya comes from two distinct sources: individual shareholders and institutional investors. Individual shareholders have now recognised the attractiveness of holding securities as an alternative investment to real assets such as land and buildings.

Evidence of the high demand for securities is provided by:

(i) **Oversubscription of new issues.**

Recent experience with the Barclays Bank, Kenya Commercial Bank, and Jubilee Insurance issues, suggests that there exists an unsatisfied demand for securities in Kenya. These issues, which were restricted only to individuals, were all oversubscribed by between two to five times. To ensure what the issuers call "equity" subscribers were allotted only 100 shares each irrespective of the number of shares applied for. This of course had a social advantage that the shares were widely distributed to many people.

(ii) **Unfulfilled buy orders**

Information from the brokers suggests that they are never short of purchase orders and have more customers willing to buy shares than there are shares available for sale in the market. This is supported by evidence provided by the price list information of the exchange. This suggests that, had there been an adequate supply of securities at the right prices, the market would transact in almost all securities each week.

(iii) The demand from institutional investors

The last public issues of shares have tended to discriminate against institutional investors. They have not been allowed free subscription, and in some cases they have been barred from subscribing (Kenya Commercial Bank). This is in spite of the fact that such investors have been very much interested in investment in financial assets. The unfulfilled demand from this group of investors has forced many of them to adopt short-term investment strategies. For example, The World Bank (1987) report on industrial development in Kenya states that life-insurers argue that their investments are biased towards the short-term for two exchange-related reasons: restriction on lending to, and investing in, non-publicly quoted companies; and the absence of any new supply of publicly traded equities and bonds.

Hopefully this will change, since the Government has recognised these weaknesses and, through the CMA, has devised steps aimed at revitalising the exchange. The increased awareness of the attraction of financial assets represents one of the dynamic forces not exploited fully in the Kenyan Capital market. There seems little doubt that an adequate demand for securities exists.

3.3.9 **The Supply Of Securities**

There are two sources of supply of securities to the exchange. The first is the primary market, where new securities are issued. The second is the secondary market, the stock exchange itself, where existing securities are traded.

3.3.9.1 **The New Issues Market**

The key role of the capital market is that of financial intermediation and capital formation. This role is fulfilled by being a catalyst in the mobilisation of savings, and by channelling those savings into profitable investment. The primary market segment of the capital market deals with any new issues of shares and bonds.

In Kenya the new issues market for shares has been dominated by the stock brokers. This is probably because they have the advantage of close contact with the companies willing to go public. Without sophisticated financial analysts and investment advisory services, they are also seen as the only ones who understand the rigour and technicalities of issuing securities. The Government manages the issues of its stock and bills and does not involve brokers directly.

Procedure for new issues of shares.

When a company decides to go public, the management approaches a selected Broker or Underwriter. The broker or underwriter may be selected by introduction, knowledge, or - in some cases - by association. The role of the underwriter will be to look at the financial needs and plans of the company wishing to issue securities. He will advise on the best strategy to use in raising the funds. When the strategy is agreed, the managing underwriter or sponsoring broker will start managing the process of floating the securities.

To be able to raise funds on ordinary shares from the public, the company must be a registered public company under the Companies Act. For this purpose, a private company must be converted into a public company.

With the help of the managing underwriter, the company will apply for formal authority to the CIC (now CMA). As discussed earlier, the role of the CIC is to determine the terms of the issue, including the pricing. It also approves the timing of the issue. Once permission is granted by the CIC the company makes an application for listing to the Committee of the exchange. The company making the new issue is helped by a sponsoring broker, who must be a member of the exchange. The necessary requirements for quotation must be fulfilled. These requirements are (NSE: RULE 104):

1.Every company wishing to go public will be required to provide a certificate from its Auditors stating that the company has been properly registered within the terms of the Companies Act (Cap. 486).

2. The minimum issued and fully paid up capital of a company wishing to obtain a quotation should be a total of at least K.£.100,000 in Ordinary and/or fixed interest capital.

3. In order to obtain a public quotation, a company must issue or offer for sale to the public not less than 20% of its authorised share capital, or shares to the nominal value of K.£.50,000, whichever is less.

4. Certain details are required in the accounts submitted before a company offers its shares to the public, particularly concerning:

(a) All Directors, the Company's Secretary, Auditors and Legal Advisers, and the date of the financial year end.

(b) Particulars of any subsidiaries or associated companies together with their profit and loss accounts.

Any subsequent changes to the above must be notified immediately to the Nairobi Stock Exchange.

5. The Nairobi Stock Exchange requires seven copies of the company's audited balance sheets for the previous five years, or for all years if the company has been in existence for less than five years, together with sufficient copies of its Articles of Association for retention by the members of the Nairobi Stock Exchange.

6. The Nairobi Stock Exchange requires to be informed in detail of the existing and intended distribution of the company's Ordinary share capital with regard to whether control is, at the time of new issue of shares, held locally or overseas, and on any intended alteration. Where a company has Certificates of Approved Enterprise in relation to capital imported, an Auditors' statement giving details of such Certificates has to be produced.

7. A public quotation for a company is dependent upon the making of a minimum issue or offer of shares, as above, to the public. This issue or offer must be sponsored by a stockbroking firm which is a member of the Stock Exchange. The sponsoring broker is responsible for making an application to the Stock Exchange for a public quotation and for the preparation of a prospectus for an offer or issue to the public which meets the requirements of the law. The prospectus must gain the approval of the Nairobi Stock Exchange Committee and the New Issues Committee.

8. A Hearing Fee of Shs. 1,000/- is payable by any company applying for a first quotation of its shares. This fee is

payable immediately the application is submitted by the sponsoring broker.

9. A fee of Shs. 1,000/- for each class of shares or debentures for which a quotation is required must be paid to the Exchange within 30 days of the quotation being granted.

10. Separate applications for additional quotations must be made to the Nairobi Stock Exchange for any further alterations of capital, subject to a quotation fee Shs. 1,000/-.

11. Companies are required to pay an annual quotation fee according to the rate of charges set from time to time by the Stock Exchange in General Meeting. The current rate of charges are as follows:

quoted share capital	**Annual Fee**
Up to K.£. 1,000,000	Shs. 1,000/-
Up to K.£. 2,000,000	Shs. 1,400/-
Up to K.£. 3,000,000	Shs. 1,800/-
Up to K.£. 4,000,000	Shs. 2,200/-
Up to K.£. 5,000,000	Shs. 2,600/-
Up to K.£. 7,500,000	Shs. 3,200/-
Up to K.£.10,000,000	Shs. 4,000/-
Over K.£.10,000,000	Shs. 6,000/-

12. Companies are required to recognise and register only those transfers of the quoted shares where the transactions have gone through one of the members of the Nairobi Stock Exchange.

13. The quotation of any share may be cancelled or suspended by the Committee without giving any reason for such decision.

14. Companies with quoted shares must abide by the rules and regulations of the Nairobi Stock Exchange.

In order to comply with the above requirements a prospectus must be prepared. The prospectus must also be filed with the registrar of companies.

Once the above procedures are completed, the shares are offered to the public. After the processes of offering are completed, the shares are listed on the stock exchange and can be traded from then on.

New Issues 1979 TO 1988

The market for new issues cannot be said to have been very impressive over the past decade to 1988. From the inception of the CIC very few public offerings of debt and equity securities have taken place. Table 3.2 shows the new issues for the period 1979 - 1988.

TABLE 3.2 LIST OF NEW SHARE ISSUES 1979 - 1988

COMPANY	YEAR OF ISSUE	NO. OF SHARES	PAR VALUE	ISSUE PRICE	CAPITALISATION
			kshs.	kshs.	kshs.
Pan African Paper	1979	1000000	10.00	20.00	20000000
Jubilee Insurance	1984	800000	5.00	14.50	11600000
Barclays Bank	1986	5000000	10.00	16.00	80000000
Kenya Finance	1988	500000	10.00	17.50	8750000
Kenya Com. Bank	1988	7500000	10.00	20.00	150000000

All issues were over-subscribed. This may be an indication that there exists an ample demand for securities in Kenya. The supply side seem to represent the major problem in the issues market. This problem may have arisen from:

(a) the ability of the private companies to get funds cheaply from the banking sector without diluting control. The current interest rate policies tend to favour the large well-established companies. The fixing of the maximum interest rates directly by the Government amounts to financial repression. This tends to assure that the banking sector can obtain cheap funds from the public generally, and channel such funds to selected companies. The companies on the other hand have a major source of cheap funds from the financial sector. There is no need therefore to seek funds from the organised exchange, and thereby dilute control or be forced to comply with more stringent disclosure requirements.

(b) the operations of the financial sector outside the exchange. The financial sector does not currently have adequate money market instruments which it can use on the organised exchange. The absence of such instruments as commercial paper, short-term bills of credit, and negotiable certificates of deposit means that no trade can emerge to deal with them on the exchange.

(c) the existing restrictive tax practices. Firstly, underwriting expenses are not tax deductible. Secondly, dividends are double-taxed. Thirdly, there are no corporate tax advantages to be gained from a firm going public.

(d) Government's intervention in the new issues market through the operations of the Capital Issues Committee (Replaced by the Capital Markets Authority in 1989). This Committee has been so slow and time consuming in its work that it has been causing substantial delays in share issues.

(e) the nature of the stock exchange itself. We noted earlier that the brokers have greater control over the market and that there are no jobbers or specialised merchants bank underwriters. This is demonstrated by the fact that the underwriters in the Jubilee and Barclays issues were two sister companies. In the Barclays issue it was Barclays Industrial, and in the Jubilee Insurance issue it was Diamond Trust of Kenya. While in each case the issue was a success, being over-subscribed by between two and five times, in a more developed equity market and without regulated under-pricing being imposed by the CIC, new issues may fail [World Bank (1987)]. In such a case the risk bearing and management functions of the underwriter become important. Without such a group of specialised risk bearing agents an extensive new issues market is difficult to establish.

(f) the NSE's listing requirements. We noted above that, to be listed, a firm needs a five year record of continuous trading. This militates against making of public issues by new venture capital firms.

3.3.9.2 **Secondary Market**

There is little doubt that the supply of securities in the secondary market is thin. This is evidenced by the number of sell orders received by brokers, and the occurrence of transactions on the exchange [Table 7.1]. Several factors may contribute to the inadequate supply of securities in the secondary market:

(a) The weaknesses of the new issues market discussed above.

(b) The costs of transactions, which are fixed by the exchange and increased by Government taxes, may affect supply in that they reduce the returns from equity investments. These costs include purchase/sale commission of two percent or more, stamp duty, and transfer fees.

(c) The nature of some of the market participants. In particular, insurance companies are only allowed to invest in stocks of firms publicly traded on the NSE. As a result any shares that become available are instantly bought up by these institutions and held in their portfolios. Since changing such a portfolio is costly and difficult, given the thinness of the market, it takes quite a while for such securities to reappear in the market for trading.

(d) The listing requirements also affect the secondary market. To be listed, a firm only has to make available 20% of its total shares for trading purposes. In many cases 80% of the shares are retained by holding companies, many of which are based overseas or are in the hands of family groups. These groups are unlikely to trade these major blocks of shares. This clearly restricts the aggregate supply of tradable stocks in the secondary market.

PART 3:

3.4 ORGANISATION OF TRADING ON THE EXCHANGE

3.4.1 Introduction

The NSE deals with two classes of securities. These are the variable income securities and the fixed income securities. The ordinary shares predominate in the variable income class while preference shares, debenture stock, and municipal and Government bonds form the portfolio of fixed income securities.

Shares in quoted companies can only be purchased through a registered broker. We stated earlier that this market does not have any specialists or dealers. Brokers deal with each other directly on day to day basis. Nevertheless, brokers do not buy or sell on their own account, but on behalf of their clients.

The minimum level of trading on the exchange is for 100 shares or more, and the quotations on the stock must be for lots of such amounts. Any transaction in a lesser number of shares is known as an odd-lot transaction (NSE Handbook). The broker is a major player in the price setting process, as all transactions take place at a price asked or offered by him.

We examine how a transaction originates, how it is handled and concluded and what is involved when shares are purchased cum- and ex- div, with rights and with bonus issues. We then look at the costs of transacting on the NSE, short selling, and the reporting system.

3.4.2 The origins of a transaction

According to the NSE Handbook, potential customers contact the brokers either by mail, telephone, personal visits or through registered agents, and give their buying or selling orders. The brokers receive from their clients either a market or limit order.

3.4.2.1 Market Orders

This is an order given by a person to his broker for purchasing or selling a security. The broker is expected to execute the order at the best market price that occurred on that particular day. Hence a sell order should be at the highest price for the day and a buy order should be at the lowest price. The broker exercises his discretion on the transaction and the investor has no control over the price at which the transaction occurs.

3.4.2.2 Limit Orders

An investor placing a buy or sell limit order expects the broker to execute the order at a proposed price. Hence, a sell limit order is executed if the market price for a particular share rises to that price. A buy limit order is executed if the market price for a particular share moves to that price. The investor has complete control over the price of limit orders.

The nature of the above orders may vary depending on the individual needs of the client with respect to time, quantity of shares, type of securities, etc. With the orders in his possession the broker proceeds to the next stage: that of making the transaction.

3.4.3 Making transactions: bidding and offering

The NSE, unlike markets in developed countries has no trading floor or mechanised trading systems. It has been labelled a "telephone market" in that brokers are supposed to communicate with each other on telephone.

The broker with the buy market or the buy limit order will be interested in obtaining a low price. On the other hand, brokers holding sell orders will be interested in getting the highest price. The broker with the order will ask for a quote from another broker(s). The broker contacted will make a quotation on a buy and sell. The broker quoting does not know if his counterpart has a buy or sell order. It is important to recognise that the rules are that once the quotes are established no bid or offer at a lower price can be made. Similarly when an offer is established no offer or bid at a higher price can be made until the market clears on that stock between the two brokers. The broker may nevertheless decide not to do business with this broker and ask for a quotation from the next broker. The process of quotation is then repeated. If the broker decides to do business after receiving a quote he will make a counter offer but restricted within the original quote. At this time he will disclose whether it is a buy or sell order. The other broker may decide to accept the counter offer, otherwise the counter offering continues until a transaction price is struck. Limit orders do restrict the freedom of the prices at which the transactions are concluded. When the first deal is concluded any new order is treated as new business and the process starts afresh.

The nature of the market and the number of brokers means that sometimes a broker may have both buy and sell orders for the same share. In such situations professional ethics demand that the broker seeks to transact with other brokers first on the stock before crossing the orders. There are, however, no rules laid down that the broker should not cross the order immediately himself, and it will then be entirely an internal transaction.

When the broker has struck a price, the deal with the other broker(s) is concluded, and the purchase or sale can be formalised.

3.4.4 **Purchase of shares**

When the broker concludes a buy order for his client he issues a Purchase Contract Note to that client. The note is a legal document that acts as proof of ownership of shares until the share certificate arrives. The note will show the number of shares purchased, the price per share, the commission chargeable in accordance with the rates stipulated by the Committee of the stock exchange, the contract stamp, transfer fee chargeable by the company for the processing of transfer documents and the Government's stamp duty. The final figure will show the total amount to be paid to the broker immediately on receipt of the contract note (NSE Notes p.9).

All purchases are deemed to be for cash unless there is agreement between the brokers in writing within twenty four hours of the offer. Any purchaser who fails to settle his account within the stipulated time of the Purchase Contract Note can be charged interest at the ruling bank rate.

The stock broker shall complete the transaction of purchase by forwarding to the buyer a transfer deed, having been signed in blank by the seller. The buyer is expected to complete his name in full, with address and signature, and the deed must be witnessed by an independent person. The duly executed transfer deed, together with the relative share certificate(s), are lodged with the Registrar of the company whose shares were purchased and the Registrar records the name and address of the shareholder in the place of the previous owner whose name is deleted. A new share certificate is sent to the buyer via the stock broker.

3.4.5 **Sale transactions**

In a sale transaction the seller receives a Sale Contract Note from his broker. The note shows the net sales proceeds available to the seller. The seller bears the administrative charges of the sale, which include commission to the broker and contract stamp.

The seller is assumed to sell for cash, unless he has allowed for credit in writing. The seller of shares shall make or tender delivery within sixty days after the date of the transaction except:

(a) by agreement with the buyer, or;

(b) where the contract note is endorsed 'for quick delivery' in which case delivery shall be made or tendered within ten days after the date of the transaction, or;

(c) where the seller is doubtful as to his ability to deliver within sixty days and declares so at the time of making the transaction (NSE Rule 90).

Once the stock broker sells shares, a blank transfer form is sent to the seller for signing and the signature shall be witnessed by an independent person. The executed transfer together with the share certificate are returned to the broker for delivery to the buyer.

3.4.6 Transactions involving Dividends, Bonus and Rights issues

Dividends announced by quoted companies are payable to shareholders who are on the register at a particular date. The date depends on when the dividend is declared. When dividends are declared shares are quoted on the exchange cum-dividend from this date for twenty one days. After this date the register is closed and shares are quoted ex-div. Any investor purchasing shares during the cum-div period will be entitled to the dividend even if he is not in the register. After the register is closed shares are on ex-div basis.

Any person who sells shares cum-dividend shall forward the dividend to the buyer even though the buyer's name had not been entered into the register at the time the register was closed. The same principle applies to bonus and rights issues.

3.4.7 **Cost of transacting on the NSE**

The direct costs of transacting are:

(a) Commission

Both buyers and sellers of securities pay commission to brokers at predetermined rates fixed by the Committee of the Exchange. The current rates of the commissions are:

(i) On Companies Shares and Stocks

Consideration per share		**Brokerage per Share**		**%age**
Up to	Shs. 1.50	cents	10	7%
Over	Shs. 1.50 to 2.50	"	15	7.5%
"	Shs. 2.50 to 5.00	"	20	5%
"	Shs. 5.00 to 7.50	"	25	4.2%
"	Shs. 7.50 to 10.00	"	30	3.3%
"	Shs.10.00 to 15.00	"	35	3%
"	Shs.15.00 to 20.00	"	40	2.2%
"	Shs.20.00	2% on the consideration		

(ii) On Government and Municipal Stocks

On nominal amount

Up to K£. 10,000 - 1.5%

Over K£. 10,000 - 1.25%

(iii) On short-dated stock with one year or less to maturity - on the nominal amount - 1%

(iv) Rebates - A return commission of 25% is allowable to registered agents on business done for their clients at the discretion of the members.

(v) Minimum Commission on one transaction is as follows:-

Consideration	**Minimum Commission**
Below Shs.200/=	at members' discretion
Shs.200/= to Shs.600/=	Shs.40/=
Over Shs.600/=	Shs.60/=

(iv) Portfolio Valuations - Shs. 20/- per item with a minimum charge of Shs.40/- for every valuation.

(vii) For professional advice a fee shall be charged at a minimum rate of Shs.400/- per hour.

(viii) On take-overs, new issues and rights in which commission exceeds K.£. 50,000, a member at his discretion may charge three-quarters of the normal commission shown in (i) above.

(b) The stamp duty on the transfer of shares currently standing at 0.5% of the consideration.

(c) Contract stamp. This is a Government revenue stamp that must be affixed on each contract note as follows:

Consideration		Amount
Below	Sh.2000	Sh.1.00
Between	Sh.2000 and Sh.10000	Sh.2.00
For every other Sh.10000 or part		Sh.2.00

These are negligible in percentage terms but they do add to the cost of transacting.

(d) The transfer fees charged by companies on issue of new share certificates and on entry into the shareholders register. These are nominal and fixed.

3.4.8 Short-selling

A short sale is a procedure by which an investor or speculator sells securities that he does not own, hoping to "cover" the transaction later at a lower price and make a margin on the difference between his selling price and the new lower price net of transaction costs [IFC (1984)]. This procedure works well in exchanges where there is settlement by account and the exchange itself does not bar the practice. The Nairobi Stock Exchange does not allow short selling. A broker may refuse to enforce a transaction if he believes it is intended for this purpose.

3.4.9 The reporting of stock exchange activity

The broker report to each other through a call system. Each day members meet and the securities are called out in alphabetical order. When the particular security is called, the members indicate the highest order to buy and the lowest order to sell received and whether any transaction have been struck. The highest buy order price, the lowest sale order price and the transaction price are then recorded in a daily call-over sheet to indicate the state of the market. This daily call-over sheet is not available to the public.

A main call-over is held every week on Thursdays at 10.30 am. From information available from the exchange all securities are called over and the closing buy order price (bid), the closing sell order price (offer/ask) and the closing transaction price relating to each security in the week are recorded. The highest and lowest transaction prices for the week are also recorded to indicate movement of the prices for the particular security. The document recording such information is the weekly call-over sheet and is thereafter handed to the Secretaries of the exchange who distribute it to the media and other parties as public information. The document (Appendix 2) does not contain any information on the volume of trading for the week.

The methods of reporting may not look very impressive to persons who have encountered the current computerised exchange systems with automatic price listings. It must nevertheless be realised that given the current level of activity the existing system works very well. It has also the advantage of minimising the cost to the investor and may, given the circumstances, offer the most accurate and speedy way of dealing with transactions. It may also reflect accurate information on the bid of all buyers and all sellers at a particular point in time [Hirst and Wallace (1974)].

The stock exchange also issues detailed information on the accounts of quoted companies on a quarterly basis. This information was previously available on an annual basis through the NSE year books. The information is available, immediately it is released, to subscribers on record.

With the above price reporting system a problem arises, however, where the public does not participate or have access to the information. There are reasons to believe that the planned Government's initiative to revitalise the stock exchange and the monetary system will require that the current method of trading and processing information on prices be changed, hopefully for the better.

PART 4

3.5 RECOMMENDATIONS AND CONCLUSION

Previous sections have examined in detail the background and the operations of the exchange. Arising from these discussions several recommendations can be made to improve the operating efficiency of the exchange. These will be through, firstly, improving the demand and supply of securities in the market, that would in the long-term increase the quantity of new issues, both primary and secondary and secondly, improve the dissemination of information and the quality of professional services on the exchange.

3.5.1 Activating Demand and Supply of securities

The IFC (1984) and the World Bank (1987) reports have highlighted the issues that are required to be addressed on the demand and supply side. We re-emphasise some of them, and add those which have arisen since.

3.5.1.1 Activating Demand

(i) The Government should seek ways to encourage indigenous ownership of shares [IFC (1984)]. This can be done in a number of ways. One of the most attractive would be to encourage small investor share ownership schemes similar to those tried with success in the

Jubilee, Barclays and Kenya Commercial Bank issues. Under these schemes a proportion of shares were pre-allocated to Kenyan citizens. In all the issues banks arranged finance so that small investors could borrow funds to buy shares. These loan were to be re-payable over 18 to 24 months with the share certificates used as collateral.

(ii) Tax incentives should be changed to encourage demand. In particular the double taxation of dividends should be adjusted so that equities are taxed at the same rate on the margin as investments in bank deposits and treasury bills.

(iii) The market could be made more efficient and attractive through reductions in the level of "fixed" commission costs [World Bank (1987)]. The Government should require that all brokers compete for commissions and prohibit a commissions cartel. To ensure this occurs, there should evolve competing intermediaries and even banks should be encouraged to enter into retail discount brokerage in competition with the established brokers. This could not only have the benefit of reducing the average level of commissions, but, through the branch networks, would likely result in a greater dispersion of share ownership among Kenya's regional areas;

(iv) Stamp duty tax should be reduced and if possible abolished for share transactions. The tax may be retained for loan capital.

(v) There should evolve specialised investment institutions like unit or investment trusts. The investment trust holding a diversified portfolio will be an attractive investment to risk-averse investors. One important proviso is that a sufficient number of shares is made available for trading, otherwise, market pressure for these firms' stocks would increase prices and reduce returns to unattractive levels. Other investment trusts based on groups of mature development projects might also prove attractive [IFC (1984)].

3.5.1.2 **Activating Supply of securities**

(i) Tax incentives should be given to firms going public. This may mean publicly traded firms having to pay a lower corporate tax rate than private firms. If evasion could at least be partly controlled, the Government could guarantee a steady supply of new public issues by simply imposing high tax rates on privately controlled firms.

(ii) The Government powers of control of stock exchange share issues should be reduced [World Bank (1987)]. The central authority should have no say in price setting decisions. Prices should instead be based on the best instincts of merchant bank underwriters and the issuing firm. Moreover, there is good reason to believe that the country contains the resources that could quite quickly produce an adequate supply of merchant bankers utilising employees knowledge and skills at already established financial institutions.

(iv) Greater ease of access to the market should be allowed for new venture firms. The NSE's requirement of at least five years trading history is unduly restrictive and should be reduced or left to the discretion of the exchange [IFC (1984)].

(v) Privatisation of self supporting and profitable parastatals would widen the choice of quoted investments for the investors and generally increase the supply of securities.

3.5.2 Information Dissemination

The amount and quality of information disseminated to the public would require to be increased. This will take the form of increased market statistics, for example, volume of trading, nature of investors, value of transactions and changes in the nature of operations of quoted companies. Daily listing of prices should be provided. There will also be need to improve the quality of disclosure in accounting reports issued by companies.

3.5.3 The nature of the exchange operations

The brokerage system must be made more efficient. The need for instantaneous trading to reduce the possibility of conflict of interest needs to be addressed. This would require the establishment of either a centralised trading floor or perhaps more realistically the establishment of a computer screen market for "over the counter" trades among brokers [World Bank (1987)]. Indeed, the computer technology is readily available for the latter type of trading arrangement and has been applied in many markets.

3.5.4 Professional Advisers

The operating efficiency would be improved if more professional services were available for use by investors. These services would be rendered by underwriters, financial analysts and dealers. The existence of these professionals would not only provide more insight on operations but also lower the costs of transacting by providing quicker access to information and at competitive rates.

All the issues addressed in chapter 2 and this chapter have concentrated on operating efficiency of stock exchanges. The next part of the dissertation will devote itself to issues of information efficiency, that is, the relationship between the information disseminated in these markets and the share prices.

CHAPTER 4

WEAK-FORM EFFICIENCY: THEORY

4.1 INTRODUCTION

The main focus of this study is to examine issues related to weak-form market efficiency. This chapter provides the theory underlying the weak-form Efficient Market Hypothesis (EMH).

4.2 MARKET EFFICIENCY: DEFINITION

The word efficiency in economics and finance has been assigned different meanings depending on what is emphasised. It is important to understand what definition of efficiency one is dealing with in order to develop a rationale for empirical tests. It is a prelude to an interpretation of empirical research offered as tests of market efficiency [Beaver (1981a)]. Stiglitz (1981), for example, states that there are three aspects to the analysis of the efficiency of the market:

(a) Exchange efficiency

Given the set of assets which are available and the information (beliefs) of the various participants, are the available assets traded in such a way that there is no re-arrangement of ownership claims which would increase the expected utility of one individual without decreasing that of some other?

(b) Production efficiency

In exchange efficiency, the set of assets (securities) which are available is assumed to be given. Here, the concern is with the determination of the supply of various assets, given the available technology, resources, and information. The analysis of production efficiency turns on three questions:

(i) If firms maximise their market value, will the resource allocation be Pareto optimal?

(ii) Would all shareholders wish firms to maximise their market value? If not, will there be unanimity in the actions they wish the firm to pursue? If there is unanimity, will the actions which are unanimously preferred be Pareto optimal?

(iii) Are there any control mechanisms which ensure that the managers of firms will in fact pursue the policies which are in the interest of shareholders?

(c) Information efficiency

Information efficiency requires that (i) the market must provide the correct incentives for gathering the right amount and kind of information, (ii) the market price must reflect the information available to the various traders, and (iii) firms must be able to convey efficiently information about their prospects to potential investors (p. 236-237).

Another way to look at efficiency is to adopt West's (1975) two way classification of efficiency. He coined the terms Internal and External efficiency.

With respect to Internal efficiency he explained; **"... a well organised and internally efficient real world securities market should not only establish price levels which are right in the sense that they reflect available information, but also should provide the type of transaction services buyers and sellers desire at prices as low as possible given the costs of providing these services."**

Concerning External efficiency he explained; **"This notion of efficiency implies that a market's equilibrium conditions are such that trading decisions based solely on existing information do not yield expected returns in excess of expected equilibrium returns" (p. 30-31).**

In market based research the concern is mainly with the information efficiency of Stiglitz (1981) [external efficiency as defined by West (1975)]. This does not mean that other types of efficiency are unimportant, but they pose serious methodological problems with regards to empirical testing. To achieve information efficiency, the securities market may require also to be economically efficient to facilitate the trade in the securities in the first place and the creation of wealth through production to support the true value of the securities. Foster (1984), for example, argues that market efficiency may be attained because of:

(i) Competitive activities of security analysts. Each analyst is seeking to detect mis-priced securities and create perfectly hedged portfolios with zero net investment, but non-zero expected return. As each analyst identifies a significant information item it is rapidly impounded into security prices.

(ii) Incentive effects of insider trading. This explanation argues that the level of the informational efficiency of a market can be improved by relaxing prohibitions against inside trading by management.

(iii) Quality and quantity of information made publicly available. This is taken to be that adequate disclosure of information minimises ignorance in the market and causes the market price to reflect the true value of the security.

(iv) Aggregation phenomenon. Each individual analyst can make mistakes of judgment or estimation. Where the mistakes made are independent, the consensus, which is the price reflected in the market, is the best possible [Beaver (1981, p.160-162].

The above aspects deal with features which are more closely related to internal efficiency of the market, but which play a fundamental role in information efficiency.

Efficiency in this study is concerned with how successful the stock exchange is in establishing security prices that reflect the worth of the securities; success being defined in terms of whether the market incorporates all information in its security prices in a rapid and unbiased manner. Efficiency, therefore, refers to the two aspects of a price adjustment to new information, direction and magnitude (the speed and quality), of the adjustment [Keane (1983, p.9)]. Many definitions of market efficiency do exist. Foster (1984) discusses some of them but, for our purpose, the key issue is that no one person should in an efficient market be able to consistently out-perform the market, that is, earn an abnormal return given some information set.

In a discussion of market efficiency it is critical to specify the information systems for which the market efficiency condition is being defined. This is because the market may be efficient with respect to some information systems, but not others [Beaver (1981, p.148-149)].

Following Fama (1970), tests of informational efficiency have been categorised into three major levels depending on the type of information assumed to be used by the market in setting prices. These are:

(i) Weak-form efficiency tests:

The weak-form of the EMH states that the sequence of past price returns contains no information about future price returns. The tests here are designed to show that successive price returns are random and no trading strategies based on a study of past prices can yield abnormal returns. The information set used in empirical tests is the vector of past security prices.

(ii) Semi-strong form efficiency tests:

The semi-strong form of the EMH states that the security prices fully reflect all available public information. The empirical tests here are designed to show that no trading strategies based upon the release of any publicly available information, for example, accounting earnings, will enable an investor to generate abnormal returns except by chance. The basic conclusion is that, if the market is semi-strong efficient, then it will instantaneously impound all information as it becomes publicly available into security prices.

(iii) Strong-form efficiency tests:

The strong-form of the EMH states that the security prices reflect all the information available, both public and private, at each point in time. The consequence of it is that no investor, even where such an investor possesses inside information, may be able to device trading strategies based on such information to consistently earn abnormal returns.

Strong-form efficiency implies semi-strong form efficiency, and semi-strong efficiency in turn implies weak-form market efficiency. The empirical implications of efficiency with respect to a particular information set are that the current price of the security embodies all the information in that set. Since the categories of information set are nested, rejection of a weaker type of efficiency implies the rejection of all stronger forms.

Fama (1976), defines efficiency in its testable form. Attempts have been made to refine this original form [Leroy (1976); Jensen (1978); Beaver (1981a); Latham (1986)]. One important clarification was the addition of the subset property, which is that efficiency with respect to an information set necessarily implies efficiency with respect to any subset of that information set. It is by this principle that if the market is semi-strong form efficient then it must be weak-form efficient since past security prices are a subset of all public information. It is also by this principle that an event study based on published earnings figures is a test of semi-strong form efficiency. Not all public information is used, only a small subset, yet any abnormal returns associated with the earnings are taken to imply that the market is inefficient. Market efficiency requires that in setting prices at t-1, the market correctly uses all available information to assess the joint distribution of prices at t. Formally in an efficient market;

$$f\ (P_t \mid \emptyset_{t-1}) = f_m\ (P_t \mid \emptyset^m_{t-1}) \qquad (2)$$

where,

$P_t = (P_{1,t}, \ldots\ldots\ldots\ldots P_{n,t})$ is the vector of prices of securities at time t, and

$f(.)$ = the probability density function.

and

$\emptyset_{t-1}$ is the set of information available at t-1,

$\emptyset^m_{t-1}$ is the set of information used by the market,

$f_m\ (P_t \mid \emptyset^m_{t-1})$ is the market assessed density function for P_t

and,

$f\ (P_t \mid \emptyset_{t-1})$ is the true density function implied by

$\varnothing_{t-1}$

In its testable form, (2) becomes;

$$E\ (P_{j,t}\ |\ \varnothing_{t-1}) = E_m\ (P_{j,t}\ |\varnothing^m{}_{t-1}) \qquad (3)$$

and

$$E\ (R_{j,t}\ |\ \varnothing_{t-1}) = E_m\ (R_{j,t}\ |\varnothing^m{}_{t-1}) \qquad (4)$$

where

E is the expected value operator; and

$P_{j,t}$ is the price of security j at time t,

$E\ (P_{j,t}\ |\ \varnothing_{t-1})$ is the true expected price of security j implied by $f\ (P_t\ |\ \varnothing_{t-1})$

$E\ (R_{j,t}\ |\ \varnothing_{t-1})$ is the true expected return implied by $E\ (P_{j,t}\ |\ \varnothing_{t-1})$ and $P_{j,t}$.

The implications of (4) are that,

(a) In an efficient market, trading rules with abnormal returns do not exist and

(b) there is no way to use information $\varnothing_{t-1}$ available at t-1 as a basis of correct assessment of the expected return on security j which is other than its equilibrium value.

In this study, the set of information considered distinctly as forming part of $\emptyset_{t-1}$ is:

$P^*_{t-1} = (P_{1,t}, \ldots\ldots\ldots\ldots P_{n,t})$, the vector of prices of securities at time t-1.

This is the information set used as a test of weak-form efficiency.

4.3 MARKET EQUILIBRIUM MODELS CONSISTENT WITH WEAK-FORM EFFICIENCY.

Market efficiency is viewed as a property of an equilibrium mechanism or process by which security prices are formed. Under uncertainty, stock market equilibrium can be characterised as a mapping from the endowments, preferences and beliefs into prices. Individuals' beliefs will be conditioned upon the information which each receives. Hence, equilibrium price at the time **t** will in part depend upon the signal received at time **t** by each individual [Beaver (1981a, p.24,26)].

Any test of market efficiency is simultaneously a test of efficiency and the assumptions about the characteristics of the market equilibrium. Fama (1976) states:

"If the test is successful, that is, if the

hypothesis that the market is efficient cannot be rejected, then this implies that the assumptions about the market equilibrium are not rejected. If the tests are unsuccessful, we face the problem of deciding whether this reflects a true violation of market efficiency or poor assumptions about the nature of the market equilibrium" (P.137).

Fama (1976) proposed two models of market equilibrium of security prices assumed to apply in tests of weak-form market efficiency. These models are:

4.3.1 Expected returns are positive.

This model states that the market always sets, $p_{j,t-1}$ - the price of security j at time t-1, j = 1,2,....,n; where n is the number of securities in the market - so that the mean of the resulting distribution of returns [$\tilde{R}_{j,t}$] is strictly positive. That is, the market always sets $p_{j,t-1}$ so that, given its assessment of the expected price at t, $E_m(\tilde{p}_{j,t} \mid \emptyset^m_{t-1})$ then,

$$E_m(\tilde{R}_{j,t} \mid \emptyset^m_{t-1}) = \frac{E_m(\tilde{p}_{j,t} \mid \emptyset^m_{t-1}) - p_{j,t-1}}{p_{j,t-1}} > 0 \qquad (5)$$

where the tildes (~) are used to denote random variables.

An efficient market uses all available information and uses it correctly in assessing the distribution of future prices, thus:

$$f_m (p_{j,t} \mid \emptyset^m_{t-1}) = f (p_{j,t} \mid \emptyset_{t-1}), \tag{6}$$

which implies

$$E_m (\tilde{p}_{j,t} \mid \emptyset^m_{t-1}) = E (\tilde{p}_{j,t} \mid \emptyset_{t-1}) \tag{7}$$

and

$$E_m (\tilde{R}_{j,t} \mid \emptyset^m_{t-1}) = E (\tilde{R}_{j,t} \mid \emptyset_{t-1}). \tag{8}$$

Equation (5) does not say that a positive return on security j will be observed at time t. Rather the combined hypothesis of the model and efficiency of the market implies that at time t-1 the true expected return of any security j, $E (\tilde{R}_{j,t} \mid \emptyset_{t-1})$, is positive. This means that if the hypothesis is correct any investor or market analyst who disagrees with the market and posits a negative expected return on a security is incorrect.

This model is best applied in the testing of market efficiency using trading rules. The proponents of trading rules, the chartists and technical analysts, claim that market prices only react slowly and over long periods to new information. The chartists also claim that the reaction of the market to news is so slow that one needs not be concerned with the information itself. The study of past patterns can indicate the price response to new information. This claim therefore means that the market is inefficient in setting prices and in its use of past information on prices.

From the chartists perspective trends in prices tend to persist or recur. When prices have moved up in the recent past, they expect the trend to continue, and likewise when they start to decline. The chartist rules therefore use percentage changes in prices to determine buying and selling strategies. If the market is efficient in setting prices then trading rules would not hold.

4.3.2 **Expected returns are constant**

Under this equilibrium model, the market sets the current price of security j so that, given its assessment of the expected value of the future price $E_m(\tilde{p}_{j,t} \mid \emptyset^m{}_{t-1})$ then;

$$E_m(\tilde{R}_{j,t} \mid \emptyset^m{}_{t-1}) = \frac{E_m(\tilde{p}_{j,t} \mid \emptyset^m{}_{t-1}) - p_{j,t-1}}{p_{j,t-1}} = E(\tilde{R}_j) \qquad (9)$$

Where $E(\tilde{R}_j)$ is some constant which represents the expected return of security j from time t-1 to t.

This model implies that $E(\tilde{R}_j)$ is constant through time but different securities are allowed to have different expected returns.

If the market is taken to be efficient then

$$E(\tilde{R}_{j,t} \mid \emptyset_{t-1}) = E_m(\tilde{R}_{j,t}) = E(\tilde{R}_j) \qquad (10)$$

This means that since the market correctly uses all available information in setting prices then the expected return on the security is the true expected return of that security.

If the market is efficient, the above model implies that, there is no way of using available information at time t-1 as the basis of a correct assessment of the expected return on security j which is other than $E(\tilde{R}_j)$.

Tests of market efficiency based on the above equilibrium model focus primarily on a subset of information $\emptyset_{t-1}$, the potential information about expected return, that appears in the time series of past security returns. When the market is efficient, the past returns are not a new source of information about the expected value of return of security j.

The assumption that equilibrium expected returns are constant through time implies that the auto-correlation of the returns on any security j are zero for all values of the lag k. This assumption is assumed to hold when statistical rules of testing efficiency are applied.

4.4 EMPIRICAL TEST MODELS OF WEAK-FORM EFFICIENCY.

The analysis of return equilibrium models assumed in weak-form efficiency tests gives rise to two distinct methods of empirical testing of the EMH in the finance literature. These are:

(a) The use of statistical methods and;

(b) The formulation of trading rules designed to determine whether it is possible to beat the market.

4.5 STATISTICAL THEORIES IN WEAK-FORM EFFICIENCY TESTS.

Statistically based tests for testing weak-form efficiency have largely been classified as random walk tests. There have been several ways of phrasing the random walk hypothesis in statistical terms [Granger (1972)]. The earliest effort in studying the random behaviour of prices is attributed to Bachelier (1900) who in his work implied that the price changes have independent and identical distributions. In market studies dealing with share price returns, the random walk hypothesis has been the most widely researched. Empirical evidence on the random walk hypothesis is available for many of the world's stock markets. The random walk hypothesis holds that price returns are unpredictable and do not follow any known direction. This means that one cannot use past series of prices to predict the direction of change of future prices. According to Fama (1965) the theory of random walk in stock prices involves two separate hypotheses:

(1) Successive price returns are independent

and

(2) the price returns conform to some specified type of probability distribution.

4.5.1 **Independence of share price returns**

Two events A and B are statistically independent if the chance of one occurring is unaffected by the occurrence of the other, that is, Given that

$$P[A \mid B] = P[A]$$

so must the following

$$P[B \mid A] = P[B]$$

This means that the distribution of A is in no way dependent on the distribution of B. Several events may also be collectively independent. In stock price research it is usual to state that the probability distribution of a change in prices during any time period is independent of the sequence of changes of prices in the previous time periods. This means that knowledge of previous price changes cannot be used to predict price changes in the current period. The price changes would therefore be expected to be random across time.

Independence of share price returns has mainly been tested by using the following:

(a) Serial correlation tests.
(b) Run tests.
(c) Spectral Analysis

4.5.2 Serial correlation tests

In using serial correlation techniques it is assumed that the time series consist of two parts, one containing the structural part and the other the random (stochastic) variation. In statistical terms it can be expressed by the relationship:

$$X_t = \Omega_t + \mu_t \tag{11}$$

Where Ω_t is the structural part; and
μ_t is the random part.

From a security price perspective, this model, in its simplest form, is given by Granger and Morgenstern (1970, p.71,73) as;

$$P_{j,t} = P_{j,t-1} + \epsilon_t; \quad t= 1,\ldots\ldots,n \qquad (12)$$

where,

$P_{j,t}$ is the price of stock j at time t

$P_{j,t-1}$ is the price of stock j in the immediately preceding period and,

ϵ_t is a random error.

and where

$$E\ (\epsilon_t) = 0, \qquad (13)$$

$$\mathrm{Cov}\ [\epsilon_t \epsilon_{t-s}] = 0, \text{ all } s \neq 0. \qquad (14)$$

Further they state that:

(i) if ϵ_t, ϵ_{t-s} are uncorrelated, then P_t is a second order martingale.

(ii) if ϵ_t, ϵ_{t-s} are independent, then P_t is a strict random walk.

(iii) if ϵ_t, ϵ_{t-s} are independent, and ϵ_t (t=1,...,n) are all identically normally distributed, then P_t is a Wiener process.

Most of the empirical investigations of stock prices are on the martingale form and concentrate on the observed correlation between ϵ_t and ϵ_{t-s}, $s \neq 0$. Random Walk models may be tested by showing that there is no linear relationship between the error terms (ϵ_t) as exemplified by lack of serial correlation. Granger and Morgenstern (1970, p.73-74) show that (12) gives the same results as its logarithmic form of:

$$\text{Log } P_t = \text{Log } P_{t-1} + u_t \qquad (15)$$

Where

$$E\,(u_t) = 0 \qquad (16)$$

$$\text{COV}\,(u_t, u_{t-s}) = 0, \quad s \neq 0 \qquad (17)$$

This can be seen by writing (12) as:

$$P_t/P_{t-1} = 1 + \epsilon_t/P_{t-1} \qquad (18)$$

and so the models would be identical if:

$$\log\,(1 + \epsilon_t/P_{t-1}) = u_t \qquad (19)$$

Expanding the right hand side as a power series and ignoring terms of higher order other than the first, one has:

$$\epsilon_t / P_{t-1} = u_t \tag{20}$$

for the two equations to be essentially the same:

$$\epsilon_t = P_{t-1} \, u_t \tag{21}$$

The residual series $\epsilon_t = P_{t-1} \, u_t$ will have zero mean and will be uncorrelated with earlier values, as:

$$E(\epsilon_t) = E\,(P_{t-1})\; E(u_t) = 0 \tag{22}$$

and

$$\text{cov}\,(\epsilon_t, \epsilon_{t-s}) = E\,(\epsilon_t \; \epsilon_{t-s}) \tag{23}$$

$$= E\,(u_t, u_{t-s}) \cdot E(P_{t-1}, P_{t-s-1})$$

$$= 0, \; s \neq 0$$

from the properties of u_t.

The implication of the model is that the best predictor of tomorrow's price is today's price. It also follows that the best predictor of any future price is the current or most recently available price.

Further, Granger and Morgenstern (1970, p.77-78) show that if the price series P_t is recorded at time intervals of unit T, the first difference of this series will be:

$$u_t = \epsilon_t(T) = P_t - P_{t-1}, \quad t = 1, \ldots\ldots, n. \tag{24}$$

where $\epsilon_t(T)$ is the price change over the time interval T. If now, instead of simply forming the first differences, the differences over non-overlapping intervals of length kT are taken then:

$$\epsilon_j(kT) = P_{kj} - P_{k(j-1)}, \quad j = 0, 1, \ldots\ldots, n. \tag{25}$$

where the values $\epsilon_j(kT)$ are the first differences of the price series if the price series had been recorded at time interval of length kT. It can be shown that:

$$\epsilon_j(kT) = \sum_{t=j}^{j+k-1} \epsilon_t(T) \tag{26}$$

If the random walk model holds true then $\epsilon_t(T)$ will be uncorrelated with all other values of this series:

$$\text{correlation } [\epsilon_t(T), \epsilon_{t-s}(T)] = 0, \quad s \neq 0 \tag{27}$$

and, as non-overlapping intervals have been used, it follows that $\epsilon_j(kT)$ will be uncorrelated with other values of itself:

$$\text{correlation}\ [\varepsilon_j(kT),\ \varepsilon_{j-s}(kT)] = 0,\ s \neq 0 \qquad (28)$$

The implications of the above are that:

The serial correlation between the return of a security in time t, and its return recorded at a time interval of unit T is zero. This in turn implies that the serial correlation of returns separated by k time periods (lag k) within a time series is zero for all k.

To test the random walk model, the sample serial correlations for the stock price series and for values of T are calculated. The population correlation coefficient, p_k, between the return of a security in time t, and its return t-k periods earlier, is given by:

$$p_k = \frac{\text{Cov}\ (u_t,\ u_{t-k})}{\text{Variance}\ (u_t)} \qquad (29)$$

Where

p_k = the serial correlation (autocorrelation) between the return of a security in time t and its lagged return t-k periods earlier. The sample serial correlation coefficient, r_k, is assumed to be a consistent and unbiased estimate of the true serial correlation in the population, p_k.

Cov (u_t, u_{t-k}) = the covariance between the return of a security in time t and its lagged return t-k periods earlier.

Variance (u_t) = the variance of the return of a security in time t.

The serial correlation coefficient, p_k, measures the direction and strength of the statistical relationship between ordered pairs of observations of two random variables. The standard deviations of returns are positive. It follows therefore that the sign of the correlation coefficient between u_t and u_{t-k} is the same as that of the covariance between u_t and u_{t-k}. If the correlation is positive, we say that the return of security in time t is positively correlated with its return t-k periods earlier. If negative, we say that the return of security in time t is negatively correlated with its return t-k periods earlier. The correlation is always between +1 and -1. When u_t and u_{t-k} are uncorrelated, then the sample correlation coefficient is expected to be equal to zero.

If the distribution of u_t has finite variance, then for large samples, according to Kendall (1948, p.412), the standard error of the sample serial correlation coefficient, r_k, may be computed as:

$$\sigma (r_k) = 1/\surd(N - k). \qquad (30)$$

Where N is the sample size.

4.5.3 **Runs tests**

A run is defined by Siegel (1956) as "a succession of identical symbols which are followed or preceded by different symbols or by no symbols at all" (p.52). The runs tests are concerned with the direction of changes in the time series, that is, with the signs of the first differences of the series.

There are various reasons for using runs tests in market research. Run tests being non-parametric, do not depend on any finite variance assumption. It is well known that large errors in prices either at the publication or data preparation stages may generate negative and significant serial correlations in stock returns [Praetz (1976)]. The observation of such correlation may be used erroneously as evidence of market inefficiency. Runs tests are, however, not greatly affected by such errors [Cooper (1982)].

The question of whether the sequence of observed series of share price changes is a random sequence is studied by the number of runs observed in the series. The number of runs is computed as a sequence of the price changes of the same sign.

In share price series, we expect to observe the following categories of price changes: a plus or minus change according to whether the price change in the given time interval has either risen or fallen respectively, and a no change category where there has been no change in price over the time interval. This results in three mutually exclusive types of run. The series of changes are replaced by the series of symbols.

The total number of runs of the price change series will serve as an indicator of the degree of randomness of the sample. In a series of security price changes, either few or many runs are unlikely if such security price changes are truly random over time. Clustering of symbols of the same sign also shows the existence of a trend.

If the assumption holds that the sample proportions of positive and negative changes are good estimators of the population proportions, and the independence hypothesis applies to the sequence of price changes, the total expected number of runs, with three symbols, Plus, Minus and Zero is given by:

$$m = \left[N(N+1) - \sum_{i=1}^{3} n^2{}_i \right] / N \qquad (31)$$

Where N is the total number of price changes and

n_i are the numbers of price changes of each kind (Plus, Minus, No-change)

The standard error of m is

$$\sigma_m = \left[\frac{\sum_{i=1}^{3} n^2_i \left[\sum_{i=1}^{3} n^2_i + N(N+1) \right] - 2N \sum_{i=1}^{3} n^3_i - N^3}{N^2 (N-1)} \right]^{\frac{1}{2}} \qquad (32)$$

Wallis and Roberts (1956) have shown that for large N, the sampling distribution of m is approximately normal. The standardised variable (V) can then be calculated from the formula:

$$V = \frac{r + \frac{1}{2} - m}{\sigma_m} \qquad (33)$$

Where r is the actual number of runs

m is the expected number of runs

and where the continuity adjustment requires the addition of ½ to r.

4.5.4 **Spectral analysis**

Spectral methods are applied to test for seasonal and for cyclical patterns in stock market price series. Spectral analysis provides a characterisation of the autocorrelation function in terms of its Fourier transform, the spectral density function. A stochastic process ($x_t, -\infty < t < \infty$), may adequately be described by the mean, variance, and autocorrelation function in the time domain, and in the frequency domain by the Fourier transform of the autocorrelation function, the power spectrum [Sharma and Kennedy (1977)].

Spectral analysis is concerned with the decomposition of a time series into sinusoidal components. In spectral analysis the investigated series are assumed to be stationary. Economic time series are not normally stationary, but often have a trend in both mean and variance. However, some studies have shown that so long as the underlying structure of the series is not changing quickly with time, spectral analysis may be used with confidence. Trends in the mean can be removed, but not trends in the variance [Granger and Morgenstern (1964, p.169)].

Any trend in a price series will give high values to the spectrum at low frequency bands. Series of considerable lengths are needed in order for the spectrum to reveal any cycle of long duration. Any seasonal variation existing in the series will show peaks and concentrations of variances at some or all the seasonal frequencies. An estimate of the spectra of an economic series should only be made after a visible trend has been removed. Various methods of removing trends are available.

It should be recognised that spectral methods are an alternative to studying autocorrelations. Granger and Newbold (1977) describe the spectral theory relevant to economic studies. Praetz (1979) discuss practical problems encountered when testing returns for a flat spectral density. Spectral methods are mainly used to emphasise autocorrelation results [Taylor (1986)].

4.5.5 **Issues on the Use of the statistical models**

The statistical based methodologies discussed have been questioned on two grounds. Firstly, there are statistical problems in using serial correlation as a measure of independence. To test the sequence of price changes, u_t, t = 2, ... n, for serial correlation, it should be shown that the variance of u_t is finite [Taylor (1986, p.25); Conrad and Juttner (1973, p.587-588)]. If the variance of the price changes is not finite, then the correlation coefficient will be an unsuitable test statistic for resolving the issue of correlation, since the variance of u_t appears in the denominator of the formula of calculating the correlation coefficient and it therefore biases the value of the sample correlation coefficient (r_k) toward zero.

Even though researchers have noted this problem, serial correlation tests have been used extensively to test for efficiency in stock markets and evidence of this is provided in chapter 5. Fama (1965, 1976) and Granger (1972, 1975) also give support for their use in efficiency tests. Fama (1965) states that for large samples, the sample statistic, r_k, is a consistent and unbiased estimator of the true serial correlation in the population.

Granger (1972) also observes that:

> **"The fear about the usefulness of standard statistical techniques seems to have been greatly exaggerated. There is little or no evidence that observed serial correlation coefficients are unreliable. Both theoretical considerations and simulation studies suggest that least square techniques work perfectly well when ratios of quadratic forms of infinite variance stable random variables are involved provided the sample size is large enough. Thus, correlation coefficients and regression methods seem to be unaffected by long tailed distributions for large enough sample" (p.486).**

Secondly, doubts have been raised as to whether the models are powerful enough to reject the EMH when it is not true. The use of serial correlation and runs tests have dominated the testing of the EMH at weak-form level. There have arisen arguments that these traditional tests have little power against alternatives to the null hypothesis of market efficiency, and that it is as a consequence of this weakness that the EMH has not been rejected. Proponents of this argument have suggested what they regard as stronger tests of the EMH [Shiller (1981); Summers (1986); Taylor (1986); Poterba and Summers (1988)].

Taylor (1986), for example, claims that the standard statistical methodology used for random walk tests has often been inappropriate, and that some of the reported conclusions from it are questionable. He argues that autocorrelation coefficients calculated from returns have variances greater than 1/n. This, he argues, is a consequence of the changes in the return variance or conditional variance. When the true variance is greater than the autocorrelation variance (1/n), random walk tests are unreliable. He suggests that re-scaling the returns produces a series whose autocorrelation variances are generally satisfactory. Although the results obtained when returns are re-scaled are similar to those obtained when unscaled returns are used he nevertheless argues that the interpretation when unscaled returns are used is unclear.

Shiller (1981) has argued that the traditional statistical tests that have been employed are too weak to properly examine the EMH and, moreover, that they are mis-focused. Shiller adopts the intuitive perspective that if stock prices are discounted expected dividends, they then ought not vary over time as much as actual dividends. He argues that since the price is an expectation of the dividends and future prices, the actual outcome will be this expectation plus the error in the forecast. The error in the forecast should vary over time more than the price. This leads him to formulate statistical tests of the EMH which are based on the volatility of stock prices and which are claimed to be more powerful than the traditional tests.

His alternative test has faced criticism, notably from Flavin (1983), Kleidon (1986) and Marsh and Merton (1986). These critics have taken issue with Shiller's specification of the statistical tests of volatility and, more important, with the basic intuition [Ross (1986)]. They particularly contend that the single realisation of dividends and prices that is observed is only a sample of one from all the random possibilities and that the price is based on the expectation taken over all these possibilities. A little information, they argue, can have an important influence on the current price. They argue further that, when smoothing of dividends and the finite time horizon of the data samples are taken into account, volatility tests do not reject the EMH.

Shiller's idea popularised the use of variance ratios in efficiency test methodologies. There has been a growing number of tests using variance ratios in a variety of contexts [Ball and Kothari (1989); Lo and MacKinlay (1988); Poterba and Summers (1988); French and Roll (1986)]. These studies have focused on what is known as "mean reversion" in security prices. The mean reversion hypothesis proposes that stock prices swing wildly back and forth across some trend line measure of intrinsic value. The difference between the market and fundamental values is eliminated by speculative forces and the stock prices revert to their mean. This implies that stock prices have a permanent and a transitory component [Fama and French (1988)]. The variance-ratio tests exploit the fact that, if the logarithm of the stock price follow a random walk, then the return variance should be proportional to the return horizon.

These studies use a huge amount of data extending over significantly long periods of time. They are also designed to challenge the fundamental findings of the traditional tests of EMH established for developed markets, but not for developing markets. Research might usefully be extended to these methodologies once the traditional tests of the EMH in emerging markets are well grounded. It is worth noting that volatility tests have not produced evidence against the random walk hypothesis for individual stocks, which suggests that the extent of predictability of returns is economically insignificant. It follows, therefore, that although volatility tests are interesting they have not been able to challenge effectively the results obtained from using serial correlation and runs tests, that is, the stock markets are efficient.

4.6 NON-STATISTICAL TESTS (TRADING RULES)

Fama (1965) specifies that the use of serial correlation and runs as tools for testing dependence do not provide adequate tests of either practical or statistical dependence. He points out that the chartist would not regard either type of analysis as an adequate test of whether the history of the series can be used to increase the investor's expected profits. He points out that the chartist would use a more sophisticated method of identifying price movements, a method that does not always predict the termination of the movement simply because the price level has temporarily changed direction. The trading rules provide superior methods in this respect. Another short coming of the statistical tests is that the methods test for dependencies which are present through-out the data. It is possible that price changes are dependent only under special conditions, or in particular ways. For example, large changes may tend to be followed by large changes of the same sign or large changes of the opposite sign.

The non-statistical tests in security market research are directed towards testing whether mechanical trading rules can be devised to beat a naive buy-and-hold strategy. The strategies are based on buying and selling securities at the "right time". The rules are explicit and can be easily tested where market conditions allow their formulation. The rules are founded on the assumption that there may be patterns in price changes which may not be detectable by statistical tests. Many investigations have tested the strategies which investment analysts and advisers claim have been successful in generating abnormal returns for their clients. The strategies tested have included, among others, filter rules, moving average, fixed-proportion maintenance strategies, and the relative strength rule. These strategies are separately discussed in the ensuing subsections:

4.6.1 Filter rules

These provide buy and sell signals when share prices have moved a certain percentage away from a high or low point. Alexander (1964, p.338) proposed the first filter rule strategy. The rule suggested was: **"if the price of a security moves up by at least X %, buy and hold the security until the price moves down by at least X % from a subsequent high, at which time simultaneously sell and go short. The short position is maintained until the price of the security rises by at least X % above the subsequent low, at which time one covers the short position and buys.**

Moves of less than X % in either direction are ignored." This X % filter rule is a "one security and cash" trading rule, and the results it produces are relevant for the random-walk expected return model.

Brealey (1970) tested an alternative filter rule. The rule was:

> **"If by the end of the day the market has risen, purchase any share whose price has remained unchanged. Conversely, if the market has fallen, sell short the shares whose price has not changed. In either case close the position at the end of the subsequent day" (p.38).**

4.6.2 Moving average

The moving average strategy involves the buying and selling of securities as the prices move up and down a predetermined average. The buy-hold-sell strategies depend on the percentage chosen by the investor. The portfolio building rules under this strategy assume (i) perfect knowledge of the statistics of the ex-post distribution of annual holding period returns and (ii) that the statistics remain constant over time so that the probability beliefs do not change as actual results become available over time.

4.6.3 Fixed-proportion maintenance strategies

The fixed proportion strategy may be defined as the purchase of M securities at time t, with the sale of these securities at time t+n, where n is again some predetermined holding period. It is assumed that equal monetary amounts will be invested in each of the M securities, and that during the holding period all dividends are re-invested, although not necessarily in the securities on which they were paid. Rather, it is assumed that at regular intervals throughout the holding period, the investor reallocates his fund so as to maintain equal monetary amounts in each security in the portfolio [Evans (1970, p.561)].

4.6.4 Relative strength rule.

The rule was first proposed by Levy (1967). The rule is as follows:

"Define $\tilde{P}_{j,t}$ to be the average price of the j^{th} security over the period t-n prior to and including time t. Let $PR_{j,t} = P_{j,t} / \tilde{P}_{j,t}$ be the ratio of the price at time t to the t-n period average price at time t. Define percentage X (0< X <100) and a cast out rank H and invest an equal monetary amount in the X % of the securities under consideration having the largest ratio $PR_{j,t}$ at time t.

Then in week t+k (k = 1,2 .... n) calculate $PR_{j,t+k}$ for all securities, rank them from low to high, and sell all securities currently held with ranks greater than H. Finally, immediately re-invest all proceeds from these sales in the X % of the securities at time t+k for which $PR_{j,t+k}$ is greatest" [Jensen and Benington (1970, p.470)].

4.7 PROBLEMS IN TESTING FOR WEAK-FORM EFFICIENCY

The results obtained when applying models for testing weak-form efficiency may be affected by certain problems in the data. These problems are:

4.7.1 Thin trading

Thin trading arises whenever an asset is not traded at the end of the period over which its return is measured. There are many indicators of thinness of stock markets. Some of the factors which have been identified include: the market value of shares outstanding for a security, the value of shares traded, number of shares traded, number of shareholders, frequency of transactions, density of limit orders, arrival rate of limit and/or market orders and the number of securities listed on the particular exchange [Cohen et al (1978)].

Thin trading can affect the results of empirical work on weak-form and other higher level efficiency tests. Infrequently traded shares can introduce serious biases into the results of empirical work. The major source of bias is the tendency for the prices recorded at the end of a time period to represent an outcome of a transaction which occurred earlier in, or prior to, the period in question. Non-trading also introduces widening of the bid-ask spread and increases measurement errors [Dimson (1979)].

Serial correlation tests are widely used in testing for weak-form efficiency. Thin trading will induce autocorrelation in the time series of returns which would otherwise exhibit serial independence. It follows that erroneous conclusions could be deduced regarding the results of tests of weak-form efficiency. A problem also arises with the runs test if thin trading causes several non-change runs. These may be responsible for less total runs than expected thereby refuting independence [Taylor (1986)].

The problem of thin trading is difficult to solve for economic data which cannot be replicated. In this study, it is hoped that taking a 10-year rather than the usual 5-year span might reduce the effect of thin trading on the results.

4.7.2 **Distribution of share price returns**

We discussed in Section 4.5.2 that to test the sequence of price changes, u_t, t = 2 ..... n, for serial correlation, it should be shown either that the series is normally distributed or that the variance of u_t is finite. When this assumption is violated the results obtained may be misleading.

Many of the tests carried out in the fields of accounting and finance also rely upon parametric tests which are based on the assumptions of the normal distribution. If the returns are not normally distributed, the inference drawn from studies which have used tests that assume normality may be subject to doubt [Theobald (1986)]. The normal distribution is useful in market studies because it is stable under addition and therefore any arbitrary portfolio of stocks formed from the market will also be normally distributed [Kon (1984)].

There has been considerable academic interest as to whether the distribution of price returns in speculative series is normal or not. Most of the early empirical work tended to believe in the hypothesis that distribution of rates of return on common stocks were adequately characterised by the normal distribution. This view has not been supported by empirical evidence [Fama (1965); Officer (1972); Blattberg and Gonedes(1974); Praetz and Wilson (1980)].

In order to characterise and summarise the behaviour of a random variable, it is necessary to describe it in terms of a distribution function. The properties of the sampling distribution are compared with the properties of theoretical distribution functions so that a representative distribution can be selected.

In hypothesis testing a test maps the values of a random variable into a sample space dichotomised into regions where a hypothesis is either accepted or rejected. In constructing parametric tests of the hypothesis it is necessary to assume some distribution for the underlying data. As a result, when using parametric tests rejection of the null hypothesis is only equivalent to rejection of at least one of the underlying hypotheses, that of weak-form efficiency or that relating to the distribution assumption [Affleck-Graves and McDonald (1989)]. In fact certain distributions have been used to challenge some of the fundamental findings in stock market research. Ashton (1986), for example, uses a methodology based on multivariate normality to criticise the findings of Jensen (1968) on the performance of mutual funds.

Secondly, Fama (1965, p.41) explains that:

(i) the shape of the distribution of the price change is helpful from the point of view of the investor. This is because the form of the distribution is a major factor in determining the riskiness of investment in common stocks.

(ii) The form of distribution of price changes is also important from an academic view point in that it provides descriptive information about the nature of the process generating price changes. It will help in determining the extent to which returns vary with changes in information.

Empirical work on the distribution of share price returns has mainly been concerned with testing whether the distributions are best explained by:

(i) a Normal distribution

(ii) a Stable Paretian distribution [Fama (1965); Officer (1972)]

(iii) a Student distribution [Praetz and Wilson (1980); Blattberg and Gonedes (1974)]

(iv) Other distributions [Press (1967); Affleck-Graves and McDonald (1989)].

Various specific models in each of the above general families have been tested in search of that which best fits the observed security returns.

In this study, the validity of the assumption of normality of price changes is examined as part of the results of weak-form efficiency in chapter 8. Alternative security return distribution models are nevertheless not tested here as they are beyond the scope of this study.

4.7.3 Timing problems

The returns are supposed to be measured over specific time intervals. When the prices are not realised simultaneously, it follows that we are measuring returns over different time intervals. We might therefore expect returns calculated over these different intervals to have a distribution perhaps differing from that of the fixed period returns. This will in turn mean that the variances of the returns will differ as they are calculated over different time lengths [French and Roll (1986); Gibbon and Hess (1981)].

According to Working (1960) the correlation of first differences of averages in a random chain can induce correlations not present in the original, especially when working with index data. It is also noted that the first order co-efficient will be biased upwards if the prices used do not occur simultaneously. Brealey (1970), for example, found that the first order serial correlation coefficient fell from 0.32 to 0.19 when he used a share price index based on simultaneous price observations. We noted in Chapter 3 that the prices reported at the weekly call-over may have occurred any time during the week. Since they were not occurring simultaneously this could cause a timing problem by biasing the serial correlation coefficients.

As stated above, Brealey (1970) presents evidence which shows that the problem may be reduced by obtaining price observations that occur simultaneously at specific points in time. The nature of the prices and the manner of their recording on the NSE preclude the performance of tests based on simultaneous price observations as in Brealey (1970). Nevertheless, as discussed in section 3.4, in this market prices of all shares are released to the public at the same time each week. This may reduce the effects of the timing problem on the overall results. In future, hopefully, as their interest in research develops, stockbrokers may avail data on simultaneous price recordings from which a case study may be undertaken.

The next chapter provides empirical evidence on weak-form efficiency from various stock markets around the world.

CHAPTER 5

WEAK-FORM EFFICIENT MARKET HYPOTHESIS: EVIDENCE

5.1 INTRODUCTION

In Chapter 4 it was shown that tests of market efficiency are concerned with whether the market uses all the available information in setting security prices. This Chapter provides a summary of empirical evidence on weak-form efficiency.

The emergence of the efficient market hypothesis (EMH) and the cumulative evidence generated in its support has been great challenge to the chart theorists, fundamental analysts and, to a large extent based on existing evidence, the inside dealers. The chart theorists believe that the past behaviour of security prices is rich in information about its future behaviour. This means that by looking at past patterns of price changes one would be able to predict future patterns. The fundamental analysts hold the view that by using publicly available information (for example, corporate financial reports or economic indices) it is possible to determine the real value of a security and to therefore conclude whether it is either under or over-priced, and as a consequence to change ones' portfolio position. The inside dealers believe that using price sensitive information which is acquired from the companies issuing securities and which is not in the public domain, will enable them to increase expected gains. Empirical analysis show that the holding of the above positions is at least naive, and that at no time should one expect to obtain a higher than normal return by holding any of the above positions [Keane (1983); Poterba and Summers (1988)].

In a stock market which is efficient, prices are good indicators of value. The firms issuing securities to finance their operations obtain "fair" prices and investors who purchase securities pay "fair" prices for them.

Empirical evidence resulting from tests of weak-form efficiency is available for many stock exchanges and for tests using daily, weekly, and monthly data. This evidence is presented first for developed exchanges where weak-form tests started, followed by evidence arising from the extension of research to emerging markets.

5.2 EVIDENCE FROM DEVELOPED STOCK MARKETS.

The bulk of the evidence on the weak-form of the EMH is available for developed stock markets since the 1950s'. Three reasons may be cited for this. One was the awareness of researchers in those countries of the need to understand the nature of stock exchanges which were important features of the economy. Secondly was the development of statistical methodologies which could be applied in a variety of fields and which was extended to the economics and finance. Thirdly was the availability of large masses of stock price data in an accessible form and with which researchers could work.

Kendall (1964), for example, examined the temporal dependence of UK industrial share prices. He used weekly data for 18 industrial and one composite U.K. stock market indices over the period 1928 - 1938. Kendall found that, contrary to the general impression among share market traders and analysts that share prices followed trends, the knowledge of past price changes yielded substantially no information about future price changes. More specifically he found that each period's price change was not significantly correlated with the preceding period's price changes, nor with the price changes of earlier periods. The serial correlations present in the series were so weak that they could not be used for predictive purposes and hence were of little investment value and investors could not expect to make money on the stock exchange by watching price movement unless they possessed some extraneous information. This was significant support for the random walk theory.

Fama (1965) carried out a comprehensive study of 30 companies using daily data. These were the stocks of the Dow-Jones Industrial Average Index. He found that the sample serial correlations were small in absolute value.

The average value noted was 0.026. He further checked whether it was possible that price changes across longer differencing intervals would show stronger evidence of dependence. He carried out tests for differencing intervals of four, nine and sixteen days. He again found that the sample serial correlation coefficients were quite small. The average value noted was -0.039 for four days and -0.057 for sixteen days. He concluded that, from the evidence produced by the serial correlation model, the dependence in successive price changes was at most slight. He also carried out runs tests to confirm the results obtained from the serial correlation tests. He found that the differences between the actual and expected number of runs were all very small. In addition he found no important patterns in the sign of differences. He concluded that the actual breakdown of runs by sign conforms very closely to the breakdown that would be expected if the signs were generated by an independent Bernoulli process. Fama also examined the distributional evidence of his sample of companies. He concluded that the returns were not characterised by the normal, as had previously been held, but by stable paretian distribution. The results of Fama's work may have been biased due to the type of securities used. The blue-chip shares he used, because of their size and importance are highly unlikely to be used by anyone to make returns greater than the market.

Brealey (1970) examined the distribution and independence of successive rates of return from the British equity market. His random walk tests involved carrying out both serial correlation and runs tests. The tests were on the daily changes in the Financial Times All Share Index for a period of 1665 days. Brealey at first found a significant first order serial correlation coefficient of 0.219. He noted however that the correlation coefficients could be biased upwards because the prices used in calculating the FTA Index did not occur simultaneously. Brealey tried to overcome the problem by constructing a new index made up of button quotations obtained at approximately 2 pm. each day. The new index provided a serial correlation of 0.19 which was significantly different from zero at 95% level for the year 1968. Using the FTA Index for the same period resulted in a correlation coefficient of 0.32. The use of the new index resulted in a reduction in the serial correlation coefficient, but the results still showed a slight but not significant dependence between market returns on successive days. To complement the results obtained using the serial correlation tests, Brealey further conducted runs tests. He found some differences between the actual and expected number of runs. The use of the new index noted above produced a sharp narrowing, but not the complete disappearance, of the gap between expected and actual runs. After looking very closely at the results of all his tests he concluded that the observed persistence in the market movement was weak, and insufficient to yield any profits to one who wanted to exploit it. The results therefore did support the random walk hypothesis. Brealey's examination of the nature of the distribution of returns revealed a marked departure from the normal distribution. He observed that the distributions were characterised by high peaks and fat tails not characteristic of normality.

Dryden (1970) examined the statistical dependence of daily prices of three series of price indexes, FTA 500 Share Index, FTA Capital Goods Index and the Daily Mail Industrial Share Price Index. Daily data of over 1000 prices were collected for each series. The results of the study of the serial correlation coefficients of the prices revealed on the whole no statistically significant departure from randomness though each of the index series had a statistically significant first order serial correlation coefficient. The runs tests also provided little evidence for rejecting the random walk hypothesis. Dryden therefore concluded that the behaviour of the shares studied was consistent with the random walk theory. It may be concluded therefore that Dryden's evidence largely supported the efficiency of the securities market in its weak-form.

Kemp and Reid (1971) tested the random walk hypothesis using a random sample of shares quoted on the London Stock Exchange. Their study used 52 daily price observations. They carried out both the tests of runs and of serial correlation. They concluded that the share price movements were conspicuously non-random over the period considered.

They found that most of the shares that exhibited the non-randomness were those of small and less known firms. These firms might not have received much attention from analysts. The interpretation of their results as contradicting the random walk theory is questionable since the period the study covered was very short.

Conrad and Juttner (1973) studied 54 stocks from the 340 stocks listed on the German exchange. They chose stocks which had the highest number of quotations. The study covered a time period of 825 days. They found that the values of the serial correlation coefficients for the majority of stocks deviated significantly from zero. A high proportion of the stocks diverged to such an extent that the dependence revealed was not only significant from the statistical point of view, but also from an investor's point of view. They concluded:

> **"The non-parametric and parametric tests applied to daily price changes suggest that the random walk theory is inappropriate to describe the behaviour of recent prices in Germany. The empirical evidence we produced does not stand up well in the theory that stocks being are traded in an efficient market" (p.591).**

Their results from runs tests were rather inconclusive. According to their results, 19 stocks exhibited a trend, whereas for the other 35 stocks, the differences between the runs did not stand in contradiction to the number of observations consistent with a random sequence. General conclusions on the results are difficult to draw since it is not stated whether they considered the extent of transaction costs in the German market. They also examined the distribution of returns along the lines of Fama(1965). Their tests relating to the observed structure of the frequency distribution support the hypothesis that the returns follow a stable paretian distribution.

Solnik (1973) tested whether European stock prices follow a random walk. He used a sample of 234 securities from 8 major European stock markets. The data consisted of daily prices and dividend data for the 234 common stock over a period covering 1310 days. Serial correlations for weekly, bi-weekly and monthly returns were also computed. He concluded that the serial correlations were small, and probably negligible from an investors point of view.

Girmes and Benjamin (1975) carried out a study of the temporal properties of U.K. share prices using a sample of 543 share prices covering a period of 600 days. Evidence obtained showed that 20% of the shares studied behaved in a non-random manner. However, these results, like those of Kemp and Reid's study, covered too short a period and the firms showing some evidence of non-randomness were the small ones. The results were heavily criticised by Marsh (1977). He noted that they had failed to design their study to take into account the fact that their technique was valid only if share price changes were continuous and symmetric. The superior vertices and index of maximum distance tests employed by them also disregarded the effects of "no-change" observations.

Jennergren and Korsvold (1975) examined the applicability of the Random Walk Hypothesis (RWH) to the share prices of the Oslo and Stockholm Stock Exchanges. They used daily closing prices of a sample of 45 stocks traded on the two exchanges. They tested for the independence of the successive price changes by serial correlation and runs tests. The results led them to conclude that the independence hypothesis could not be supported. This meant that the RWH was not a very accurate description of share price behaviour on the Norwegian and Swedish Stock Markets. They also did point out the practical difficulties they faced with respect to data, in that most stocks were infrequently traded. Their tests on the possible relationship between level of trading and efficiency did not however support the existence of such a relationship. They also looked at the distributions of the share price changes, and their evidence showed that the distributions were non-normal. They concluded that the deviation from randomness found was insufficient to offset the transaction costs incurred in trading. They suggested the need to probe more deeply into the specifics of price formation in small markets and for infrequently traded stocks.

5.2.1 Recent studies using a variety of statistical methodologies

The weak-form of the EMH, based upon traditional tests of serial correlation and runs, has become accepted with regards to developed markets. Nevertheless, by the beginning of the 1980's, several researchers sought to apply more powerful methodologies to investigating weak-form efficiency. This section highlights some of these studies.

Shiller (1981) argued for the use of a variance-ratios methodology in testing for weak-form efficiency. He provided empirical evidence that appeared to suggest that price changes in the securities market are much more volatile than can be justified by standard asset pricing models. By implication, such evidence implies that the securities market's pricing ability is inadequate or that the model of price formation is inappropriate. This evidence regarding excess volatility in the financial markets was questioned by Flavin (1983). Flavin provided evidence that the volatility tests tend to be biased very severely towards the acceptance of the alternate hypothesis of market inefficiency. He argued that the apparent violation of market efficiency was probably a reflection of the sampling properties of the volatility measures rather than a failure of the market efficiency hypothesis itself.

Rosenberg and Rudd (1982) used serial correlation tests to study returns of common stocks on the New York Stock Exchange. They decomposed the total excess return of a security into what they called factor-related return and specific return. They found positive serial dependence in the factor-related component and negative dependence in the specific component which nearly off-set each other, resulting in zero correlation in total excess returns. They nevertheless state that the findings could be due to recording error in the prices. They could not therefore reject the hypothesis of randomness.

De Bondt and Thaler (1985) investigated whether the stock market over-reacts to information. Their focus was on shares that had experienced large capital gains or losses, rather than some firm-generated piece of information. They termed those firms experiencing extreme capital gains as "winners" and those that had experienced extreme capital losses as "losers". They then formed two portfolios based on winners and losers. Their reported results indicated that over the last 50 years, loser portfolio outperformed the market on the average by about 19.6% thirty six months after the portfolio formation while the "winner" portfolio underperformed the market on the average by about 5%. They interpreted their results as being consistent with the overreaction hypothesis, which postulates that extreme movements in share prices are followed by reversal movements that adjust for the initial movement. If the initial movement is very extreme, the adjustment process will be very large. If prices behave in such a manner, it clearly implies a weak-form market inefficiency. De Bondt and Thaler (1987) examined the issue of market overreaction and stock market seasonality further, and concluded that the hypothesis still held in spite of the criticism that the market's overreaction and the seasonality in share prices could be due to the market's response to the changing risk characteristics of firms. Their results, however, are not statistically robust. What is clear is that their two studies did not control for the competing hypothesis of stock market risk changes. Ball and Kothari (1989) show that when this competing hypothesis is not controlled for it could cause erroneous acceptance of the overreaction hypothesis.

Taylor (1986) tested the random walk hypothesis and an alternative class of models containing trends in prices. Random behaviour was rejected for all the long series tested. The results of his analysis, however, need to be accepted with caution. Firstly, although the results did reject the RWH, they were not significant enough to generate profitable rules. He stated that the statistical dependence was very small and therefore prices reflected most information accurately and quickly. Any ordinary citizen using such results was certain to incur trading costs far greater than any gross profit. Secondly, the statistics were significant for every series having less than 2000 observations. As he puts it, these results showed that it is highly desirable to study series containing at least 2000 returns. Studies of shorter series gave some significant and some non-significant test results. He finally concludes that **"it would then be difficult to state clear conclusions" (p.161).**

Lo and MacKinlay (1988) tested the RWH for weekly stock market returns using variance-ratio methodology. They claimed that the RWH was strongly rejected for the entire sample period (1962 - 1985) and for all subperiods for a variety of return indexes and size sorted portfolios. They could not reject the RWH for individual stocks. The rejection of the RWH for index and portfolio returns was largely due to the behaviour of small stocks. They dismissed the idea that it could be attributed completely to the effects of infrequent trading or time varying volatilities. Nevertheless, they concluded that the results did not necessarily mean imply that the stock market is inefficient or that prices are not rational assessments of fundamental values. Their test results, they said, should be interpreted as a rejection of the economic model used in their study.

Poterba and Summers (1988) examined the extent of mean reversion in stock prices. They analysed monthly and annual data on real and excess returns of the New York Stock Exchange. They also analysed 17 other equity markets. Their results consistently suggested the presence of a transitory component in stock prices, with returns showing positive autocorrelation over short periods, but negative autocorrelation over longer periods. They claimed that persistent, but transitory, disparities between prices and fundamental values could explain the findings. They reported that random walk price behaviour could not be rejected at conventional statistical levels. Ball and Kothari (1989) provides evidence that this observation does not result from stock price mispricing.

Ball and Kothari (1989) investigated the basis of negative serial correlations in returns. They tested two competing hypotheses: (1) stock market mispricing, with prices taking long, but subsequently corrected, departures from fundamental values, or routinely overreacting to information and (2) changing expected returns in an efficient market. They controlled for the behaviour of the market index and then computed serial correlations in abnormal returns, thus allowing a discriminating test between mispricing and changing expected returns hypotheses. They obtained evidence that suggested that negative serial correlation in relative returns was due almost entirely to variations in relative risks, and therefore expected relative returns, through time. The market mispricing hypothesis, supported by the findings of De Bondt and Thaler (1985, 87), was rejected.

Jegadeesh (1990) examined the predictability of monthly returns of the New York Stock Exchange. He used over half a million observations in fitting regression equations for predicting security returns. He found that the negative first order serial correlation in monthly stock returns was highly significant. Significant positive serial correlations were found at longer lags and the 12-month serial correlation was particularly strong. He concluded that the predictable pattern of stock returns observed appeared to be a pervasive phenomenon and therefore reliably rejected the hypothesis that the stock prices follow random walks. He nevertheless specified that the predictability of the returns can be attributed either to market inefficiency or to systematic changes in expected stock returns. The models he used in the tests could not discriminate between these two competing hypotheses, and therefore the results were inconclusive.

The conclusion from the review of all the above studies is that the findings concerning on the applicability of the weak-form EMH obtained from the use of traditional statistical methodologies still hold as strongly as they did in the 1960s in spite of the use of new methodologies.

5.2.3 Non-statistical tests (trading rules)

The non-statistical tests in security market research are directed towards testing whether mechanical trading rules can be devised to beat a naive buy-and-hold strategy. The rules are founded on the assumption that there may be some pattern in price changes not be detectable by the statistical tests. Many investigations have tested the strategies which investment analysts and advisers claim have been successful in generating abnormal returns for their clients. Evidence from studies using this methodology is reviewed in this section.

Alexander (1964) conducted extensive tests of filter rules using daily data. He used filters of one to fifty percent. He concluded that there was no possibility of making any significant gains unless one was a floor trader (in other words a person exempt from paying dealing costs). It was not possible to beat the buy-and-hold strategy.

Fama and Blume (1966) carried out tests which compared the profitability of various filters to the naive buy-and-hold strategy for individual stocks of the Dow-Jones Industrial Average. They did notice that the results of small filters of between 0.5% and 1.5% indicated that it was possible to devise trading schemes based on very short term, say daily, price swings that would on average out-perform the buy-and-hold. The average profits were nevertheless small, and they concluded that when one takes account of even the minimum trading costs, the profit identified disappeared. They also stated that when the serial correlation tests failed to uncover some dependence in price changes, no dependence was noted when filter tests were used, that is, **"... this same dependence has also remained hidden from the scrutiny of filter tests" (p.240).** There would be no justification therefore for declaring the market inefficient.

Levy (1967) tested a trading rule he called the relative strength rule. He found that two policies he adopted based on the percentage amount invested and the number of securities yielded higher returns than those of the buy-and-hold strategy. Based on his results he concluded that the theory of random walks had been refuted. Jensen and Benington (1970) reviewed Levy's work and concluded that there were several errors in the strategy which tended to overstate the excess return earned by trading rules. It was therefore not possible for the evidence provided by Levy to strictly invalidate the random walk hypothesis.

Latane and Young (1969) tested the Fixed Proportion Maintenance strategy and found inconsistent and contradicting results that, where significant and persistent differences existed among security growth rates, the Buy-and-Hold strategy tended to yield superior results across time. They were therefore unable to show that their strategy was superior to the buy-and-hold.

Jensen and Benington (1970) carried out tests to review the earlier work of Levy (1967). They directed their effort to those rules which seemed to earn substantially more than a buy-and-hold policy. Their replication of these rules on 29 independent samples of 200 securities each over a period of 5 years did not support Levy's results. They concluded that the performance of the relative strength rules were very close to the results predicted by efficient market theories of security price behaviour.

Evans (1970) was not able to discriminate effectively between the buy-and-hold and the Fixed Proportion Maintenance strategy (FP). He contended that the FP tended to show significantly superior risk-adjusted returns without considering transaction costs and taxes. However when he considered transaction costs and taxes he could not discriminate in favour of any one strategy.

Dryden (1970) used trading rules to check the results obtained when he used statistical procedures. He found a higher rate of return with small filters which was above the buy-and-hold returns. However, no adjustment had been made for transaction costs. He concluded that the trading strategy used as the filter rule did not seriously infringe the weak-form of the efficient market hypothesis.

Brealey (1970) used a sample of 29 shares to test the profitability of trading rules. He reported that in 15 out of the 29 cases the shares provided a lower rate of return after they were purchased than after they were sold. The average return was marginally higher for purchases than sales, however the median return was lower. He was unable to obtain results that were significantly superior to the naive buy-and-hold strategy. He concluded that the findings did not support the hypothesis of dependence in market rates of return.

Griffiths (1970) used the relative strength rules tests on weekly data. He carried out his study on 200 shares and reported that the top 10% shares outperformed the market during the year by 3%. The bottom 10% also underperformed the market by 3% with the rest performing more or less in line with the market. The magnitude of the reported profit was, however, insufficient to cover transaction costs. The efficient market hypothesis could therefore not be rejected.

Girmes and Damant (1975) carried out an analysis of 484 shares quoted on the London stock Exchange for a period covering 1304 days. They stated that they found significant "head and shoulder" patterns in their simulated data. This, they claimed, showed that a trading strategy could be developed from the knowledge of the series of past prices that could out-do the buy and hold. They, however, pointed out that the period covered by the study showed a marked head and shoulder movement of the market index itself. This could therefore have resulted from a selection bias. Marsh (1977) also criticised them of "data mining" in their choice of smoothing technique and in their definition of "head and shoulders".

Jennergren (1975) carried out filter tests of the Swedish market share prices. He aimed at verifying earlier work on the Norwegian and Swedish markets which had tested weak-form efficiency using statistical random walk theories. Unlike the studies in the USA and UK, Jennergren faced technical problems because short-trading was not allowed on the Swedish market. To overcome the problem, he introduced the bank account strategy where proceeds were deposited or withdrawn for the stock market operations. The differences between the filter rule he used and that of Fama and Blume (1966) and Dryden (1970) were that:

(i) the investors alternated between the long position and the bank account, whereas in other studies, the trader was always in the market, holding either a long or a short position. Since there was no organised short trading on the exchange, the filter rules involved no short positions.

(ii) the transactions on shares did not take place the same day but were assumed to take place the next day because information on prices of a day's trading was only available to the investors the next day.

Jennergren was not definite in his conclusions. He stated that there seemed to exist profitable mechanical trading rules for certain institutional investors, but only on the assumption that the prices do not become affected by the trades generated by the trading. This assumption may be unrealistic in open market operations. He also noted that filters did not seem profitable for ordinary private investors who formed a very important investing group. Given his assumptions on price movements, one may not hold his findings as sufficiently significant to challenge the hypothesis of the market being weak-form efficient.

The review of the evidence from trading rules provides support for the validity of the efficient market hypothesis. It can, therefore, be concluded that these results are consistent with those obtained from the use of statistical methodologies [Fama (1965); Dryden (1970); Brealey (1970); Jennergren (1975)].

The research evidence presented indicates that developed stock exchanges are substantially efficient in the weak sense. The few studies which showed departure from efficiency were identified as suffering from several methodological weaknesses which made their conclusion untenable. It is apparent that there is no opportunity for consistently earning excess profits by using statistical, technical, and chartist approaches.

5.3 EVIDENCE FROM EMERGING MARKETS

Published evidence on the weak and other levels of efficiency of developing stock markets has appeared sporadically. This evidence has been scanty. The main motivation underlying many of the studies of emerging markets was to see whether such markets exhibited the same characteristics as developed markets, such as those of the USA and UK. The debate on the relationship between economic and stock market efficiency was instrumental in making researchers examining the developing markets to believe a priori that they were not efficient [Samuels (1981)]. The dominant school believed in the strength of the relationship between the development of the economy and that of the financial system [Goldsmith (1970)]. Since many of the small exchanges were in economically less developed economies (and still are) then it followed that they were and are less developed. This relationship has been difficult to test but it had a significant impact on the design and emphasis of the studies of developing markets and the interpretation of the results [Parkinson (1984)]. Many of the studies, including some presented here, concentrated the bigger part of their effort on the reporting of economic variables and relationships rather than on prices and information. In this part we only report on the evidence from tests of weak-form efficiency, which relates price with information, as that is the theme of the current study.

5.3.1 **Evidence from markets (excluding the NSE)**

Niarchos (1971, 1972) carried out a study of the Greek Stock Exchange. The purpose of the study was to see whether the results from a small stock market like the Greek one compare with those obtained from New York and London stock markets. He tested for randomness using serial correlation and runs tests. The data used were the closing price series for the industrial index, the bank and insurance index, fifteen industrial stocks and twenty bond issues. The study period was for 12 years (1957 to 1968). The results obtained suggested that the prices were random walks. The average value of the serial correlation coefficient of 0.036 for the 15 stocks studied was not significant. There was nevertheless some slight, but insignificant, departure from the random walk for the industrial price index and for some bonds. The serial dependence with regards to the index may have been due to some inactive stocks included in its computation. He concluded that the prices of individual stocks and the index are random walks, i.e. they obeyed the same model found for other stock markets in the world. Thus it is not only impossible to predict a price series from its own internal behaviour, but it seems equally impossible to do it from the behaviour of other price series.

Affleck-Graves and Money (1975) studied weekly share price series of 50 stocks of the Johannesburg Stock Exchange for a period of five years to 1973. They carried out serial correlation tests over 20 lags. Only 35 out of 500 serial correlation coefficients were significant and in excess of two standard deviations from zero. They concluded that the amount of correlation was not sufficient to reject the applicability of the weak-form EMH.

Sharma and Kennedy (1977) tested the applicability of the random walk hypothesis to the stock market of India and compared the behaviour to that of the stock markets of USA and Great Britain. They used (a) a non-parametric test of randomness, by an analysis of runs and (b) a parametric test of independence by an examination of serial correlation coefficients and (c) the spectral densities of the data. They concluded:

> **"...it is evident that the stocks on the Bombay Stock Exchange obey a random walk and equivalent in this sense to the behaviour of stock prices in the markets of advanced industrialised countries" (p.411).**

Roux and Gilbertson (1978) carried out extensive tests on both the distribution and independence of price changes for 24 mining and industrial shares listed on the Johannesburg Stock Exchange. They applied both serial correlation and runs tests to investigate the independence of the price changes. They concluded that the tests, especially the runs tests, provided some evidence that the price changes were not completely independent. Their results differed slightly from those of Affleck-Graves and Money (1975). Although apparent deviations from independence were small, they were consistent with a situation in which a time trend or bunching of observations occurred. They nevertheless added that the findings did not imply that investors could utilise such small market dependence to consistently increase their profits over a naive buy-and-hold strategy.

Ang and Pohlman (1978) tested weekly prices of 54 stocks of five Far Eastern countries using serial correlation and runs tests as in Fama (1965). The time period covered were: September 1967 to November 1974 for Hong Kong; May 1970 to November 1974 for Australia and Japan; May 1972 to November 1974 for Singapore; September 1973 to November 1974 for Philippines. Stock prices were corrected for capital adjustments. The study concluded that, in general, the degree of the serial correlation coefficients were similar to those of European stocks as reported by Solnik (1972) and, for Japan, quite comparable to the USA. The study also examined the distribution of the returns and concluded that they exhibited greater standard deviation and departure from normality than American stocks.

D'Ambrosio (1980) used price indices of the stock exchange of Singapore to test for their conformity with the weak-form EMH. In order to determine the presence of trends and the degree of price dependence, this study applied runs and serial correlation tests to daily closing values of the six major indices, Industrial; Financial; Tins; Property; Rubber; and Hotels. Three of these indices, Industrial, Hotels, and Tins showed dependence based on the runs test, but exhibited low serial correlation coefficients especially at short lag intervals. At longer intervals the indices were highly correlated from one period to the next. In all instances the serial correlations were greater than those found in other equity markets. He concluded that the Singapore exchange did not behave in a manner consistent with a random walk. The conclusions were rather strong given the observations of Working (1960) and Fisher (1966) that stock market indices tend to produce biased results, especially if infrequently traded stocks are included in their computation.

Gandhi, Saunders and Woodward (1980) studied the Kuwait Stock Exchange. The study covered the period December 1975 to May 1978. The data consisted of stock market price indices published by the Central Bank of Kuwait. They used regression analysis to determine whether serial correlation existed. They found that the slope coefficients were statistically different from zero at any meaningful levels of confidence. They also carried out runs tests on the data. They found that the results of the tests were statistically significant and therefore the market tended to show some level of inefficiency. The results indicated that share prices tend to move systematically over time. This would enable investors, who are able to identify share price movements, to consistently "beat the market". They attributed the results to "thinness" of the market. They conclude:

> **"there is evidence of inefficiency in price determination ...... as might be expected in a thin market" (p.347).**

It should be noted that the above results may have been biased due to the fact that only the indices were used. When inactive stocks are included in the indices they tend to produce dependence as noted in Niarchos (1972). The source of the dependence may be attributed to the use of indices rather than to the inefficiency of the market.

Samuels and Yacout (1981) considered the economic characteristics and weak-form efficiency of the Nigerian stock exchange. They tested for serial correlation using weekly share prices for the period 1977 to 1979. They found slight traces of serial dependence which were not statistically significant. They concluded that the price series followed a random walk and the market was efficient in the weak sense.

Yacout (1981) carried out serial correlation tests of twenty companies of the Egyptian stock exchange. He found significant dependence with regards to 25% of the companies. He attributed this to data problems and concluded that even though the market did not seem to follow the random walk for the period and shares tested, considering transaction costs the market was reasonably efficient.

Cooper (1982) carried out random walk tests on a series of 50 World stock markets that included the Nairobi Stock Exchange. Using serial correlation, runs, and spectral tests on monthly, weekly and daily data, he was unable to reject the random walk hypothesis. From the serial correlation tests he found that the first order serial correlations were small in magnitude. Results for all exchanges, except for Japan, exhibited some serial correlation which were statistically different from zero up to a lag of 25. The runs tests on monthly, weekly and daily data supported the random walk when transaction costs were taken into account. Cooper (1982, p.528) concludes:

> **" .....the findings reported in this paper do lend further weight to the random walk hypothesis for those particular markets at least for the samples and time periods studied for the USA and the U.K. markets. <u>For all other markets, the evidence is less clear"</u>** ..... on (p.530) he continues **"....if we do reject the Random Walk**

Hypothesis (thereby Weak-form efficiency) because of some dependence in successive price or index changes, the question then arises whether or not non-randomness is of a sufficient magnitude for an investor to make profits in excess of a randomly selected portfolio,....the actual amount of dependence is so small as to be unimportant, given transaction costs."

Al-Mudhaf (1983) examined the efficiency of the Kuwait Stock Exchange and those factors which affected the market directly. He gave complete coverage to some of the issues in the organisation of the exchange. He also carried out statistical tests of the weak-form efficiency using thirty companies listed on the exchange. The data used was for the period 1976- 1980. He adjusted the price for bonus, dividend and rights. He carried out serial correlation tests over 10 lags. The largest serial correlation coefficient was (-0.192). The mean was 0.055. He concluded that there were no significant correlations in stock returns.

Barnes (1986) studied the 30 stocks of the Kuala Lumpur stock exchange using serial correlation, runs, and spectral analysis. Serial correlation showed only 2 stocks exhibiting a departure from the weak-form. Significant runs results were only for one stock. The spectral results indicated confirmation with the weak-form EMH. He concluded that the exchange exhibited a high degree of weak-form efficiency.

Yong (1987) carried out a study on all stocks which were traded on weekly basis on the Kuala Lumpur Stock Exchange from January 1977 to May 1985. Based on the serial correlation test for individual lag, a high percentage of stocks exhibited independence between price changes. Based on the overall serial correlation test of the Q-statistic, a high percentage exhibited independence among the percentage price changes. A small percentage did exhibit non-randomness in the percentage price changes. He attributed the results to stocks which were thinly traded. The runs test gave results which exhibited non-randomness in the percentage price changes. The relationship between the level of trading and efficiency was non-evident from the results of the Spearman's rank coefficients. Distributional evidence also indicated that the returns were not normally distributed.

5.3.2 **Studies of the Nairobi Stock Exchange (NSE)**

The pioneering work on the NSE may be attributed to Lomas (1961). He investigated the indices of ordinary share prices on the NSE. The study's objectives were to show the trend and magnitude of changes in the NSE from 1955 to 1961 and to measure the effect upon the share prices of the politically induced depression that came about because of the process of decolonisation following the Lancaster House Conference of 1960. This study gave a vivid account of the historical development of the NSE and its stated aims and objectives at inception. Besides this, it examined the nature of the trading activity on the NSE and found significant evidence of non-trading which he concluded could lead to imperfections in the process of price determination on the exchange.

To gauge the effects of the political change on share prices, he constructed indices weighted on the issued ordinary share capital on monthly basis using 40 companies and examined their trend. His results indicated that:

(a) From 1956, the trend of ordinary share prices was downwards and that, on average, ordinary shares lost over half their value between 1956 and 1961.

(b) between 1956 and the Lancaster House Conference in 1960, ordinary shares lost on average approximately one quarter of their value.

(c) From the Lancaster House Conference in 1960, ordinary shares prices had fallen much more rapidly than in the preceding years, and by July 1961 they had lost over one third of their value.

These declines were attributed to the changing political climate at the time. This study was not a test of the EMH as we know it today but one would be tempted to say that from the evidence given, the hindsight which Lomas did not have then was that such changes in share market prices could be explained by the efficient market hypothesis. The behaviour of the market then was consistent with the EMH. The decline in share prices was not in itself evidence of market imperfection. Keane (1987, 1990) argues that when economic prospects are interpreted to be suddenly and dramatically altered, the revision of the prices will show because it will also be correspondingly sudden and dramatic. If the market does not respond as such, but delays reaction, then it will be acting irrationally. The political events of the time and their attendant economic consequences had a dramatic effect on the riskiness of the investments and this was properly reflected in the speed of response of the market prices.

Arowolo (1971) examined the development of capital markets with specific reference to Kenya and Nigeria. He studied the economic details surrounding the NSE. The main contribution of his study lies in the identification of the crucial part that the NSE could play in the investment-development process. He did not concern himself with the exchange trading and pricing activities.

Munga (1974) re-examined Lomas' (1961) contribution but concentrated on the history and organisation of the NSE and its role in the Kenyan economy. He particularly gave a good historical account of the NSE, how it evolved, and the complexities involved. The study also examined the raising of funds and gave a theoretical treatment of the role of the exchange in development. Unlike Lomas (1961) no attempt was made even to carry out fundamental analysis of the prices of the exchange.

Cooper (1982) included the NSE as one of his sample exchanges. He studied the NSE weekly indices using serial correlation, runs, and spectral analysis. He found eight cases of significant serial correlation. The standardised value of the runs test was -5.58. Spectral analysis revealed 39 readings outwith the 95% confidence band. This evidence may be considered to indicate that the RWH was not a good description of the successive changes of the NSE-Index. These types of results for indices should be interpreted with caution, however, because index data may introduce autocorrelations not present in the original series [Working (1960)]. He did not have an adequate basis for rejecting the RWH when transaction costs were considered.

Runyenje (1985) studied the impact of capital gains taxation on the prices of ordinary share using a sample of 20 companies quoted on the NSE over the period 1973 to 1983. Tables and graphs were used as the principle tools of analysis on annual, monthly, and weekly data. He reported that ordinary share prices on the NSE exhibited a significant trend between 1973 and 1983. He sought a trend on the NSE-Index as a basis for drawing conclusions about the impact of the tax, and a trend was noted. It should be recognised that this was not, however, a statistical test of the share prices of the NSE. Of particular importance, nevertheless, was the manner in which it was able to show graphically the movement of the share price index over the period 1973 to 1985. Such an analysis is a contribution in its own right [Ibbotson and Sinquefield (1987)].

Parkinson (1984) provides, perhaps, the most serious empirical work on the NSE to-date. He examined the NSE for the period 1974 to 1978 with the objectives of showing its role in the development process and the degree to which it conformed to the patterns of stock exchanges elsewhere. To undertake the study he obtained his data from several sources:

(i) economic indices data was obtained from published official government statistics.
(ii) company specific information was obtained from annual stock exchange fact books.
(iii) stock price data was obtained from one of the stock brokers of the exchange.

His comprehensive review of the economy revealed that for the period covered, negligible new funds had been raised through the NSE. There was also evidence to show that there was an unsatisfied demand for new securities, but that companies had failed to tap that demand.

He also carried out various tests of the EMH. These tests covered 50 stocks which were listed on the exchange for the period 1974 to 1978. He used monthly price observations. The results of his serial correlation tests showed that the signs were predominantly negative for 80% of the shares. He found first order serial correlation of more than 0.3 for eleven (22%) of the fifty shares. He concluded that, for some companies, there was a noticeable pattern of share price behaviour over time. This would violate the extreme random walk hypothesis. He also noted that since he had used extrapolated prices for six out of the eleven companies with high serial correlation, this could have been the cause of such high correlation.

Parkinson carried out further tests on the data using the non-parametric method of analysis of runs up and down. He used both one tailed and two tailed tests of significance at 5% level of significance. He found that forty nine (98%) of the fifty companies exhibited fewer runs than would be expected from randomly distributed prices, and was forced to reject the hypothesis of randomness. The results of basic tests of the distribution of successive share price changes were also reported. They indicated considerable evidence of positive skewness. The level of kurtosis was also high suggesting a considerable degree of leptokurtosis. No other tests on the distributions were undertaken.

He concluded that the random walk hypothesis was not a valid description of the share price changes of the NSE. The study was therefore not conclusive on whether there is evidence consistent with weak-form efficiency. There may be ground for questioning the results obtained and the conclusions reached, firstly on the quality and quantity of data, and secondly on the level of analysis.

Parkinson used data only of stock broker, thereby restricting his data source. The structure of the NSE is such that complete sets of market price information are available only when all brokers exchange information at the weekly call-over. The price lists of individual brokers are incomplete to that extent. This therefore restricted the amount and quality of the data used in his analysis.

The quantity of the data could have been affected by the length of time covered. Parkinson carried out his tests over a five years period (1974-1978). Given that the exchange faces a high incidence of infrequent trading, this would have introduced data limitation problems to his study. The problem was probably compounded by the use of monthly return intervals. This means that he could only expect to obtain a maximum of sixty observations which, with thin trading, was not possible for some of the companies sampled.

The other issue concerns the control of data errors. Data errors have been identified as important sources of significant results if not controlled [Praetz (1976)]. The effort and cost required to achieve high level data accuracy through editing is enormous. Parkinson admits the problems he had in dealing with his data. Cost considerations did not enable him to pursue thoroughly the completeness and accuracy of his data. He, for example, does not explain how he dealt with suspect data or his editing procedures. The existence of extreme values, some probably caused by suspect data, may produce evidence not consistent with randomness.

Secondly, the depth of analysis and resulting evidence, was not sufficient for him to arrive at strong conclusion. In the analysis, the serial correlation tests covered only one lag. This is insufficient to make valid conclusion on the applicability of the independence hypothesis [Niarchos (1972); Yong (1987)]. Any dependence, as in many other studies before and after, would have to be shown to exist consistently across lags.

Another issue in the analysis that he failed to include was the "no price change" position in his runs test. The results of Conrad and Juttner (1973, Table 1) tend to show that there may exist significant differences in results when either including or excluding the no change position.

Another problem is that the result may have arisen because extrapolated data were used. As Parkinson noted himself, the extrapolation of the data may cause problems in the results obtained. He extrapolated data for a total of 20 (40%) of the fifty companies.

It would therefore not suffice to make any clear conclusions on the validity of the EMH on Parkinson's evidence only. The study needs to be challenged, taking into consideration its fundamental weaknesses and the problems inherent in EMH studies in the emerging markets reviewed above.

CHAPTER 6

METHODOLOGY: RESEARCH QUESTION AND HYPOTHESES

6.1 INTRODUCTION

In Chapter 2 the nature of stock markets in developing countries was discussed. It was concluded that there have been major improvements in the operating characteristics of the markets, but that more attention is still required to increase the level of activity. In Chapter 3 the structure of the NSE was examined. The nature of the trading activity was identified and discussed in detail. Many features inherent in emerging markets were seen to apply in this market. In Chapter 4 the theory underlying weak-form efficiency was explained. In Chapter 5 evidence on efficiency from both developed and emerging exchanges was presented. This Chapter looks at the implications of existing literature and evidence from emerging markets on methodology. The research question and hypotheses to be tested are also developed.

6.2.1 THE EMPHASIS OF PREVIOUS RESEARCH

It is apparent from the literature that major emphases in the studies of emerging markets have been placed on forging a theoretical link between economic and market efficiency [Drake (1977, 1985); Samuels (1981); Samuels and Yacout (1981); Al- Mudhaf (1983); Kitchen (1986, 1987); Parkinson (1984, 1984a, 1987)]. There seems little doubt that there exists a relationship between the competitiveness of capital markets and the efficiency of the economy. The more efficient the economy the more competitive the market [Stiglitz (1981)]. In a fully efficient economy the capital markets will also be perfectly efficient. In an efficient economy the allocation of the resources generated in that economy is Pareto optimal. Of course no economy is likely to achieve this optimal level of efficiency. Developing countries are worse-off when compared to developed countries because the distribution of resources is often highly skewed to only a small percentage of the population.

The approach to defining the efficiency of capital markets from the perspective of the efficiency of the country's economy is appealing. The problems arise when it is desired to test the approach empirically. As Stiglitz (1981) says, it would be very difficult to define what a set of feasible resource allocation represents. In a perfect market an asset would have a price that is exactly equal to its present value, and, as a consequence, the sale of an asset in such a market is a zero Net Present Value (NPV) transaction. [Watt and Zimmerman (1986, p.21-23) provide a summary of assumptions underlying a perfect capital market.]

Like a perfect market, an efficient market involves zero

NPV transactions. However, an efficient market does not have to be perfect. In other words, perfect markets are efficient markets, but efficient markets are not always perfect markets [Ross and Westerfield (1988)]. In the finance literature, efficiency refers to efficiency with respect to information. A market is efficient with respect to a particular set of information. A market where prices quickly reflect all available information is efficient. The Efficient Markets Hypothesis (EMH) maintains that the total market is quite sophisticated in the way it digests all available information and arrives at equilibrium security prices.

There are no rigid rules or assumptions about market efficiency. There are those who do not believe, for example, with Samuels (1981 p. 129) assertions that the nature of emerging markets is such that:

> **" prices cannot be assumed to fully reflect all available information. It cannot be assumed that investors will correctly interpret the information that is released; and it cannot be assumed that insiders cannot operate on a scale sufficient to influence the price. The corporation, on the one hand, has greater potential to influence its own stock market price, and yet, on the other hand, there is a greater possibility that its price will move about in a manner not justified by the information available."**

Officer (1980) stated that an efficient stock market does not require that every buyer and every seller be fully informed. He adds:

> **"In the limit, one informed trader may be sufficient to ensure market efficiency providing the share market is thin (few trades being made) and/or he has sufficient capital to trade until he considers the full effect of the information is reflected in the price and there is no further reward from acting on this information" (p.8).**

Beaver (1981), for example, states very clearly that market efficiency does not connote social desirability or any other normative connotation. Market efficiency, he points out, is concerned with the relationship between information and share prices. He continues to add:

> **"No value laden or normative connotations are implied. For example, a society might choose to have a securities market that is efficient with respect to a coarser information system over one that would be efficient with respect to a finer information system. Similarly, there is no direct or simple relationship between the 'greater' market efficiency and 'improved' allocation of resources. Hence, a distinction must be made between**

allocation and informational efficiency. They are distinct concepts and the relationship between them has not been rigorously derived" (p.168).

Keane (1983), on his part, argues that there is only one significant assumption upon which the validity of the market efficiency depends and that:

"it is not a proposition premised on a particular view of the world. It is not conditional upon there being a certain proportion, let alone a majority, of skilled investors. There is no assumption that the most or indeed any investors have access to or comprehend all available information, or are in agreement about the significance of the information. The only assumption that the EMH can be said to depend upon is one which states that it is possible notwithstanding the existence of naive investors, and despite the activities of speculators and claim by analysts to possess superior skills, that the market is nevertheless successful in generating prices that instantaneously and correctly capture all new information" (p.13).

Ross and Westerfield (1988) provide further support for this position. They argue that many persons are skeptical that the market price can be efficient if only a fraction of the outstanding shares change hands on any given day.

They further explain that:

> **" the number of trades in a stock on a given day is less than the number of people following the stock. This is because an individual will trade only when the value of the stock to him differs enough from the market price to justify incurring brokerage commission and other transaction costs. Furthermore, even if the number of traders following the stock are small relative to the number of outstanding shareholders, the stock can be expected to be efficiently priced as long as a number of interested traders use publicly available information even if many stockholders never follow the stock and are not considering trading in the near future and even if some stockholders trade with little or no information" (p.308).**

The concept of efficiency put forward in the finance and accounting literature deals with information efficiency. Irrespective of the persuasiveness of the arguments advanced for or against efficiency of any market the best judgment can only be made when empirical evidence is presented. Efficiency is purely an empirical issue [Keane (1983, p.13)]. This means that previous research in emerging markets would usefully have placed more emphasis on providing strong evidence on information efficiency through the nature and structure of empirical tests. This study places emphasis on the empirical evidence for information efficiency.

6.2.2 Issues of data

There is no doubt that many studies of emerging markets have had to contend with significant data problems [Yacout (1981); Parkinson (1984)]. These problems arise from at least three sources. One is the non-existence of computerised databases which the researchers can use. The second is the unavailability of data due to the nature of the stock market activities in developing countries. The third is the cost and effort required to assemble adequate data for meaningful research.

The non-availability of computerised databases has had a significant effect in market studies in developing countries and consequently on published evidence. One particular approach to this problem has been the use of indices which, for many exchanges, are published and therefore available at lesser cost [Cooper (1982); D'Ambrosio (1980); Gandhi, Saunders and Woodward (1980); Sharma and Kennedy (1977)]. The evidence from the indices is itself a very significant contribution, as demonstrated by Cooper (1982). There are, however, problems that arise when indices are used and when results not consistent with efficiency are obtained. Fisher (1966), for example, showed that infrequent trading causes an index constructed from such resulting share price data to induce positive serial correlation into returns which are calculated from the index and the estimated variance of the returns on the index to be biased downwards.

Another major problem with the data is its cost of acquisition. The costs are quite high in relative terms. Parkinson (1984) notes that his decision to use monthly data was based on the pragmatic criterion of the time available for data collection, and on the mass of data which had to be physically transported many thousands of miles (p.259). Experience from the current research has also proved that adequate resources have to be put at the disposal of the researcher otherwise the quality of the findings may be greatly affected.

Even when the cost of acquiring the data is manageable, there arises the problem of the availability of that data. Thin trading can affect the results of empirical work with regards to weak-form and other higher levels of efficiency. Infrequently traded shares introduce serious biases into the results of empirical work. The major source of bias is the tendency for the prices recorded at the end of a time period to represent an outcome of a transaction which occurred earlier in, or prior to, the period in question. It follows that erroneous conclusions can be made regarding the results of tests of efficiency.

Recognising this problem in studies of emerging markets requires the extension of the study periods to generate more data. Taylor (1986) argues that longer price series improve variance estimates, increase the power of random walk tests, and are essential for investigation of trading rules. He states that the duration of a time series should be as long as possible. He recommends that at least four years of daily price data with about 1000 observations are required to obtain worthwhile results and if possible eight years of data providing about 2000 observations or more should be investigated. This is itself a costly exercise and many researchers with limited budgets may not be able to afford it. For some markets it is a technical impossibility. This probably explains the use of monthly returns in, for example Parkinson (1984), and why, where weekly returns are used, very short time durations are taken [Yacout (1981)].

This study attempts to deal with the data problems in two ways. The first is by establishing a high qualitative database for the stock exchange. The second is by using a longer time (10 years of weekly data) than that adopted by many of the previous studies. Lo and MacKinlay (1988) argue that weekly data is preferable in that the biases associated with non-trading, the bid-ask spread, and asynchronous prices are avoided. The nature of the data used is described in Chapter 7.

6.2.3 The nature of the price series used

Very little attempt has been made in previous studies to identify, leave alone study, all the price series in the market. In a market, three price series are usually observed, the transaction, the bid, and the ask price series. The first represents the trading price in that market and the other two represent the quotations made on particular securities. Few studies mention the price series used.

This research investigates all the three price series concurrently for two reasons. The first is because of the views held about the pricing system in emerging markets. Samuels (1981), for example, tends to suggest that due to their very nature, prices in emerging markets fluctuate non-randomly. This is because, he argues, in such markets ill-informed investors are more numerous than the informed investors, and the trading activity is low, meaning that prices do not instantaneously adjust to information. He contends that inadequate corporate disclosure is likely to lead to a range of expectations by investors and therefore to increase the fluctuations in the market price of a share.

It is true that investors' behaviour in a market is not only reflected by the price at which securities are traded but the price quotations. Jang's (1987) study of the microstructure of securities markets illustrates that the bid and ask prices are determined by the expected return of each trader. The ask price increases with respect to both the buyer's expected return and the seller's expected return. The ask price will decrease as a buyer becomes more risk averse and his subjectively estimated variance of the future price increases. It also decreases when a seller becomes more risk averse. For the bid price it increases with respect to the buyer's expected return as well as the seller's expected return. It increases as the seller becomes more risk averse and as the buyer becomes more risk averse [Jang (1987, p.11)]. One would therefore expect, a priori, to find that all the three price series exhibit the same characteristics. Nevertheless, in a market characterised by a dominant group as in Samuels' argument this may not be the case. Empirical evidence from the returns of the three series will shed light on this problem.

Secondly, a variety of prices are commonly used in market studies. There have been studies based upon either transaction prices or closing bid and ask quotations. Keim (1989), for example, states that stock returns used in most empirical financial research are computed with closing bid or ask prices. These may not represent 'true' prices and may introduce measurement errors in portfolio returns if investor buying and selling behaviour displays systematic patterns.

There are many studies which have used transaction prices. The stock returns from the Center for Research in Security Prices at the University of Chicago are widely used in market studies in the USA. These returns are computed using the last transaction price of the day on days when the stock trades.

Cohen et al (1978) conduct their investigation on the effect of thinness in security markets by using both transaction returns and returns based on bid/ask quotations. They argue that studying all the prices is justified in that demand shifts need not trigger transactions, and hence closing transaction prices, unlike closing quotes, need not reflect all current information. They show that the expected quotation and transaction returns are equal, but that drift in the aggregate demand shift process causes the estimator of transaction returns variance to be greater than quotation returns variance.

Some studies use a series created by averaging the buyer and the seller prices. Parkinson's (1984) study of the NSE, for example, used some version of the average price. The price of a share was taken to be the mid-way between the buying and the selling prices. To make the series complete, where only the buying or selling price was available, and therefore the average could not be computed, that price was used. Where only the transaction price was available, then that price was used.

Opong's (1989) study of the London Stock Exchange used Datastream historical prices. These prices are based on the average between the buy and sell prices. He noted that the spread for small and infrequently traded securities could be large and it might introduce noise in the price return observations.

In many of the studies that use the average of the bid and the ask, it is assumed that it is the "true price" since the quoted price is either at the bid or the ask price. Unless both trader have the same subjective variance with regards to the future of the risky asset, the average of the bid and ask prices is either positively or negatively biased from the "true" price according to the relative size of the trader's subjective variances [Jang (1987)].

The above analysis provides reasons for the need to have clear evidence on whether any of the price series is efficient or not. The study of the efficiency of the whole pricing system of the NSE will hopefully also contribute significantly to the understanding of the market micro-structure.

6.2.4 Issues in the interpretation of results

There are several reasons why interpretation of results requires attention. We have observed that there are some particular problems associated with stock market studies of emerging markets. These problems need to be recognised in the interpretation of results. For example, results not consistent with the random walk hypothesis and therefore weak-form efficiency tend not to recognise that problems in the research design may be the cause [Gandhi, Saunders, and Woodward (1980); Yacout (1981); Parkinson (1984)] and not necessarily the possibility that the market is inefficient. There may of course be no incentive to deal with this issue because of the a priori held notion of inefficiency. This position has not been helped by the fact that results tend to have resulted from single studies of particular markets. Keane (1983) argues that for inefficiency to be exploitable it should, among other things, be persistent. This means that any existing inefficiency should also be exploitable in future, and that the market will not learn from the experience. The fact that it is not possible to exploit the market consistently has also been a cardinal point in the definition of market efficiency. Al-Mudhaf (1983), for example, showed that Kuwait Stock Exchange is efficient in contradiction to the results of Gandhi, Saunders, and Woodward (1980). We believe that emerging stock markets have been judged without providing the weight of evidence which proves inefficiency beyond reasonable doubt.

Another issue concerned with interpretation is of those results that claim to be consistent with efficiency. Given the host of problems inherent in undertaking research in emerging markets, should these results be interpreted as strongly as those of developed markets? In this study we have taken the view that efficiency is purely an empirical issue. The results obtained should be viewed in this light. We find no basis for interpreting results, if consistent with efficiency, differently.

Much of the published evidence from emerging markets does not derive from detailed analyses of the price series. In randomness tests, for example, the results are often generalised on the findings of the coefficients of one lag. The results at lag 1 may suggest serial dependence, but it should also be shown whether such dependence is consistent across more lags before a case can be made for or against independence. This study will examine the serial coefficients across 30 lags consistent with Cooper (1982) and Taylor (1986). Many of the studies, both for developed and emerging markets, that have attempted to compute coefficients for more than one lag have failed to apply appropriate statistics for interpreting the joint significance of the results across lags. This fact was recognised earlier by Taylor (1986) and Yong (1987). In contrast to those studies, methodology is presented in the present study appropriate for interpreting results across lags.

6.3 SELECTION OF WEAK-FORM EFFICIENCY TEST MODELS.

In Chapter 4, the various models for testing weak-form efficiency were discussed. This section presents the models which are used in this study, and the basis of their selection.

Taylor (1986, p.14) argues that any model will only be an approximation to the rules which convert relevant information and numerous beliefs and actions into market prices. We found in Section 4.3 that in testing for market efficiency it might be necessary to specify the model that is assumed to hold in the market. Some of the models assumed will be more accurate in describing the market than others. The model chosen should, firstly, be consistent with past prices. Secondly, the hypothesis implied by the model ought to be amenable to rigorous testing so that, in principle, the model is capable of validation. Thirdly, the model should be as simple as possible. Fourthly, the model should provide forecasts for future returns and prices, which are statistically optimal assuming the model is correct. Fifthly, the model can be used to aid rational decision making.

The statistical tests used to test for weak-form efficiency are assumed to be applicable in this market. The trading rules approach was not selected for two reasons. Firstly, as discussed in Chapter 3, short-selling is not allowed on the NSE. Any study wishing to adopt trading rules would have to set up a filter strategy which overcomes this problem. This would require also a specific link of the financial system with the exchange to see how such a mechanism can overcome the technical problem. As Jennergren (1975) has shown, the results might not be worth the effort.

Secondly, if statistical tests tend to support the assumption of independence, then one can conclude that there are no mechanical trading rules or chartist techniques which would make an investor's expected profits greater than they could be if he followed a simple buy-and-hold strategy [Fama and Blume (1966); Niarchos (1971, p. 81)]. This position has been supported by evidence from many of the world's stock exchanges.

The tests of serial independence follow closely those adopted in earlier studies conducted by Fama (1965); Solnik (1973); Cooper (1982); Parkinson (1984). In statistical terms the hypothesis tested is that successive price returns are independent random variables. The basis of the random walk model was presented in chapter 4. The logarithmic form will be used and it was presented in (15) as:

$$\text{Log } P_t = \text{Log } P_{t-1} + u_t$$

that is

$$\text{Log } P_t - \text{Log } P_{t-1} = u_t \tag{34}$$

Where

u_t represents the first difference of log prices and is defined as the change in the logarithm of stock prices, from one point in time t-1 to the time t.

Note that randomness requires the change in returns to be serially independent such that,

$$E\ (u_t) = 0 \tag{35}$$

$$COV\ (u_t, u_{t-k}) = 0\ , \quad k \neq 0 \tag{36}$$

$$COV\ (u_t, u_t) = \sigma_u^2 \tag{37}$$

The logarithmic transformation is justified because,

(a) Absolute price changes suffer the disadvantage that they are to some extent dependent on the actual price level of the stock and

(b) The change in the natural logarithms of the price of a stock is the yield with continuous compounding from holding that stock over the period of time the change is measured [Fama (1965, 1976); Cooper (1982)].

The serial correlation analysis and the runs tests are conducted on the price transformation of all the sample stocks selected as provided in Chapter 7.

6.4 RESEARCH QUESTION AND HYPOTHESES

This section develops the research question and the hypotheses to be tested in the study. For many of the published studies the hypothesis(es) tested are implied but not stated [Fama (1965); Yacout (1981); Parkinson (1987)].

6.4.1 Independence and randomness of share price returns

It was discussed in section 6.2.1 that the issue of whether a market is efficient or not is purely an empirical one. Of particular interest at the weak-form efficiency level is the need to provide more evidence that sheds light on the nature of stock markets in developing countries. Two reasons makes this issue important. The first is the need to challenge empirically the notion held that the pricing systems in emerging stock markets are, a priori, inefficient. Secondly, the literature review has indicated that existing empirical evidence is not clear cut in its support of efficiency at weak-form level. This means that because of the status of the emerging markets they, unlike the developed ones, still attract attention.

This study examines the Nairobi Stock Exchange, an emerging market in a developing country, Kenya. Evidence provided by Parkinson (1984) is not conclusive on the validity of the random walk hypothesis on the NSE. He asserts that, **"there is evidence that prices in the market**

violate the random walk hypothesis, though probably not in the practical sense" (p.302). We believe, therefore, that due to the inconclusive nature of the evidence available and the methodological problems inherent in Parkinson's study, the applicability of the random walk hypothesis and the validity of the EMH at the weak-form level at the NSE should be examined.

The theory of random walk applied to the valuation of stocks says that the future path of individual stock prices is no more predictable than a path of a series of random numbers. Each share of stock is assumed to have an intrinsic value based on investors' expectations of the discounted cash flows generated by that stock. In effect, it is not possible to predict this week's price from last week's stock price. Knowledge of the sequence of the past price returns prior to the current time period is of no help in defining the probability distribution of price returns in any current or future period [Rose (1989)]. In this case, the question which this research attempts to answer with respect to the Nairobi Stock Exchange is the following:

> **Are successive share price returns on the Nairobi Stock Exchange independent random variables so that price returns cannot be predicted from historical price returns?**

This study answer the question by testing the following hypotheses:

H_o: The observed price return series on the NSE is an independent random series.

H_a: The observed price return series on the NSE is not an independent random series.

The aspects being examined in the above Hypothesis are the independence and randomness of the price series. To examine these issues more clearly, the above hypotheses can be separated into three distinct hypotheses.

The first of the hypotheses is designed to test for independence of successive price returns at individual lags by company. It was shown in section 4.5.2 that, if successive price returns are independent then, p_k, the population serial correlation of returns separated by k time periods (lag k) within a time series is zero, hence:

H_o1: $p_k = 0$, i.e. the correlation coefficient of successive price returns on the NSE at lag k is zero.

H_a1: $p_k \neq 0$, i.e. the correlation coefficient of successive price returns on the NSE at lag k is not zero.

The second of the hypotheses is formulated as a test for independence of successive price returns across all lags by company. It was shown in section 4.5.2 that, if successive price returns are independent then, $p_1 = p_2 = \ldots\ldots = p_k = 0$, that is, the population serial correlations coefficients at all lags of the return series are zero, hence:

H_o2: $p_1 = p_2 = \ldots\ldots = p_k = 0$, i.e. the correlation coefficients of successive price returns on the NSE at all lags are zero.

H_a2: The correlation coefficients of successive price returns on the NSE at all lags are not all zero.

The third of the hypotheses is intended to test for randomness of successive price returns by company.

H_o3: The successive price returns of a company's shares on the NSE are random.

H_a3: The successive price returns of a company's shares on the NSE are not random.

To test the above hypotheses only the sample coefficients can be computed and they are assumed to be consistent and unbiased estimates of the true population coefficients.

For Hypotheses 1 the sample serial correlation coefficients, r_k, are computed for each company across 30 lags as in other studies of weak-form efficiency [Cooper (1982); Taylor (1986)]. The individual coefficients are then tested by examining whether their values are consistent with the population value of zero. The level of significance used for interpreting individual serial correlation coefficients results in this study is 5%. A two tailed test is used because the dependence hypothesis does not stipulate the direction of the deviation from randomness. A coefficient is considered statistically significant if it exceeds ± 1.96 of its standard error, $\sqrt{[1/(N - k)]}$, where N is the number of return observations and k is the number of lags. (Results at the 1% level of significance, ± 2.57 of the standard error, are given for comparison purposes.)

Hypotheses 2 requires that one test statistic be used to form an opinion on the results of all 30 lags for individual companies. The decision on individual coefficients looks straight-forward. A significant coefficient means that the series is non-random at that lag. However, obtaining a few significant coefficients at individual lags may not shed much light on serial correlation coefficients of a company computed over many lags, say 10, 20, or 30. To make a decision on the independence of the price series of a company when, for example, 30 serial correlation coefficients are computed over 30 lags requires an overall statistic be used. Taylor

(1986), for example, argues that the binomial distribution may be used to obtain the probability of N or more out of K coefficients being significant at a given level, say 5%, when H_o, the hypothesis of independence, is true. Taylor (1986, p.138) shows that such a test, at 5%, will require numbers K and N_r (N_r represents the number of statistically significant coefficients) for which

$$\alpha(K, N_r) = \sum_{i=N_r}^{K} \frac{K!}{i!(K-i)!}(0.05)^{i}\,(0.95)^{K-i} \simeq 0.05 \qquad (38)$$

Where

α = the probability of obtaining N_r significant coefficients out of K coefficients (in this case, α, equal to 5%).

From this it obtains that H_o is rejected at 5% if the number of significant coefficients (N_r) across all lags 1 to 30 for each company is either equal to or greater than 4, i.e. $N_r \geq 4$

The above statistic may be affected where some coefficients are significant due to chance or are significant, but small in absolute values. Box and Pierce (1970) show that an overall test for a flat serial correlation function can be carried out using the Q-statistic. Under the null hypothesis that all serial coefficients are zero (H_o: $p_1 = p_2 = ... = p_k = 0$), the

Q-statistic (Q_k) is given by:

$$Q_k = N \sum_{j=1}^{k} r_j^2 \qquad (39)$$

Where N is the number of coefficients and r_j = sample serial correlation coefficient at lag j.

The Q-statistic is distributed as Chi-square (χ^2) with k degrees of freedom. The null hypothesis is rejected if Q is greater than χ^2 with k degrees of freedom at the corresponding significant level (α). In this study 30 coefficients will be computed for each company and H_o2 is rejected if $Q_{30} > 43.77$ for $\alpha=0.05$. Taylor (1986); Yong (1987); and Schwert (1990) use this statistic successfully.

Hypothesis 3 is tested by examining sample runs. The existence of fewer runs than expected suggests the existence of a time trend or some bunching of prices due to lack of independence. This is evidence of positive dependency. Negative dependence exists where the actual number of runs is significantly more than the expected number of runs.

It was explained in Section 4. 7. that the test statistic for runs, (V), is computed as:

$$V = \frac{r + \frac{1}{2} - m}{\sigma_m} \qquad (40)$$

Where r is the actual number of runs

m is the expected number of runs and

Where the continuity adjustment requires the addition of $\frac{1}{2}$ to r.

For independence, the standardised variable is normally distributed with mean 0 and variance 1. A 5% level of significance is used. The computed value, V, (labelled Z-value in Tables 8.8, 8.9, and 8.10) is a standardised normal variable and is significant at a 5% level if it lies beyond its critical value of ±1.96.

Results obtained from the Z values also indicate the nature of the dependency. The negative Z value is a sign of positive dependence while a positive Z value is a sign of negative dependence.

6.4.2 Frequency of trading and the size of weak-form efficiency test statistics.

One of the main characteristics of smaller stock exchanges is the existence of a large proportion of shares that are infrequently traded. Granger (1972), Solnik (1973), Jennergren and Korsvold (1975), Samuels (1981), Yong (1987) proposes that the less frequently traded a share the more likely for it to show results not consistent with efficiency. At the weak-form level one would expect to find that the size of the sample serial correlations coefficients and the sample standardised variables for the runs tests would increase as the level of trading frequency decreased. Solnik (1973), for example, argues that the sample serial correlation coefficients for European stocks were on average slightly larger than their USA equivalents due to thinness of the market and discontinuity of trading. Ang and Pohlman (1978) also provided evidence that tended to show higher weak-form efficiency coefficients according to the sophistication of the market. This position has been given prominence by the recent evidence in semi-strong form efficiency tests of abnormal returns observed for small companies (Dimson, 1988), which also characterise developing exchanges. One would therefore expect that statistics from weak-form efficiency tests would also reflect close association with the level of trading in the market. The following hypotheses are tested to examine this relationship:

H_O 4: The size of the sample serial correlation coefficients of the price series on the NSE are independent of the continuity in trading.

H_a 4: The size of the sample serial correlation coefficients of the price series on the NSE are dependent of the continuity in trading.

H_o 5: The size of the absolute sample standardised variables for the runs tests of the price series on the NSE are independent of the continuity in trading.

H_a 5: The size of the absolute sample standardised variables for the runs tests of the price series on the NSE are dependent of the continuity in trading.

The hypotheses are tested to see whether there is a relationship between the sample serial correlation coefficients and the sample standardised variables for the runs tests and the level of trading. The level of trading is measured by the number of share price return observations. The test of the hypotheses is carried out as follows:

The 30 stocks are ranked from 1 to 30 according to:

(a) The number of trading days (with rank 1 for the stock with the most trading days).

(b) the value of the Q statistic of the correlation coefficient for each company over the 30 lags (with rank 1 for the stock with the smallest absolute Q-statistic). The overall serial correlation coefficient statistic (Q-statistic) is used instead of the serial correlation coefficients at individual lags (r_k) because the Q-statistic represents the general results of the r_k test.

(c) the absolute value of the standardised variable for the runs test (with rank 1 for the stock with the lowest absolute standardised variable).

Spearman's rank correlation test are then performed for the rankings of (a) and (b) and (a) and (c).
A rank coefficient, r_s, is given by

$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} \qquad (41)$$

Where d_i is the difference between the two ranked data sets and n is the sample size (Daniel and Terrell, 1989, p.698).

If the computed value of r_s exceeds ± 0.3620 then it can be concluded that there is a relationship between either the level of trading as measured by the number of share price return observations and the sample correlation coefficients or the level of trading and the sample standardised variables for the runs test.

The test approach is similar to those of Jennergren and Korsvold (1975, p.52) and Yong (1987). The test here differs from theirs in that they examined the relationship between the level of trading and efficiency. Such a test can be criticised on at least two counts. Firstly, if the market is weak-form efficient, the expected value of all the coefficients is zero and they therefore cannot be used for ranking. Secondly, whether weak-form efficiency is present cannot be measured on a scale. Our test attempts to circumvent these two difficulties.

The nature of the data for testing these hypotheses is presented in Chapter 7.

CHAPTER 7

METHODOLOGY: DATA AND SAMPLE SELECTION

7.1 INTRODUCTION

This Chapter explains how the database for this study was created and identifies the problems faced in its creation. Some of the problems encountered did not have solutions, but an attempt was made to minimise their impact on the quality of the findings. The criteria and procedures for selecting the sample for this study are also discussed. Finally, the issue of availability of data is addressed.

7.2 IMPORTANCE OF COMPUTERISED DATABASES.

There are gains in research to be derived from having a sound database. The magnificent advances of security market research in the USA have been facilitated by the existence of computerised databases on large number of stocks over a long period of time. It has enabled much light to be thrown on the behaviour of stock market prices. Russell (1972) and Dryden (1969) noted that the absence of comparable historical data in machine readable form on the London Stock Exchange by the turn of the 70's restricted research investigations to those for which a limited amount of data could be reasonably easily extracted from the printed tabulated sources. They were was supported by Solnik (1973) who noted that, at the time of his study, there were few serious tests of the random walk which had been performed on European data **"... probably due to the lack of systematic computerised databases" (p. 1151).**

Solnik was echoing the observations of Dryden (1969) who had noted that the development of research data in the UK. required

> **"a mammoth number of manhours, not to mention computer hours, in order to build up a statistical picture of UK share price behaviour"** (p.49).

The task of gathering data, setting up a database, and ensuring the internal and external validity of its structures for the purpose of market-based research can be a very difficult one indeed. This is more so in developing countries where data may be unavailable or where the persons responsible for such data may not be aware of its importance as a source of research material. Data collection in developing countries is almost always an expensive exercise. This is because of the need to use field staff to collect and code data which adds substantially to the cost per sample.

Russell (1972) writing about the formation of the London Stock Exchange data bank at City University observed:

"Anyone totally unfamiliar with the development of a computer data bank or the state of the art of information storage on London Stock Exchange data in the late 1960's and at the beginning of the 1970's might suppose that, given reliable price information already punched on cards, it was a very simple and straightforward matter to arrange these into readily usable, machine readable form. Anyone familiar with either of these will not be surprised that the task has proved neither simple nor straightforward" (p.638).

One may therefore imagine a situation of this nature with the data for this study sought from the Nairobi Stock Exchange. This study faced the enormous task of first finding data which was kept in manual office files. The next step was to check the completeness of the data. After this the data had to be transcribed into a form that could be used for this and other research work.

There are advantages available to researchers now which were unavailable in the 1970's. The creation of databases in the early 1970's faced particular problems arising from the limitations of the computers of the day. Since then, there have been tremendous development in computer software, and the costs of developing usable database even in developing countries is now manageable. Currently, there are many stock exchanges which have readily available computerised databases [Datastream

International; IFC (1990)]. These are of recent establishment and hence the level of research is still behind that of the USA. These countries are, however, far ahead when compared to the data at present available for some stock exchanges in developing countries where no machine-based database exist. The Nairobi Stock Exchange is a case in point.

The International Finance Corporation (IFC) is one of the few bodies which has a database for emerging markets. The database was the first to provide detailed statistics on the stock markets of developing countries [IFC (1990, p. viii). But even this database is of recent origin. It was began in 1981, but it has only been available on-line from 1987 in America. Unfortunately, the Nairobi Stock Exchange is not one of the exchanges for which total activity data is available. A database for the NSE had therefore to be created. The database for this study was designed in such a manner that it will be possible for it to contribute in the future to the creation of a fully integrated research database for the Nairobi Stock Exchange.

7.3 TYPE OF DATA COLLECTED

Research in securities markets relies heavily on historical data. The data consist primarily of the past series of security prices, earnings and other company or national indices. The NSE has 55 quoted companies which have issued 52 equity (common or ordinary) shares and 18 preference shares up to 31 December 1988. To ensure consistency with other studies, only companies which had issued equity shares are considered. The following data were collected for those companies:

(i) **Share price data**

The share price data collected fell into the following categories.

(a) **Buyers (Bid) prices**

- These represent the prices at which buyers were offering to buy particular shares.

(b) **Sellers (Ask) Prices**

- These represent the prices at which sellers were willing to sell particular shares.

(c) **Transaction prices**

- These represent the prices at which the transactions took place.

The price recording system generating the prices was described in chapter 3.

(ii) **Dividend /Bonus issues data**

Dividend/bonus issues data were collected for all companies over the period January 1979 to December 1988.

(iii) **Par value per share**

- Dividend information is provided as a percentage of par value. The par value information was necessary to determine the amount of dividend declared and paid.

(iv) **Issued ordinary shares**

The issued ordinary shares information was collected from the company reports for use where necessary. For example, it has been used to calculate the market capitalisation in Table 3.1.

(v) **Share price index**

Information on the weekly Nairobi Share Price Index was collected. The basic information was on the closing index at the end of each week.

7.4 DATA SOURCE

Data for this research was obtained from the **NAIROBI STOCK EXCHANGE.** The nature and operations of the exchange were discussed in detail in Chapter 3. The exchange does not have any formal office. Most of its records are maintained by Africa Registrars, a firm of professional company secretaries, who act as the Secretaries to the Exchange. Share price lists used in this study were obtained from them.

Company specific information on issued share capital and dividends was extracted from company files maintained by the Secretaries to the Exchange.

The Secretaries to the Exchange represent the most reliable source of data for share price trading in Kenya. Any information issued by companies, for example, earnings, rights issue, dividends, annual reports and change in nature of operations or management are required to be reported to the Secretaries of the Exchange first before release to the public as per the Stock Exchange rules.

The Secretaries are also responsible for public circulation of share price data. Copies of the share price lists are issued to the Secretaries immediately after the weekly call-over on Thursdays at 12.00 noon, for circulation to other parties. The Secretaries will then release the information to the press. Once released, the information is available for public inspection at any time.

7.5 DATA PREPARATION

It was important that the raw data collected were formulated into a complete and correct database consistent with the objectives and resources of the research. The steps undertaken were the creation of the database and editing of data.

7.5.1 Creating the database.

The source documents for creating the databases were:

(i) The weekly share price lists for the periods January 1979 to December 1988. (An example of the weekly call-over share price list is provided in Appendix 2)

(ii) A data collection form was designed for the purposes of tapping dividend information for companies. An example of the dividend data collection form is provided in Appendix 3.

(iii) A listing of the Nairobi Stock Exchange Index on a weekly basis.

Three computer-based databases were created. These databases were:

(1) **The share price database:**

This database was created to record information relating to the price of shares. The database was designed to give information on, buyer (bid) price, seller (ask) price, transaction price, the company to which the price information relates and the related week of trading.

The database formed was therefore in the form of a DATA MATRIX where the rows of the matrix correspond to a particular company, while the columns correspond to the variables of interest.

(2) **The dividend database:**

The dividend database was created to record the dividend history of the company for a particular year. It was designed to give information on:

- The company
- The week of the year in which the dividends were declared.
- The week of the year in which the prices went ex-div
- The amount of dividend declared as a percentage of par value or the rate of bonus issue.

- The par value of the share. This was necessary to facilitate adjustment of the dividend percentage to value.

(3) **The share price index database:**

The share price index database was created to record the Nairobi Stock exchange index over the study period. The database was designed to give information on:

- The week corresponding to the index.
- The level of the index.

7.6 CODING

The main variables of interest in the study were:

- The various series of prices (Buyer, Seller and Transaction prices)
- The week of activity
- The specific identification of the listed companies
- The dividends declared
- The par value of the various companies
- The issued share capital of each listed company
- The missing variables

To create integrated databases, common variables in the databases were assigned the same codes. The basis of some codes is given below. Specific codes were assigned to the above variables as follows:

TYPE OF VARIABLE	VARIABLE CODE	MISSING VALUE CODE
Company Identity	Companid	-
Week of Activity	Weekcode	-
Buyers price	Buyerpr	999.99
Sellers price	Sellerpr	999.99
Transaction price	Tranpr	999.99
Par value of share	Parvalue	-
Dividend declared	Dividend	999.99
Issued Share capital	Shares	-
Index value	NSEINDEX	9999.99

Companies Codes:

Companies were assigned specific codes from 0010; 0020; 0030; etc. (A list of the quoted companies and their code numbers is presented in Appendix 1).

Code for Week of Activity:

As explained earlier, the exchange was formally inaugurated in January 1954. Weeks of activity were assigned codes, with the first week of January 1954 being weekcode 0001. (For example the week of trading where the prices were released on 22/12/1988 is given weekcode 1825; representing the 1825th week from January 1954). This coding allows for the extension of the databases for future studies covering longer periods. Other variables were given codes convenient for identification purposes in each of the databases created.

7.7 DATA EDITING

The data relevant to a particular study summarise the facts concerning the phenomena under investigation. The data may be quantitative, qualitative, or a mixture of both types. In carrying out any investigation it is important to understand that there may be inherent problems with the data. This is because data very frequently are subject to the measurement and reporting inaccuracies of human behaviour. These errors include observation errors, round-off and approximation errors, hiding of information, and errors of computation [Intriligator (1978)].

Praetz (1976) also points to the importance of ensuring the correctness of databases. He observes that there are many stages at which errors can occur in recorded stock prices. These errors, when they occur, can cause negative first order serial correlation and "fat-tails" in return distributions. If the errors are large they may give misleading results. Taylor (1986) notes that one or two large observations, generally called outliers, can be responsible for apparent skewness.

The tasks described below represent what was done to prevent and detect errors in the databases. This was performed through data editing. Data editing consisted of checking the data before entry and detecting and correcting possible errors that occurred during the data entry process.

7.7.1 Checking the data before entry.

Missing data lists

The first task was to go through all the price lists obtained from the stock exchange and identify whether any were missing. Where share price lists were missing photocopies of the lists were sought from the stock broking firms.

7.7.2 Data entry checks

(i) Manual Checks

Each database was printed and the listing was manually checked against the source documents. Errors identified were corrected. This process involved the use of a team of research assistants consisting of second year accounting majors from the Department of Accounting, University of Nairobi. To minimise errors in the manual check, the research assistants had to demonstrate a basic understanding of the DB3+(R) operations. In addition they were put through a two day training exercise with each document counter-checked by another assistant. The researcher also went through samples of work done. Any assistant with more than four errors per one hundred observations was not hired. The sample checking was repeated several times over the period of the manual check. The assistants systematically went through the database against original records under the supervision of the researcher. The process, although costly, also had the advantage of identifying omitted data, punching errors, and incorrect coding of variables during data entry.

(ii) **Computer based checks**

Manual checks of a database are not likely to eliminate fully all data conversion errors. Computer-based checks were applied to check further on the data. Re-keying the data as a check for data entry errors was considered, but not used because of cost and facilities considerations. Other checks were preferred, and are explained below:

Overall checks

The first of the checks involved processing the database through the SPSS-PC+(R) soft ware. The results obtained were able to show weeks for which data was missing, or price variables which were not consistent with known values (for example, sh. 13.77 instead of sh.13.75, since prices in Kenya are denominated to the nearest five cents), and which were overlooked during the manual check.

Consistency checks

The next check applied was that of assessing consistency of the research data. Within-case checks were performed to ensure the consistency of the data for each company overtime. For example, a sharp change in Buyer price in Week 1 for Company 1 from sh. 20.00 to sh. 40.00 in week 2, and back to sh.21.00 in week 3 would be an odd occurrence for investigation.

Range checks.

There are ranges in which particular prices are expected to fall. The stock exchange provides the high and low of the stock for the year. The price series were compared with these prices and any deviations investigated.

7.8 OTHER CONSIDERATIONS AFFECTING THE DATABASE

In creating and editing the database there were other aspects which had to be considered. These may have an important impact on the accuracy and reliability of the databases. These aspects were:

7.8.1 **Reliability of original data**

Reliability is very much a function of the characteristics of the organisation that produces and publishes data. All the data are collected by organisations. The users of such data cannot take it for granted that care has been exercised in the collection and reporting of information. The problem increases when one depends on other organisations for one's data collection because the researcher has no influence on the organisational procedures that produce the data. The more one relies on particular data the more one needs to know the organisational processes that governed the collection and archiving of information [Jacob (1984)]. The prices recorded on the NSE's weekly call-over are transcribed from manual records available from each broker. With the data originating from several manual sources, there may arise transcription errors which pass unnoticed. A check was made for these type of errors by investigating any price observations that looked exceptional or peculiar. The peculiarities observed were not material and were confirmed with the brokers.

7.8.2 **Manipulation of data**

It is recognised that data may be contaminated by either ideological or organisational values. The data that organisations collect can have favourable or unfavourable consequences for them. In such cases some organisations try to tilt the data collection process in their favour. Palacios (1975), for example, argues that the brokers in the Spanish stock markets failed to disclose the actual amount of transactions to avoid paying higher taxes. He went further to state that Spanish firms disclosed inaccurate financial information in an effort to avoid tax exposure. We are sure that this problem is not unique to Spain and may be a feature of many other small stock exchanges. We do not have factual evidence that share price data or published corporate reports have been contaminated in Kenya. Currently, however, a broker on the NSE is not obliged to disclose any transaction handled exclusively by himself. We may never know whether all transactions are actually reported at weekly call-over sessions. Certainly buyer and seller prices, but not transaction prices, are readily disclosed by the brokers even over the phone. A broker will not answer a question on transaction prices and will refer the questioner to the call-over list. It was taken in good faith that the data available was not subject to organisational manipulation, and represented the true state of the market.

7.9 SAMPLE SELECTION

The sample for this study was selected from the database of the equity securities created above. The sample consisted of the 30 mostly actively traded companies as measured by the number of transaction price observations. To qualify for selection, other criteria applied were:

(i) The equity shares of the company must have been quoted by 1 January 1979 and remained continuously quoted to 31 December 1988.

(ii) Complete dividend history was available for all years of the study period, that is, 1979 to 1988.

(iii) The equity share must have a minimum of sixty observations. This is because the goodness-of-fit tests need a reasonable sample to detect subtle but real differences in the analysis of the data [Praetz and Wilson (1980)].

The year 1979 was selected because Parkinson (1984) had carried out efficiency tests on the Nairobi Stock Exchange for the period 1974 to 1978. This study can be considered in this respect at least as an extension of the Parkinson's work.

The time period was significant in that it gave 10 years of weekly data. This was an attempt to minimise the data problems inherent in other stock market studies in emerging markets [Yacout (1981); Parkinson (1984)]. This meant that for each company there was expected to be a total of 520 weekly price observations.

7.10 THE STRUCTURE OF THE SAMPLE DATA

The data for each of the 30 companies selected is summarised in Table 7.1. The number of returns over the ten year period for each share shown in the Table indicates clear evidence of infrequent trading.

The transaction prices observed for the total sample was 52.7%. The number of price observations improve considerably as one moves to the seller prices where the total observations are 59.43%. For the buyer prices the situation is even better. The total observations are 96.56%.

The availability of data on buyer prices and the thinness of transaction prices is expected given the nature of stock markets in developing countries. In such markets one would expect to find that the key problem is on the supply rather than the demand side [Drake (1985)]. It is expected that there would be many buyers willing to buy any shares coming into the market provided the offer price reflects the true worth of the security. The thinness of transactions may be explained by the problem that investors wishing to transact in the market to change their portfolio position are hampered by the unwillingness of others to offer their securities for sale. The supply side restriction makes it difficult to generate many transactions on the exchange.

TABLE 7.1: SUMMARY OF EXPECTED AND ACTUAL OBSERVATIONS OF THE SHARE PRICE SERIES OF THE NAIROBI STOCK EXCHANGE (1979- 1988). (MISSING OBSERVATIONS ARE ALSO GIVEN IN PERCENTAGES).

		BUYER PRICES			SELLER PRICES			TRANSACTION PRICES		
NAME OF THE COMPANY	EX.OBS	AC.OBS	MISSING	%AGEM	AC.OBS	MISSING	%AGEM	AC.OBS	MISS	%AGEM
020 A. Baumann & Co. Ltd.	520	510	10	1.92	323	197	37.88	152	368	70.77
030 B.A.T. Kenya Ltd.	520	517	3	0.58	181	339	65.19	368	152	29.23
040 Bamburi Portland Cement Co.Ltd.	520	506	14	2.69	431	89	17.12	262	258	49.62
060 Brooke Bond Liebig Kenya Ltd.	520	505	15	2.88	297	223	42.88	371	149	28.65
070 Car and General (Kenya) Ltd.	520	511	9	1.73	431	89	17.12	301	219	42.12
090 City Brewery Investments Ltd.	520	518	2	0.38	69	451	86.73	161	359	69.04
100 Consolidated Holdings Ltd.	520	518	2	0.38	467	53	10.19	308	212	40.77
110 CMC Holdings Ltd.	520	506	14	2.69	392	128	24.62	376	144	27.69
120 Credit Finance Corp Ltd.	520	501	19	3.65	233	287	55.19	195	325	62.50
130 Diamond Trust of Kenya Ltd.	520	517	3	0.58	174	346	66.54	358	162	31.15
160 E. A. Bag & Cordage Co.Ltd.	520	512	8	1.54	457	63	12.12	277	243	46.73
170 E. A. Breweries Ltd.	520	517	3	0.58	423	97	18.65	508	12	2.31
180 E. A. Cables Ltd.	520	501	19	3.65	128	392	75.38	156	364	70.00
200 E.A. Packaging Ind. Ltd.	520	515	5	0.96	343	177	34.04	283	237	45.58
220 E. A. Road Services Ltd.	520	505	15	2.88	404	116	22.31	208	312	60.00
230 Elliot's Bakery Ltd.	520	488	32	6.15	195	325	62.50	172	348	66.92
240 Express Kenya Ltd.	520	500	20	3.85	297	223	42.88	161	359	69.04
250 George Williamson Kenya Ltd.	520	495	25	4.81	299	221	42.50	242	278	53.46
270 ICDC Investment Co. Ltd.	520	504	16	3.08	314	206	39.62	457	63	12.12
290 Kakuzi Ltd.	520	507	13	2.50	389	131	25.19	321	199	38.27
310 Kenya National Mills Ltd.	520	517	3	0.58	427	93	17.88	448	72	13.85
320 Kenya Oil Co. Ltd.	520	454	66	12.69	390	130	25.00	180	340	65.38
340 Kenya Power & lighting Co. Ltd.	520	513	7	1.35	295	225	43.27	398	122	23.46
370 Motor Mart Group Ltd.	520	451	69	13.27	299	221	42.50	166	354	68.08
380 National Printer& Publisher	520	509	11	2.12	344	176	33.85	308	212	40.77
390 National Industrial Credit	520	514	6	1.15	232	288	55.38	270	250	48.08
410 Pan Africa Insurance Co. Ltd.	520	421	99	19.04	260	260	50.00	148	372	71.54
420 Pearl Dry Cleaners Ltd.	520	515	5	0.96	296	224	43.08	173	347	66.73
440 Sasini Tea& coffee Ltd.	520	514	6	1.15	184	336	64.62	201	319	61.35
490 Unga Group	520	503	17	3.27	298	222	42.69	295	225	43.27
Overall Sample	15600	15064	536	3.44	9272	6328	40.57	8224	7376	47.30

KEY:
EX.OBS - Expected number of weeks of price observations.
AC.OBS - Actual number of weeks of price observations.
Missing - Number of weeks of prices not observed.
%AGEM - Percentage of total weeks prices not observed.

This observation is evidenced by the over-subscriptions which accompany many new issues of shares. In fact there are those who believe that the securities markets in many developing countries are investment-based rather than speculative [Yacout (1981)]. This is because the restricted nature of alternative investment opportunities available in such countries makes it important to continue to hold on to shares once purchased. Investors buy securities for investment rather than speculation.

This observation with regard to the Nairobi Stock Exchange is not unique among stock exchanges. Recently, Keim (1989, Table 1, p.78) shows evidence that even on the American exchanges non-trading on certain days may be observed, although it is admittedly minimal.

Jennergren and Korsvold (1975) in their study of the Norwegian and Swedish stock markets had difficulties in obtaining complete series of transaction prices. They faced the problem of thin trading. In some cases they only had 28% of expected price observations even though their sample consisted of the mostly actively traded securities. The data used in their study therefore consisted of price sequences of different lengths. They did not see this as a major problem and concluded that it was interesting to see the results of efficiency tests from such price sequences.

Cooper (1982) noted that the number of companies quoted on an exchange is not an indicator of the number of securities that are actively traded in the various markets. Control of companies quoted on many exchanges continues to be in the hands of small groups who may have no motivation to trade. In Peru, for example, he noted the number of securities quoted, the volume of transactions, and the number of actual securities accounting for the total volume of transactions was generally very small. Furthermore, those securities which had achieved a wide acceptance from the investing community faced stiff competition from other safer forms of investment. In the Buenos Aires Stock Exchange, for example, there were virtually no new issues and the Government securities market had virtually disappeared. In India, it was noted that, although there are eight stock exchanges, trading occurred very infrequently.

Yacout (1981) faced severe data problems when carrying out his market efficiency studies of the stock exchanges of Nigeria and Egypt. He nevertheless did carry out his tests on the transaction data available. No indication is available from his work on the action he took to minimise the effects of the data problem.

Parkinson (1984) also faced similar problems of data on the NSE but he argued that the advantage to research of using what was available far outweighed the problems.

7.11 DEALING WITH INCOMPLETE PRICE SERIES

Given the incomplete nature of the price series from the exchange and the problems faced by other researchers, the issue arises as to whether it is necessary to take "remedial" action when the observed price series are incomplete. The action is usually aimed at increasing the number of observation which consequently may improve the validity of the findings. Interpolation was considered to be a possible alternative for this purpose. The actual transaction prices could be interpolated linearly for the days when there was no trading. This, however, has its problems. In the use of non-experimental data like share prices it is impossible to replicate the conditions that gave rise to the data, so additional data points cannot be generated [Intriligator (1978)]. This means that even if the data is interpolated there would be no basis for assuming that the interpolated prices represent what would have occurred if there had been transactions.

Secondly, linearly interpolated prices would tend to increase the dependence between successive price returns, that is, reduce the degree of randomness, and perhaps produce misleading results in the tests of efficiency. We noted earlier that Parkinson (1984), for example, did observe significant serial correlation for the companies whose data had been interpolated.

Thirdly, the problem of missing data points is common to many of the studies of the behaviour of share prices. One may even take an extreme view, by stating as Jennergren and Korsvold (1975) did, that weekends and holidays actually represent missing data points, although market studies to date have not attempted to interpolate for them.

No changes were therefore made to the observed price series.

7.12 PRICE SERIES USED IN THE STUDY

As discussed in Chapter 6, this is a study of the three price series: the buyer, the seller, and the transaction price series over a ten year period (1979 - 1988).

The period used is longer than any of the previous periods covered by other studies of emerging markets in Africa and elsewhere [Sharma (1977); Yacout (1981); Parkinson (1984); Yong (1987)]. This means that we are able to obtain many more observations than the previous studies. This, hopefully, may provide stronger evidence for or against efficiency. It will also add to the evidence on behaviour of share prices in small exchanges which, as other studies have noted, are infrequently traded. This was also the motivation of Jennergren and Korsvold (1975) who stated that even though the price series they used were not complete, carrying out the study **"has the advantage that we may investigate price behaviour of stocks with**

different frequencies. However it obviously also reduces the length of the time series available" (p.40).

We may also take comfort from Yule and Kendall (1965) who argued that **"however incomplete the data may be, the investigator must take what he can get and be thankful" (p.xix).**

7.13 ADJUSTMENT FOR DIVIDENDS AND BONUS ISSUES

The prices used in the study were adjusted for any dividend and bonus issues. The prices were adjusted by the full amount of the dividend in the week the shares went ex-div. The adjustments assume that the share price falls by the full dividend amount at the day when it goes ex-div. The full adjustment is made because the actual change is currently unknown. Brealey (1970) argued for adjusting the prices with the after-tax dividend. Some studies do not adjust because such information is not available [Solnik (1973); Conrad and Juttner (1973)].

Bonus issues were adjusted based on the bonus rate declared at the date when the shares go ex-bonus. For example if a two-to-one bonus issue was declared and the share went ex-bonus in week t, the actual closing price of the share in week t was doubled, and the price change between week t and week t-1 was taken to be the difference between the doubled price of week t and the closing price of week t-1. The adjustment reflects the fact that the process of bonus issues represents no change either in the asset value of the company or in the wealth of the individual shareholders.

CHAPTER 8

RESULTS: WEAK-FORM EFFICIENCY TESTS

8.1 INTRODUCTION

In Chapter 4 the various methodologies for testing for weak-form efficiency were discussed. It was shown that tests of this level of efficiency are mainly concerned with showing that successive price returns are independent and random and that these returns are therefore unpredictable. In chapter 6 the hypotheses to be tested were developed. In chapter 7 the data for testing the hypotheses was presented. This chapter provides evidence from tests of weak-form efficiency on the Nairobi Stock Exchange.

8.2 RESULTS OF SERIAL CORRELATION TESTS

It has been explained that the serial correlation coefficient is a useful measure for testing for serial independence of share price returns. In Section 6.2.3 it was shown that it is useful to test for the independence of the three price series: Transaction, Bid, and Ask prices. Using weekly data, the sample serial correlation coefficients have been computed for each of the 30 companies for lags of 1 to 30 weeks. The results of the Transaction, Bid, and Ask price returns are presented in that order. The calculated serial correlation coefficients are to be used to test the following hypotheses:

H_o1: $p_k = 0$, i.e. the correlation coefficient of successive price returns on the NSE at lag k is zero.

H_a1: $p_k \neq 0$, i.e. the correlation coefficient of successive price returns on the NSE at lag k is not zero.

The hypotheses are designed to test independence of successive price returns at individual lags.

H_o2: $p_1 = p_2 = ... = p_k = 0$, i.e. the correlation coefficients of successive price returns on the NSE at all lags are zero.

H_a2: The correlation coefficients of successive price returns on the NSE at all lags are not all zero.

The hypotheses are designed to test independence of successive price returns across all lags for each company.

From Section 6.4, an individual coefficient is significant if it exceeds ± 1.96 of its standard error $\sqrt{[1/(N - k)]}$, where N is the number of return observations and k is the number of lags. (Results at the 1% level of significance,

$\pm$ 2.57 of the standard error, are given for comparison purposes.)

For each company results over all 30 lags are significant if:

(a) the number of significant coefficients (N_r) across all lags 1 to 30 is either equal to or greater than 4, i.e. $N_r \geq 4$, and/or

(b) the computed Q-statistic, Q_k, is greater than 43.77, i.e. $Q_{30} > 43.77$.

Results of serial correlation coefficients using monthly returns from each of the price series are also presented for comparison purposes.

8.2.1 Serial correlation coefficients for transaction returns

The summarised results of the serial correlation coefficients for transaction returns are presented in Table 8.1. The Table shows the serial correlation coefficients at lags 1, 10, 20 and 30. The Table also presents the average serial correlation coefficient, the number of coefficients which are significant at 1 and 5%, and the Q-statistic for each company.

TABLE 8.1: CORRELATION COEFFICIENTS FOR TRANSACTION RETURNS OF THE NAIROBI STOCK EXCHANGE (1979 - 1988) LAGS 1, 10, 20, AND 30

(1)	LAG 1 (2)	10 (3)	20 (4)	30 (5)	AVERAGE SCC TR (6)	NO.COEFFICIENT SIGN AT 1% (7)	SIGN AT 5% (8)	Q-STATISTIC (9)
0020	.0944	.0541	.0408	.1209	-0.0128	0	0	4.8193
0030	-.0212	-.0291	-.0414	.0430	-0.0065	0	1	1.6678
0040	-.0130	-.0807	.0064	.0283	-0.0095	1	1	3.6826
0060	-.0188	-.0930	.0851	.0700	0.0040	0	0	2.7786
0070	.0123	.0436	-.0234	.0740	0.0209	0	0	2.4849
0090	.0408	-.0559	.0407	-.0316	-0.0135	0	0	3.7849
0100	-.0328	.0092	-.0642	.0673	0.0073	1	1	3.2101
0110	.0211	.0337	-.0031	-.0073	0.0042	0	2	2.5531
0120	.0683	.0157	-.0295	.0173	0.0107	0	0	4.3372
0130	-.0321	.0416	.0116	.0487	-0.0002	0	0	1.2015
0160	-.0993	-.1153	-.0712	-.0848	-0.0077	0	0	3.5852
0170	-.0040	.0124	.0128	-.0284	0.0060	1	1	2.1715
0180	-.0168	.0218	.0439	-.0108	-0.0066	0	0	3.1550
0200	-.0293	.0188	-.1402*	-.0120	-0.0058	0	1	3.5236
0220	.0748	-.0105	-.0984	-.0250	0.0019	0	1	3.2983
0230	-.0365	-.0241	.0896	-.0520	-0.0114	0	0	4.3986
0240	-.0568	-.0455	.0030	-.0232	-0.0130	0	1	5.1545
0250	-.0131	.0455	-.0691	-.0637	0.0183	0	2	4.0176
0270	.0080	.0245	.0004	-.0051	0.0036	0	1	1.4540
0290	.0073	-.0044	.0619	.0181	-0.0025	0	0	2.3669
0310	.0867	.0258	-.0120	-.0617	0.0049	0	1	1.8395
0320	-.0483	-.0821	-.0199	-.0079	-0.0062	0	2	5.7031
0340	.0710	.0223	.0130	-.0389	0.0122	0	1	1.8651
0370	.0986	-.0294	.1020	-.1401	-0.0016	0	0	6.2152
0380	-.0685	-.0306	-.0795	-.0837	-0.0058	0	2	3.3955
0390	.0467	.0209	.0006	-.0767	0.0025	0	1	2.5736
0410	.0540	.1124	-.0482	-.0979	-0.0125	0	0	4.4056
0420	-.0278	.1062	-.0750	-.1359	0.0076	0	3	5.5886
0440	-.0888	-.0046	-.0042	-.0443	-0.0011	0	1	3.8216
0490	.1273*	.0047	-.0304	-.0402	0.0080	0	1	2.6624

* coefficient is significant at 5% level
** coefficient is significant at 1% level
c number of significant coefficients are either equal to or greater than 4.

Detailed results of the serial correlation coefficients for all lags are reported in Appendix 4.

Serial correlation coefficients at individual lags

Detailed results for individual lags are reported in Appendix 4. The majority of the serial correlation coefficients [876 out of 900 (97.33%)] are not statistically different from zero at the 5% level of significance. At lag 1, for example, the results indicate that only one coefficient is significant at the 5% level (Company 490). This coefficient of .1273 has very little explanatory power. It can only explain 1.6% of variation of returns at this lag. The results of other lags are similar. No significant coefficients are observed for 12 lags (lags 4, 7, 8, 10, 11, 13, 14, 17, 26, 27, 28, 30). One significant coefficient is observed for 13 lags (lags 1, 5, 12, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25). Two significant coefficients are observed for 4 lags (lags 2, 3, 6, 9). Three significant coefficients are observed for 1 lag (lag 29). These significant coefficients are very small in magnitude.

We can reject the independence hypothesis for individual coefficients for only 24 out of the 900 coefficients at the 5% level (2 out of 900 at the 1% level).

Overall results for individual companies

The serial correlation coefficients results for individual companies over 30 lags are evaluated using two statistics: the number of significant coefficients across the 30 lags and the Q-statistic. The results are discussed in that order.

Results using number of significant coefficients

The number of significant coefficients across the 30 lags for each company are shown in Columns (7) and (8) of Table 8.1. No statistically significant coefficients are indicated for 12 out of the 30 companies at any lag. 13 companies have only one significant coefficient at the 5% level. 4 companies have two significant coefficients. One company has three significant coefficients. These coefficients are widely distributed and do not show any consistent pattern.

The results in Table 8.1 show that no company has either 4 or more significant coefficients. Using the decision rule of $N_r \geq 4$, the hypothesis of independence cannot be rejected for any company for weekly transaction returns.

Results using the Q-Statistic

The Q-statistic computed across 30 lags for each company is shown in Column (9) of Table 8.1. The decision rule is that the coefficient is significant if $Q_{30} > 43.77$. None of the computed statistic exceeds this critical value. In this case the hypothesis of independence of share price returns across all lags cannot be rejected for any company. These results are consistent with those of the $N_r \geq 4$ rule.

These results also confirm the observation that the individual serial correlation coefficients are small in magnitude. This may also be observed from the average coefficients. The average serial correlation coefficients of the companies across the 30 lags are very small. The highest average coefficient is 0.0209 (Company 70) which is not very different from zero.

8.2.2 **Serial correlation coefficients for Bid returns series**

The summarised results of the serial correlation coefficients for bid returns are presented in Table 8.2. The Table shows the serial correlation coefficients at lags 1, 10, 20 and 30. The Table also presents the average serial correlation coefficient, the number of coefficients which are significant at 1 and 5%, and the Q-statistic for each company. Detailed results of the serial correlation coefficients for all lags are reported in Appendix 5.

TABLE 8.2: SERIAL CORRELATION COEFFICIENTS FOR BID RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1, 10, 20, and 30

LAG (1)	1 (2)	10 (3)	20 (4)	30 (5)	AVERAGE SCC BP (6)	SIGN AT 1% (7)	SIGN AT 5% (8)	Q-STATISTIC (9)
0020	-.0026	-.0171	.0327	-.0344	-0.0147	1	1	1.2399
0030	-.0577	.0047	.0148	.0160	0.0045	0	1	0.8995
0040	-.0525	-.0036	-.0114	.0229	-0.0010	1	3	2.3319
0060	.0204	-.0101	.0579	-.0344	-0.0142	1	1	1.2809
0070	-.0665	.0513	.0024	-.0001	-0.0086	0	0	0.7780
0090	-.0397	.0038	.0050	-.0010	-0.0028	0	2	0.9238
0100	-.0983*	-.0003	.0710	-.0061	0.0033	1	2	1.7137
0110	-.0282	.0169	.0299	.0245	0.0092	0	0	0.3111
0120	-.0323	-.0287	-.0093	.0340	-0.0047	0	0	0.7091
0130	-.0208	.0103	.0057	.0038	-0.0052	0	0	0.2173
0160	-.0406	-.0471	.0047	.0738	-0.0024	0	1	1.6001
0170	-.0282	-.0061	-.0905*	.0058	-0.0032	0	1	0.9186
0180	-.0461	.0216	-.0932*	.0184	-0.0148	1	3	2.1582
0200	-.0050	.0226	-.0378	.0607	-0.0057	0	0	1.0749
0220	-.0679	.0106	-.0645	.0101	0.0054	0	1	0.8567
0230	.0034	.0005	.0203	.0028	-0.0012	0	0	0.6201
0240	-.0230	.0115	-.0064	-.0167	-0.0241	3	4 c	3.1894
0250	.0394	-.1661**	-.1020*	.0049	-0.0249	2	3	2.9667
0270	-.0306	-.0419	.0512	-.0446	-0.0235	0	2	1.4995
0290	.0586	.0028	-.0958*	-.0267	-0.0239	0	1	2.0501
0310	-.0415	-.0129	.0108	-.0265	-0.0190	0	0	1.0209
0320	-.0033	-.0237	-.0774	.0355	-0.0223	0	0	2.0464
0340	-.0035	-.0426	-.0061	-.0036	-0.0039	1	1	1.0609
0370	-.0712	-.0208	-.0096	-.0284	-0.0188	0	4 c	2.5276
0380	-.0877*	.0480	-.0053	.0455	0.0048	0	2	1.5580
0390	-.0084	-.1542**	.0412	-.0002	-0.0163	4	8 c	4.9011
0410	-.0118	.0086	-.0476	-.0482	-0.0274	0	0	1.6062
0420	-.0156	-.0065	-.0265	-.1641**	-0.0051	2	2	1.7875
0440	-.0117	-.0041	-.0382	.0022	0.0021	0	2	1.3477
0490	.0099	.0235	.0199	-.0065	0.0081	0	0	0.9014

* coefficient is significant at 5% level
** coefficient is significant at 1% level
c number of significant coefficients are either equal to or greater than 4.

Serial correlation coefficients at individual lags

Detailed results for individual lags are reported in Appendix 5. The majority of the serial correlation coefficients [854 out of 900 (94.89%)] are not statistically different from zero at the 5% level of significance. At lag 1, for example, the results indicate that only two coefficients are significant at the 5% level, but are small in absolute value. The largest, -0.0983 (Company 100), can only explain less than 1% of the variation of the return as resulting from past price changes. The results of other lags are similar. No significant coefficients are observed for 5 lags (lags 3, 11, 12, 13, 23). One significant coefficient is observed for 10 lags (lags 6, 7, 8, 16, 22, 24, 26, 27, 28, 30). Two significant coefficients are observed for 12 lags (lags 1, 4, 5, 9, 10, 14, 15, 18, 19, 21, 25, 29). Three significant coefficients are observed for 1 lag (lag 17). Four significant coefficients are observed for 1 lag (lag 20). Five significant coefficients are observed for 1 lag (lag 2). These significant coefficients are very small in magnitude. We can reject the independence hypothesis for individual coefficients for only 46 out of the 900 coefficients at the 5% level (15 out of 900 at the 1% level).

Overall results for individual companies

The serial correlation coefficients results for individual companies over 30 lags are evaluated using two statistics: the number of significant coefficients across 30 lags and the Q-statistic. The results are discussed in that order.

Results using number of significant coefficients

The number of significant coefficients across the 30 lags for each company are shown in Columns (7) and (8) of Table 8.2. There are no consistent patterns of significant serial correlation coefficients that can be noted for any company. 10 out of the 30 companies do not have any significant coefficient at any lag. 7 companies have only one significant coefficient. 7 companies have two significant coefficients. 3 companies, companies 40, 180, and 250, have three significant coefficients each.

Companies 240, 370, and 390 have either four or more significant coefficients. Using the decision rule of $N_r \geq 4$ for lack of independence, the hypothesis of independence is rejected for each of the three companies. Rejection of independence should, nevertheless, be interpreted cautiously. It was suspected that the extreme values of the returns of these companies could be the cause of the problem. To check if the extreme positive and negative values did contribute to the significant results of companies, the values were eliminated and the serial correlation coefficients recomputed. In all the cases, significant coefficients did not recur. The suggestion of dependence may, therefore, arise from these extreme values.

Results using the Q-Statistic

The Q-statistic computed across 30 lags for each company is shown in Column (9) of Table 8.2. The decision rule is that the coefficient is significant if $Q_{30} > 43.77$. None of the computed statistics exceeds this critical value. In this case the hypothesis of independence of share price returns across all lags cannot be rejected for any company. These results using an overall statistic confirm that the findings under the $N_r \geq 4$ rule above are not clear cut and one should hesitate to reject independence based on the rule alone.

These results also confirm the observation that, overall, very few coefficients are significant at the 1% and 5% levels.

8.2.3 Serial correlation coefficients for Ask returns series

The summarised results of the serial correlation coefficients for the Ask returns series are presented in Table 8.3. The Table shows the serial correlation coefficients at lags 1, 10, 20 and 30. The Table also presents the average serial correlation coefficient, the number of coefficients which are significant at the 1 and 5% levels, and the Q-statistic for each company. Detailed results of the serial correlation coefficients for all lags are reported in Appendix 6.

Serial correlation coefficients at individual lags

Detailed results for individual lags are reported in Appendix 6. The majority of the serial correlation coefficients [872 out of 900 (96.89%)] are not statistically different from zero at the 5% level of significance. At lag 1, for example, the results indicate that only one coefficient is significant at the 5% level, and small in absolute value. The coefficient, 0.1256 (Company 340), can only explain about 1.6% of the variation in returns. The results of other lags are quite similar. No significant coefficients are observed for 10 lags (lags 4, 7, 9, 13, 14, 16, 19, 25, 27, 28). One significant coefficient is observed for 14 lags (lags 1, 2, 3, 8, 10, 12, 15, 17, 18, 20, 21, 22, 23, 24). Two significant coefficients are observed for 4 lags (lags 11, 26, 29, 30). Three significant coefficients are observed for 2 lags (lags 5 and 6). These significant coefficients are very small in magnitude.

TABLE 8.3: SERIAL CORRELATION COEFFICIENTS FOR ASK RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1, 10, 20, and 30

LAG (1)	1 (2)	10 (3)	20 (4)	30 (5)	AVERAGE SP (6)	SIGN AT 1% (7)	SIGN AT 5% (8)	Q-STATISTIC (9)
0020	.0789	.0323	-.0309	-.0430	0.0004	0	1	1.5210
0030	.0277	.0996	-.0237	-.0587	0.0430	0	3	5.9428
0040	.0140	-.0161	-.0067	-.0105	-0.0030	0	0	0.8224
0060	.0693	-.0459	.0172	-.0396	0.0251	0	1	2.4708
0070	.0555	-.0183	.0820	.0478	0.0218	0	0	2.4337
0090	.0803	-.2504	.0677	.1549	0.0450	0	0	14.5376
0100	.0225	-.0553	.0148	.0593	0.0085	0	0	1.4263
0110	.0486	.0031	-.0206	-.0309	0.0051	0	1	1.5609
0120	-.0087	.0301	-.1179	.0086	0.0151	0	0	1.9962
0130	-.0524	-.1104	.0337	.0642	0.0231	0	1	2.6771
0160	.0285	.0579	-.0955*	.0124	0.0088	1	2	2.2891
0170	.0305	.1050*	-.0117	.0255	0.0385	1	3	2.5903
0180	.0284	-.0815	.0076	.0112	0.0079	0	0	3.5309
0200	-.0200	-.0390	.0163	.0620	0.0020	0	1	1.7688
0220	-.0114	-.0057	.0909	.0604	-0.0096	0	0	2.1151
0230	.0232	.0538	-.0377	.0031	0.0246	0	2	4.3166
0240	-.0175	-.0017	-.0196	.0298	-0.0034	0	0	0.7979
0250	-.0789	.0046	.0147	.0086	0.0019	0	1	1.7743
0270	.0938	.0966	-.0231	.0836	0.0594	0	2	5.0392
0290	.0567	.0360	-.0235	-.0915	-0.0053	1	1	2.5414
0310	.0054	.0251	-.0275	.0272	0.0164	0	2	1.6111
0320	-.0884	-.0442	.0036	-.0748	-0.0267	0	0	1.5661
0340	.1256*	.0560	.0275	.0536	0.0413	0	3	3.5164
0370	.0818	.0055	-.0230	.1221*	0.0231	0	2	2.7701
0380	-.0494	.0751	.0371	.0444	0.0378	0	0	2.2895
0390	.0225	.0140	-.0001	.0064	0.0086	0	0	2.3247
0410	-.0750	.0205	.0234	.0569	0.0336	0	0	2.1266
0420	.0062	-.0117	.0079	.1299*	0.0278	0	1	2.7151
0440	-.0051	.0242	-.0035	-.0031	0.0205	0	1	2.9742
0490	-.0166	.0795	.0524	.0835	0.0273	0	0	2.1489

* coefficient is significant at 5% level
** coefficient is significant at 1% level
c number of significant coefficients are either equal to or greater than 4.

We can reject the independence hypothesis for individual coefficients for only 28 out of the 900 coefficients at the 5% level (3 out of 900 at the 1% level).

Overall results for individual companies

The serial correlation coefficients results for individual companies over 30 lags are evaluated using two statistics: the number of significant coefficients across 30 lags and the Q-statistic. The results are discussed in that order.

Results using number of significant coefficients

The number of significant coefficients across the 30 lags for each company are shown in Columns (7) and (8) of Table 8.3. At individual company level, 13 companies out of 30 do not have a significant serial correlation coefficient at any lag. 9 companies have only one significant coefficient across the 30 lags. 5 companies have two significant coefficients. 3 companies have three significant coefficients. The significant serial correlation coefficients are widely distributed and do not show any pattern or consistency across lags. The significant serial correlation coefficients are also small and very few are significant at the 1% level.

No company has either four or more significant coefficients. Using the decision rule of $N_r \geq 4$ for lack of independence, the hypothesis of independence is not rejected for any company for weekly Ask returns.

Results using the Q-Statistic

The Q-statistic computed across 30 lags for each company is shown in Column (9) of Table 8.3. The decision rule is that the coefficient is significant if $Q_{30} > 43.77$. All computed statistics do not exceed this critical value. This means that the hypothesis of independence of share price returns across all lags cannot be rejected for all the 30 companies. The results on the whole are consistent with the findings under the $N_r \geq 4$ rule.

8.2.4 **Serial correlation coefficients for monthly returns**

We noted that the coefficients of weekly returns of the three price series studied were generally small and insignificant. Several studies have examined longer differencing intervals, usually using monthly returns, for evidence of dependence. In this section emphasis is shifted from weekly to monthly returns. The use of monthly returns reduces the number of observation and may weaken the results. It should, nevertheless, provide more evidence for or against randomness for the stock exchange under study. We shall also have evidence to compare with the findings of Parkinson (1987) who used monthly returns to study the same market.

The results of the serial correlation coefficients for monthly returns for the three price series are presented in Table 8.4. The Table shows the coefficients at lag 1, the Q-statistic and the number of significant coefficients at the 5% level. The results of Parkinson (1987) are also presented in Column (11). Detailed results of individual coefficients are reported in Appendix 7.

Results of individual coefficients

The absolute sizes of the individual coefficients seem to be higher than those observed for the weekly data. These results are consistent with Fama (1965). The increase in the size of the coefficients does not necessarily mean that the price returns over longer intervals show more dependence, since it is known that the variability of the coefficients are inversely related to the sample size.

The majority of the coefficients are not statistically significantly different from zero at the 5% level and the hypothesis of independence cannot be rejected for 858 out of 900 coefficients (95.33%) of transaction returns, 866 out of 900 (96.22%) of bid returns, and 866 out of 900 (96.22%) of ask returns. The hypothesis of independence can be rejected for only 42 out of 900 coefficients of transaction returns, 34 out of 900 of bid returns, and 34 out of 900 for ask returns. The significant coefficients are themselves small in absolute value.

TABLE 8.4: SERIAL CORRELATION COEFFICIENTS FOR MONTHLY TRANSACTION, BID, AND ASK RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988)

	TRANSACTION RETURNS			BID RETURNS			ASK RETURNS			PARKINSON 1974-1978
COMPANY NUMBER (1)	SCC AT LAG 1 (2)	SIGN AT 5% (3)	Q-STAT (4)	SCC AT LAG1 (5)	SIGN AT 5% (6)	Q-STAT (7)	SCC AT LAG 1 (8)	SIGN AT 5% (9)	Q-STAT (10)	SCC AT LAG 1 (11)
20	.0270	3	19.3234	-.1684	2	11.0611	.1407	2	12.1501	-.0030
30	-.0556	1	4.5188	-.0041	1	10.5760	.2267	1	16.2885	-.0553
40	-.2128*	1	5.8666	-.1623	2	9.8883	.0276	0	3.5466	-.0815
60	-.0339	2	11.8728	-.2487**	1	5.8518	.0609	3	18.4976	-.2804
70	.0016	0	3.7041	-.1410	1	12.7799	-.0085	0	6.9663	-.2908
90	-.0086	1	10.2736	-.1645	0	7.1795	.1563	0	19.3502	-.0916
100	-.0768	2	10.6012	-.1699	0	5.7892	.1715	2	10.5958	-.4968
110	.1012	0	2.3966	.1034	1	8.0993	.0848	1	8.9104	.1095
120	.1911	3	14.1934	-.1652	1	7.5436	.2753*	3	11.1214	-.0988
130	-.0775	0	1.8161	-.2212*	1	7.0057	.0632	0	11.6555	-.2534
160	-.1442	2	9.1486	-.1312	1	8.5952	.0151	0	5.6109	.0925
170	-.1612	2	10.1320	-.0035	3	12.1987	.0123	2	8.6223	.0182
180	-.1342	0	11.9516	-.0993	1	8.3066	-.0465	0	9.6062	-.0235
200	.0061	3	7.5637	-.1139	0	10.3376	-.0278	2	8.6817	.0932
220	-.0418	2	12.5571	-.1580	0	5.7196	.0303	0	5.8478	.0042
230	-.2375*	1	7.1288	-.0555	3	10.5669	.0458	0	8.7520	-.0565
240	-.0545	0	6.5769	-.0276	3	9.8336	-.0276	0	14.2644	N/A
250	-.0608	0	8.2143	-.1226	0	3.1752	.0398	0	6.7313	.1334
270	-.0460	0	1.2159	-.0454	0	4.7540	.1615	2	16.4945	-.3533
290	-.0398	1	4.5753	-.1122	1	4.6402	.0123	1	11.6222	.0126
310	-.1273	1	6.9687	-.0604	3	10.0137	.0710	2	8.3530	-.1970
320	.2127*	2	12.3795	-.0347	0	13.4251	-.0300	1	9.9236	-.2284
340	.1857*	2	9.9733	-.1490	2	8.6624	-.0051	2	13.4567	.1940
370	.1832	3	15.5889	-.1336	1	7.3034	-.0180	1	14.6422	-.1485
380	-.0961	2	11.3386	-.1149	0	5.9074	.0080	1	8.5942	-.2245
390	-.0832	3	13.4570	-.1129	1	7.1150	-.0235	0	4.1923	.0412
410	-.0508	1	9.5397	-.0544	0	5.1167	-.1567	1	10.6973	-.2452
420	.1042	2	15.1815	-.1015	0	4.3516	-.1003	3	12.9156	-.2279
440	.1375	0	10.6489	-.1038	0	3.7913	-.1017	0	9.0892	-.1645
490	.0236	2	10.4193	-.2794**	3	12.7589	-.0951	1	6.7823	-.0581

* coefficient is significant at 5% level
** coefficient is significant at 1% level
c number of significant coefficients are either equal to or greater than 4.
N/A Not Available

There are differences between these results at lag 1 and those of Parkinson (1984, 1987) for the same market. Although he did not report how many of his companies had significant coefficients, by using the standard error for a sample of 60 observations at lag 1, 17% of the coefficients were significant at 5%. This compares to only 13% for transaction returns (4 out of 30 coefficients), 10% for bid returns, and 3% for ask returns. It should be noted that the standard error in the current study is theoretically $\pm$ (0.1789) compared with $\pm$ (0.2530) for Parkinson (1984). This subjects the current research results to a stricter decision rule, but they still give much more convincing results.

There is also a major difference between the size of the coefficients observed in the two studies. The results presented here indicate very few coefficients over 0.2000 for any of the price series (3, 3, and 2 coefficients for Transaction, Bid, and Ask prices respectively) compared with 9 coefficients for Parkinson (1984). His highest coefficient was -0.4968 compared with -0.2794 for the current study.

Parkinson (1984) did not perform any analysis beyond lag 1. Comparison at other lags is therefore not possible. In section 8.4.3 we examine why Parkinson's results may differ from those of this study.

Overall results for individual companies

As for weekly returns the overall serial correlation results for individual companies are evaluated using two statistics: the number of significant coefficients across 30 lags and the Q-statistic. The results are discussed in that order.

Results using the number of significant coefficients

The number of significant coefficients at the 5% level across the 30 lags for Transaction, Bid, and Ask returns are shown in Columns (3), (6), and (9) of Table 8.4 respectively. No company has either four or more significant coefficients. Using the decision rule of $N_r \geq 4$ for lack of independence, the hypothesis of independence is not rejected for any company for monthly returns.

Results using the Q-Statistic

The Q-statistic computed across 30 lags for each company is shown in Columns (4), (7), and (10) of Table 8.4 respectively. The decision rule is that the coefficient is significant if $Q_{30} > 43.77$. None of the computed statistics for all the three price series exceed this critical value. This means that the hypothesis of independence cannot be rejected for any company when monthly return series are used. The results on the whole are consistent with the findings under the $N_r \geq 4$ rule.

8.2.5 Discussion

The results for the three price series showed some significant coefficients at some lags although they were not significant when examined overall. There may be several sources of these significant individual coefficients. These possible sources are discussed in this section.

The first may be due to the variations in the times at which the prices are recorded. As discussed in Chapter 3 the prices are reported once a week. The reported price may have occurred at any time in that week. These non-synchronised prices may induce autocorrelation in the price series. The returns are supposed to be measured over specific time intervals. When the prices do not occur simultaneously, it follows that we are measuring returns over different time intervals. We might therefore expect returns calculated over these different intervals to have a distribution differing from that of the fixed period returns. This will mean that the variances of the returns will differ as they are calculated over different time lengths [French and Roll (1986), Gibbon and Hess (1981)]. This will in turn affect the serial coefficients since variances are used in their computations.

Secondly, it is possible that, even though rigorous attempts were made to control for all the errors in the database, the prices used had error of original entry from the broker's side. Praetz (1976) shows that this will tend to induce significant serial correlation coefficients in a series. Praetz argues that if a price series has k errors, these affects at most 2k returns. We found in section 8.2.3 that, if the extreme positive and negative values were removed, the significant serial correlation coefficients were eliminated. Eliminating the extreme values, nevertheless, reduces the amount of data and may affects the reliability of the coefficients.

Thirdly, it is possible that the significant serial correlation coefficients are due to chance. When all the coefficients are considered, some will probably suggest significance even when the random walk hypothesis holds. For example, on average 1 out of 20 would then suggest significance at the 5% level. We can therefore expect at least one coefficient to be significant by chance for any of the 30 lags and 30 companies studied. Since all other correlations are close to zero, it suggests that the significant correlations observed at some lags are spurious and due to chance.

Fourthly, even though some serial correlation coefficients are significant when compared with their standard errors, it should be noted that they have very little explanatory power. This low explanatory power is unlikely to be significant from an investor's point of view. In any case as Fama (1965) puts it:

> **" What constitutes a 'minimum acceptable' level of dependence depends on the particular problem that one is trying to solve. For example, one doing statistical work in the stock markets may wish to decide whether dependence in the series of successive price changes is sufficient to account for some property of the distribution of price changes........By contrast the stock market trader has more practical criteria for judging what constitutes important dependence in successive price changes. For his purposes the random walk model is valid so long as the knowledge of past behaviour of the series of price changes cannot be used to increase expected gains.......... Dependence that is important from the trader's point of view need not be important from a statistical point of view" (p.35).**

8.2.6 Serial correlation coefficients for Nairobi Stock Exchange Index.

A share price index is probably one of the most widely used statistical series in market studies. Understanding the series is of importance in market-based studies because of the reliance on the index as a surrogate of the market [Bowman (1983), Roll (1977)]. It was felt necessary to extend the test of randomness to the Nairobi Stock Exchange Index. The structure of the index was explained in Chapter 3.

Results of individual coefficients

The serial correlation coefficients for the NSE Index returns are given at the bottom of Appendix 4. The majority of the coefficients (20 out of 30) are not statistically significant and are very small in magnitude.

Overall results

As for the weekly and monthly returns the overall serial correlation results for individual companies are evaluated using two statistics: the number of significant coefficients across 30 lags and the Q-statistic. The results are discussed in that order.

Number of significant coefficients

The coefficients are significant in 10 out of the 30 lags (Lags 2,3,4,5,9,15,17,18,20, and 30). The largest coefficient of 0.2158 is at lag 3. This coefficient explains 4.66% of the index return variation with respect to past returns. In some instances, a significant coefficient is followed by another significant coefficient. Using the decision rule of $N_r \geq 4$ for lack of independence, the hypothesis of independence of successive index return may be rejected at the 5% level.

Q-statistic

The Q-statistic for the NSE index correlation coefficients is 7.8307 which is less than its critical value of 43.77 at the 5% level of significance. The hypothesis of independence is not rejected. These results also confirm the observation that, overall, the coefficients are small in size.

Significant coefficients at individual lags have been observed when indices have been used in similar studies. Cooper (1982), for example, presents results of the correlation coefficients for 31 stock exchanges including the NSE. For the NSE, the highest coefficient was 0.25 at lag 1. He also found that 8 coefficients were significant at the 5% level. The results obtained here are not therefore materially different.

Stock indices can display more first-lag correlation than individual stocks because of the market factor and thin trading of small companies [Gibbon and Hess (1981)]. This market factor was also noted by King (1966). According to Working (1960) the correlation of first differences of averages in a random chain can induce correlations not present in the original data especially when working with an index. The first order co-efficient will also be biased upwards if the prices used do not occur simultaneously. Brealey (1970), for example, found that the first order serial correlation fell from 0.32 to 0.19 when he used a share price index based on simultaneous price observations. We noted in Section 5.4.8 that the prices reported at the weekly call-over, and which are used to calculate the index, did not occur simultaneously but could have occurred any time during that week. This could cause a timing problem which could be reflected by the non-independence of the index.

Another factor may be that some of the companies included in computing the index are very thinly traded. This would cause a bias in the index resulting in non-randomness. Fisher (1966) showed that infrequent trading causes an index constructed from such share price data to induce positive serial correlation into returns which are calculated from the index and the estimated variance of the returns on the index to be biased downwards.

It should be noted that the significant coefficients may not be material enough to attract profitable trading opportunities from an investment point of view, given the level of transaction costs.

8.2.7 The sign of the serial correlation coefficients

The issue of the sign of the serial correlation coefficients observed in weak-form efficiency tests has gained renewed interest in recent finance literature [Ball and Kothari (1989)]. Current efforts are designed to explaining why certain signs predominate.

For example, in the studies on the New York stock exchange, evidence has revealed the predominance of negative serial coefficients in stock returns. This study does not attempt to seek the reasons for the existence of certain signs of the coefficients of the Nairobi stock exchange returns, but to present evidence of their nature in line with the majority of other previous randomness studies. A positive serial correlation would indicate a tendency for a rise in price at time t-1 to be followed by a further rise at time t. A negative serial correlation would show a tendency for a rise in price to be followed by a price fall at time t and vice versa [Niarchos (1971)].

The results of the signs of the serial correlation coefficients for three price series are presented in Table 8.5. The Table shows numbers of negative and positive coefficients at each lag. The signs of the coefficients of transaction returns are evenly distributed across all lags. 13 lags have predominantly negative and 14 have predominantly positive coefficients.

TABLE 8.5: SUMMARY OF SIGNS OF SERIAL CORRELATION COEFFICIENTS FOR LAGS 1 TO 30 (1979 - 1988)

	TRANSACTION RETURNS		BID RETURNS		ASK RETURNS	
LAG	NEGATIVE SIGN SCC	POSITIVE SIGN SCC	NEGATIVE SIGN SCC	POSITIVE SIGN SCC	NEGATIVE SIGN SCC	POSITIVE SIGN SCC
1	16	14	25	5	11	19
2	16	14	25	5	9	21
3	19	11	20	10	7	23
4	13	17	16	14	9	21
5	12	18	20	10	9	21
6	16	14	18	12	7	23
7	12	18	17	13	7	23
8	18	12	14	16	10	20
9	11	19	17	13	14	16
10	13	17	16	14	12	18
11	17	13	18	12	8	22
12	12	18	17	13	13	17
13	17	13	15	15	10	20
14	11	19	15	15	9	21
15	15	15	17	13	13	17
16	11	19	15	15	11	19
17	15	15	18	12	17	13
18	16	14	19	11	12	18
19	17	13	20	10	15	15
20	16	14	16	14	15	15
21	14	16	16	14	10	20
22	13	17	16	14	14	16
23	14	16	15	15	13	17
24	13	17	19	11	14	16
25	17	13	15	15	15	15
26	15	15	15	15	10	20
27	13	17	11	19	9	21
28	14	16	14	16	9	21
29	16	14	17	13	13	17
30	21	9	15	15	8	22

Key
SCC = Serial Correlation Coefficients

The signs of the coefficients for bid returns are predominantly negative (20 out of the 30 lags). The results are the reverse for ask returns where 26 out of the 30 lags are predominantly positive.

Solnik (1973) argues that the predominance of positive serial correlation coefficients, for example those observed here for ask returns, could be created by slow adjustment to new information. Characteristics such as thin markets and discontinuity of trading across weeks could also explain the existence of the predominating positive signs.

Another factor that may explain the dominance of the positive signs is the market factor identified by King (1966). The serial correlation coefficient for a share will be partly determined by the serial behaviour of the market component and partly by the serial behaviour of the factors peculiar to that share. As the market component is common to all shares, its behaviour, during the sampling period, may tend to produce a common sign for the serial correlation coefficient of all the shares.

Two competing hypotheses have been offered for explaining the existence of negative serial coefficients in returns, for example those observed in this study for bid returns. Summers (1986), De Bondt and Thaler (1987) argue that they result from stock market mispricing, with prices taking long, but subsequently corrected, departures from fundamental values or routinely overreacting to information. Fama (1976) and Chan (1988) argue that they are caused by changing expected returns in an efficient market.

Ball and Kothari (1989) show empirically that negative coefficients in relative returns are due almost entirely to variations in relative risks and therefore expected relative returns, through time. They are able to reject the mispricing hypothesis.

8.3 COMPARISON WITH OTHER STUDIES

The discussion of results would not be complete without comparing them with those of other studies from the developed and developing exchanges.

8.3.1 Studies of developed exchanges

The nature and results of major studies of developed exchanges are discussed in Chapter 5. The results of the majority of those studies were in support of the random walk hypothesis. The results obtained for the serial correlation tests for the NSE compare very well with the findings of studies of these markets. The results of the average serial correlation coefficient for this study does not show any marked difference when compared, for example, with the results of study of the Solnik (1973) of European

Stock Exchanges. These results, all for weekly returns, are given for comparative purposes in Table 8.6:

TABLE 8.6 SUMMARY STATISTICS FOR DEVELOPED EXCHANGES

Country	Sample Size	Average Serial corr.
France	65	-0.049
Italy	30	0.001
UK.	40	-0.055
Germany	35	0.056
Netherlands	24	0.002
Belgium	17	-0.088
Switzerland	17	-0.022
Sweden	6	0.024
USA.	-	-0.038
Kenya	30	0.006

[Partly adopted from Solnik (1973, p.1156, Table 2)]

It may be argued that the results are not comparable as they are for periods earlier than this study, for different sample sizes, and even different time lengths.

The efficient market hypothesis has nevertheless been shown to apply not only when different time periods are considered, but also for different samples and markets [Ang and Pohlman (1978)]. Other comparable statistics may be found in Granger (1972, p.477). The coefficients obtained in the current study were relatively small and insignificant as in the above studies.

8.3.2 **Studies of developing exchanges**

The nature and results of major studies of developing exchanges are discussed in Chapter 5. The results of the majority of those studies were in support of the random walk hypothesis. Several studies, not supporting the hypothesis, were identified to have inherent problems of methodology and data and therefore to be very unreliable. This study's results for the serial correlation tests support the hypothesis of independence, and add to the growing number of such studies from emerging markets. The correlation coefficient of 0.0068 for lag 1 is similar to that of Niarchos (1972) of 0.036 for Greece, Jennergren and Korsvold (1975) of 0.083 and 0.109 for Norway and Sweden respectively, and Al-Mudhaf (1983) of 0.055 for Kuwait. The evidence supports Cooper (1982), whose evidence, although he used index data, represents one of the most robust supports of the random walk hypothesis in developing exchanges.

8.4 RESULTS OF THE RUNS TEST

The serial correlation tests have produced evidence which is consistent with independence of the price series. An alternative test was considered to check the strength of the results and provide evidence on the randomness of the price series. It was stated in Section 4.4.3 that the runs test is suitable as a test for randomness of share price returns series. Its application is appealing in that, unlike the serial correlation test discussed earlier, it is not affected by the extreme values in the return series. The runs test was conducted for the sample of 30 companies of the Nairobi Stock Exchange. The results will be presented for the three price series being studied. The results of the runs test are used to test the following hypothesis:

H_o3: The successive price returns of a company's shares on the NSE are random.

H_a3: The successive price returns of a company's shares on the NSE are not random.

The hypotheses are designed to test randomness of successive price returns. The decision rule used in the runs test was stated in Section 6.3. The computed test statistic (V) is assumed to be normally distributed with mean 0 and variance 1. A 5% level of significance is used. The computed value (labelled Z-value in Tables 8.8 and 8.9) is significant if it beyond the critical values of $\pm$ 1.96.

Results obtained from the Z values also indicate the nature of the dependency. The negative Z value is a sign of positive dependence while a positive Z value is a sign of negative dependence.

8.4.1 Results for runs test for transaction returns

The results of the runs test for transaction returns are presented in Table 8.7, columns (2), (3) and (4). The results show that the actual number of runs is less than the expected number of runs in 14 out of the 30 companies studied. The actual number of runs exceeds the expected number of runs in 14 out of the 30 companies. From the Table it is also to be noted that of the 30 companies in the sample, 14 produced a negative Z value and 14 produced a positive Z value. The results are evenly distributed and are not predominantly in favour of either positive or negative dependency. Two companies (200 and 250) produce the dramatic result of the actual and expected number of runs being equal.

TABLE 8.7: RUNS RESULTS FOR TRANSACTION, BID AND ASK RETURNS

		TRANSACTION RETURNS			BID RETURNS			ASK RETURNS		
COLUMN	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	COMPANY CODE	EXPECTED NO. OF RUNS	ACTUAL NO. OF RUNS	Z-VALUE	EXPECTED NO. OF RUNS	ACTUAL NO. OF RUNS	Z-VALUE	EXPECTED NO. OF RUNS	ACTUAL NO. OF RUNS	Z-VALUE
	20	102	101	-0.1733	193	209	1.7911	153	151	-0.2794
	30	242	243	0.1117	238	253	1.4449	106	104	-0.3506
	40	164	158	-0.8273	188	203	1.7309	210	197	-1.5702
	60	246	243	-0.3334	257	239	-1.7681	185	178	-0.9004
	70	190	181	-1.1489	180	195	1.8366	205	205	0.0000
	90	104	95	-1.5550	144	162	2.6859 *	42	42	0.0000
	100	188	196	1.0383	180	191	1.3893	207	201	-0.7614
	110	238	229	-1.0246	223	209	-1.6223	195	185	-1.2478
	120	130	138	1.2243	253	259	0.6130	101	105	0.6829
	130	238	247	1.0161	262	260	-0.2010	84	89	0.8843
	160	178	176	-0.2628	185	199	1.6506	191	196	0.6658
	170	336	332	-0.3790	231	249	1.7508	211	210	-0.1131
	180	105	111	1.0264	171	177	0.8573	81	74	-1.3758
	200	187	187	0.0000	194	203	1.0396	166	166	0.0000
	220	136	132	-0.6026	207	211	0.5044	154	145	-1.3671
	230	114	122	1.3132	161	151	-1.4780	81	78	-0.5616
	240	101	99	-0.3524	175	162	-1.7989	95	98	0.5989
	250	161	161	0.0000	209	220	1.1891	153	143	-1.5343
	270	296	306	1.0141	252	239	-1.3306	197	191	-0.7477
	290	212	209	-0.3584	219	230	1.1999	198	193	-0.6139
	310	296	304	0.8091	225	235	1.1122	193	191	-0.2617
	320	119	125	0.9621	183	175	-0.9997	180	167	-1.7197
	340	262	250	-1.2918	215	229	1.4673	165	160	-0.7107
	370	103	101	-0.3507	156	165	1.1218	75	84	1.7834
	380	203	222	2.3277 *	261	271	1.0074	192	187	-0.6578
	390	180	203	2.9870 *	233	224	-0.9448	132	122	-1.5922
	410	99	104	0.8791	131	135	0.6668	85	86	0.2004
	420	116	112	-0.6502	157	165	1.1494	139	136	-0.5011
	440	132	146	2.1293 *	192	216	2.5539 *	107	105	-0.3524
	490	192	199	0.8843	180	179	-0.1433	108	102	-1.0879

* Significant at 5% level

These results are very close to those obtained for signs of the serial correlation coefficients. From Table 8.5 it was observed that 14 out of 30 lags had predominantly positive coefficients while 13 had negative coefficients.

There are three significant coefficients for companies, 380, 390, and 440. The coefficients are positive indicating that the actual number of runs exceeds the expected number of runs. This means that the hypothesis of randomness may be rejected for 3 out of the 30 companies.

8.4.2 **Results for runs test for bid returns**

The results of the runs test for bid returns are presented in Table 8.7 columns (5), (6) and (7). The results show that the actual number of runs exceed the expected number of runs in 21 out of the 30 companies examined. The actual number of runs are less than the expected number of runs in 9 out of the 30 companies.

From the Table it is also to be noted that of the 30 companies in the sample, 21 produced a positive Z value and 9 produced a negative Z value. The results are predominantly inclined to negative dependency of bid returns.

These results are very close to those obtained for signs of the serial correlation coefficients. From Table 8.5, it was observed that 20 out of 30 lags had predominantly negative coefficients while 7 had positive coefficients.

There are two significant coefficients for companies 90 and 440. The coefficients are positive, indicating that the actual number of runs exceeds the expected number of runs. This means that the hypothesis of randomness may be rejected for 2 out of the 30 companies.

8.4.3 Results for runs test for ask returns

The results of the runs test for ask returns are presented in Table 8.7 columns (8), (9) and (10). The results show that the actual number of runs is less than the expected number of runs in 21 out of the 30 companies examined. The actual number of runs exceeds the expected number of runs in 6 out of the 30 companies.

From the Table it is also to be noted that of the 30 companies in the sample, 21 produced a negative Z value and 6 produced a positive Z value. The majority of cases therefore show evidence of positive dependency. Three companies (70, 90, and 200) produce the dramatic result of the actual and expected number of runs being equal.

These results are very close to those obtained for signs of the serial correlation coefficients. From Table 8.5 it was observed that 26 out of 30 lags had predominantly positive coefficients while only 1 had a negative coefficient.

8.4.4 Discussion

The computed Z values of the three price series are not significant for the majority of companies at the 5% level. There are nevertheless some significant results. 3 companies have significant Z values for transaction returns and 2 companies for bid returns. This means that we can reject the hypothesis of randomness for 3 and 2 companies for transaction and bid ask price series respectively at the 5% level.

These results are interesting in that, even though the signs of the Z value agree with the trend shown by the serial correlation coefficient, the overall conclusion in support of the random walk hypothesis seem stronger for the serial correlation coefficients than for the runs, especially for transaction returns.

As explained in Section 8.2 we cannot reject the hypothesis of independence for both transaction and ask returns when using the serial correlation coefficient test. The companies which had significant results for the bid returns did not show similar results under the runs test.

The differences between the two results may arise because the runs test is affected more readily by trends than the serial correlation test [Fama (1965)]. Caution is also required when interpreting the results of runs tests. This is because the expected number of runs increases proportionately with the sample size while the standard error increases proportionately with the square root of the sample size (Fama 1965, p.76). This means that a constant but small percentage difference between the expected and actual number of runs will produce higher Z values as the sample size is increased. The significant results of the runs test for some companies are nevertheless not at a level where they may be used to formulate profitable trading strategies when transaction costs are taken into account.

8.4.5 Results for runs test for monthly returns

The results for the monthly returns are presented in Table 8.8 for the three price series. The results are very similar to those of weekly returns. For transaction returns the results indicate that the actual number of runs exceeds the expected number of runs in 18 out of the 30 companies examined. The results are predominantly inclined to negative dependency of transaction returns. Significant results are noted for companies 30 and 380.

TABLE 8.8 MONTHLY RETURNS RUNS TEST Z-VALUES

COLUMN (1)	TRANSACTION RETURNS (2)	(3)	(4)	BID RETURNS (5)	(6)	(7)	ASK RETURNS (8)	(9)	(10)
COMPANY CODE	EXPECTED NO. OF RUNS	ACTUAL NO. OF RUNS	Z-VALUE	EXPECTED NO. OF RUNS	ACTUAL NO. OF RUNS	Z-VALUE	EXPECTED NO. OF RUNS	ACTUAL NO. OF RUNS	Z-VALUE
20	56	54	-0.4704	77	79	0.3913	62	60	-0.4492
30	76	88	2.4378 *	74	72	-0.4380	49	59	2.5231 *
40	77	75	-0.4021	65	72	1.3800	74	67	-1.4242
60	76	72	-0.7955	56	65	1.8820	56	53	-0.6977
70	74	72	-0.4096	63	70	1.3857	78	75	-0.5972
90	60	57	-0.6816	63	69	1.1939	24	28	1.5012
100	76	76	0.0000	77	77	0.0000	79	76	-0.5945
110	79	82	0.5936	64	71	1.3948	72	66	-1.2480
120	67	73	1.2887	75	73	-0.4298	49	47	-0.5045
130	76	79	0.6061	60	68	1.6310	43	42	-0.2716
160	76	77	0.2018	60	70	1.9630 *	75	76	0.2015
170	69	63	-1.3017	70	72	0.4182	73	81	1.6591
180	61	62	0.2269	64	70	1.2040	36	40	1.1889
200	74	71	-0.6121	55	66	2.2028 *	71	62	-1.8869
220	67	70	0.6466	83	81	-0.3943	71	70	-0.2078
230	59	62	0.6874	61	66	1.0616	41	36	-1.3986
240	52	49	-0.7354	66	70	0.8121	54	53	-0.2455
250	72	75	0.6243	65	70	1.0223	57	59	0.4683
270	78	78	0.0000	84	81	-0.6012	60	66	1.3621
290	74	74	0.0000	80	79	-0.1992	74	65	-1.8383
310	79	85	1.1821	64	70	1.2259	73	66	-1.4501
320	54	55	0.2351	43	57	2.8951 *	69	58	-2.3371 *
340	76	76	0.0000	55	64	1.9100	61	61	0.0000
370	57	59	0.4671	58	65	1.4271	49	48	-0.2587
380	76	87	2.2092 *	71	75	0.7971	65	72	1.5327
390	67	73	1.3068	89	81	-1.6677	54	53	-0.2422
410	54	59	1.1976	55	59	0.8850	46	42	-1.0412
420	58	61	0.6951	71	74	0.5952	60	69	2.0570 *
440	65	66	0.2196	74	75	0.2015	43	48	1.3624
490	75	78	0.6103	58	67	1.7933	58	56	-0.4723

* Significant at 5% level

For bid returns the results show that the actual number of runs exceeds the expected number of runs in 23 out of the 30 companies examined. The results are predominantly inclined to negative dependency of bid returns. Significant results are noted for companies 160, 200, and 320. For ask returns the results indicate that the expected number of runs exceed the actual number of runs in 19 out of the 30 companies examined. The results are predominantly inclined to positive dependency of ask returns. Significant results are noted for companies 30, 320 and 420. These results show that the hypothesis of randomness may be rejected for 2, 3, and 3 companies for transaction, bid, and ask price returns respectively. The significant results may arise as explained in Section 8.3.4.

Parkinson's (1984) runs test results for monthly returns are not easily comparable because he did not consider three runs but only two (positive and negative) and ignored the "non-change" runs in his analysis. Nevertheless he rejected the hypothesis of randomness for 28 of the 29 companies included as part of the sample. This compares to 3, 2, and 3 rejected for transaction, bid, and ask price returns respectively in the current study. These different results probably arise from price averaging and the omission of no-change runs from the analysis.

8.5 COMPARISON WITH THE PARKINSON'S STUDY OF THE NAIROBI STOCK EXCHANGE

The nature of Parkinson's (1984, 1987) study of the NSE was discussed in Chapter 5. In section 8.2.4 and 8.4.5. the results of this study and those of Parkinson were compared. The results obtained for both the serial correlation coefficient and the runs analysis differ significantly from those reported by Parkinson for the same market. Parkinson found significant results for the serial correlation coefficient and the runs test which he argued were not consistent with the randomness of the price series. There are particular reasons why the results obtained in this study may differ from those of Parkinson. We attribute these reasons to two main sources: the quality and quantity of data used and the method of analysis.

The quality and quantity of data affects the results in several ways. The first is the issue of the data source. Parkinson used data from only one stockbroker. The structure of the NSE is such that a complete set of market price information is available when all brokers exchange it at the weekly call-over. The price lists of individual brokers are incomplete to that extent. This therefore restricted the amount and quality of the data used in his analysis. This study avoided that problem by obtaining the official price lists of the exchange itself.

The other issue is on the length of period covered. Parkinson carried out his tests over a five years period (1974-1978). Given that the exchange faced high a incidence of infrequent trading, this would have introduced data limitation problems in his study. The problem was probably compounded by the use of monthly return intervals. This means that he could only expect to obtain a maximum of sixty observations which, with thin trading, was not achieved for some of the companies sampled. This study used weekly intervals over a period of 10 years (1979-1988). As a result it had more observations which hopefully tended to improve the results.

Data errors have been identified as possible sources of spuriously significant results for emerging markets. The effort and cost required to achieve high level data accuracy through editing is enormous. Parkinson admits the problems he had in dealing with his data. Cost considerations did not enable him to pursue thoroughly for completeness and accuracy of his data. He does not explain his editing procedures, or how he dealt with suspect data. As discussed in section 8.2.3, extreme values, some probably caused by suspect data, will produce evidence not consistent with randomness. The present study recognised this fundamental problem faced by many previous studies of emerging markets. A detailed plan was set up to create an elaborate database and to ensure a high level of accuracy of the data. This was hopefully rewarded by the increased reliability of the results obtained.

The differing length of periods selected in this study in contrast to Parkinson's may not themselves be sufficient to explain the diversity of results, since the use of monthly returns still gives results which are different from his. The reason may be that Parkinson's study used interpolated data to achieve a uniform number of test observations. This, as shown in Section 7.7, increases dependence between successive terms of price series. His results were in this case biased, and he could have erroneously rejected the random walk hypothesis. This study did not interpolate missing data points and therefore avoided the problems of biased coefficients. Parkinson also failed to include the "non-price change" position in his runs test. The results of Conrad and Juttner (1973, Table 1) show that significant differences may arise between either including or excluding the non-change position. This study made use of all three types of runs expected in a price series. This approach is consistent with Fama (1965).

8.6 FREQUENCY OF TRADING AND THE SIZE OF WEAK-FORM EFFICIENCY TEST STATISTICS.

In Section 6.3 we entered the debate on the relationship between the frequency of trading the size of weak-form test statistics. We stated that the following hypotheses are to be tested with respect to the NSE:

H_o 4: The size of the sample serial correlation coefficients of the price series on the NSE are independent of the continuity in trading.

H_a 4: The size of the sample serial correlation coefficients of the price series on the NSE are dependent of the continuity in trading.

H_o 5: The size of the absolute sample standardised variables for the runs tests of the price series on the NSE are independent of the continuity in trading.

H_a 5: The size of the absolute sample standardised variables for the runs tests of the price series on the NSE are dependent of the continuity in trading.

The hypotheses are tested by computing the rank correlation coefficients (r_s), between the level of trading and the Q-statistic and between the level of trading and the standardised value of the runs statistic (Z-value). The decision rule is that if the computed value of r_s exceeds ±0.3620 then it can be concluded that there is a relationship between either the level of trading as measured by the number of share price return observations and the correlation coefficients or the level of trading and the standardised variables for the runs test.

The results are presented in Table 8.9. The Table shows the computed Spearman's rank correlation coefficient (r_s).

TABLE 8.9: SPEARMAN'S RANK CORRELATION COEFFICIENT FOR THE RELATIONSHIP BETWEEN THE LEVEL OF TRADING AND SERIAL CORRELATION AND RUNS COEFFICIENTS

	TRANSACTION RETURNS r_s	BID RETURNS r_s	ASK RETURNS r_s
Q-STATISTIC	-0.3418	-0.2650	-0.2013
RUNS	-0.0081	0.2645	-0.0590

The results show that there is no significant relationship between the frequency of trading and either the serial correlation or the runs coefficients. It is not possible to support the propositions expounded by Granger (1972) and Samuels (1981) that small stock markets with infrequently traded shares will demonstrate a relationship between weak-form efficiency test statistics and trading frequency.

8.7 DISTRIBUTION OF SHARE PRICE RETURNS

It was suggested in Section 4.7.2 that considerable interest has been generated in the nature of the distribution of the returns of equity shares, especially because of the effect it may have on tests of efficiency. The aim here is to determine whether successive rates of return for the Nairobi Stock Exchange are characterised by a Normal distribution. An important attribute of the normal distribution is that a known proportion of observations fall within a given number of standard deviations from the mean. This study investigates the following question:

Are the returns on shares on the NSE characterised by the normal distribution?

To answer this question the following hypotheses are tested:

H_{o6}: **The returns on shares on the Nairobi Stock Exchange are characterised by the normal distribution.**

H_{a6}: **The returns on shares on the Nairobi Stock Exchange are not characterised by the normal distribution.**

These hypotheses are examined through basic tests of normality. These tests of normality are based on the sample skewness ($\sqrt{\tilde{b}_1}$), sample kurtosis ($\tilde{b}_2$), and the chi-square test of the goodness-of-fit [D'Agostino and Stephens (1986, p.375). The sample skewness ($\sqrt{\tilde{b}_1}$) and sample kurtosis ($\tilde{b}_2$) are the calculated as:

$$\sqrt{\tilde{b}_1} = M_3 / (M_2^{3/2}) \tag{42}$$

$$\tilde{b}_2 = M_4 / \tilde{M}_2^{2} \tag{43}$$

Where

$$M_k = \sum (X_i - \bar{X})^k / n, \; k > 1 \tag{44}$$

and

$$\bar{X} = \sum X_i / T \tag{45}$$

and

$X_1, \ldots\ldots\ldots\ldots X_T$ = a random sample of size T.

If the distribution is symmetric about its mean $\bar{X}$, as in the normal distribution, $E(\sqrt{\tilde{b}_1}) = \sqrt{b_1} = 0$. Values of $\sqrt{\tilde{b}_1} \neq 0$ indicate skewness and so non-normality. For a normal distribution the kurtosis coefficient $E(\tilde{b}_2) = b_2 = 3$. Values of $\tilde{b}_2 \neq 3$ indicate non-normality. Furthermore values of $\tilde{b}_2 > 3$ indicate a distribution with tails thicker than normal, and values of $b_2 < 3$ indicate a distribution with thinner than normal tails.

The chi-square goodness-of-fit test enables the determination of whether the sample data are compatible with the hypothesis that they were drawn from a population that follows the normal distribution. The procedure for carrying out this test is well documented in standard statistical textbooks [Daniel and Terrell (1989, p.604-615)].

The results of these tests are shown in Table 8.10. The results are summarised for each price series as indicated in the Table. Skewness coefficients are shown in columns (2), (6), and (10). Kurtosis coefficients are shown in columns (3), (7), and (11). The chi-square goodness-of-fit test was carried out for the three price series and the (χ^2) for transaction, bid, and ask returns are given in columns (4), (8), and (12) respectively. The critical value of χ^2 for α = 0.05 with 7 degrees of freedom is 14.07. (To compute the chi-square value, the returns of each company were separated into 10 class intervals. 10 groups were chosen because most empirical studies have been using deciles for analysing returns [Dimson (1988)]).

TABLE 8.10: DISTRIBUTION STATISTICS OF NAIROBI STOCK EXCHANGE PRICES 1979-1988

	TRANSACTION PRICES				BUYER PRICES				SELLER PRICES			
	Mean	Skewness	Kurtosis	χ^2	Mean	Skewness	Kurtosis	χ^2	Mean	Skewness	Kurtosis	χ^2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0020	-.491	-.213	.941	31.05371	-.209	-.151	150.704	537.9707	-.109	.090	101.873	293.6559
0030	-.019	-3.112*	77.555	391.6422	.438	6.493*	76.022	522.9661	-.058	-.623*	17.618	110.2032
0040	-.419	-.906*	14.004	145.7593	.360	-1.388*	19.368	451.1390	-.308	-.633*	74.032	331.7690
0060	.051	-.002	153.896	435.3262	.107	-2.478*	67.143	480.5636	.085	2.403*	15.354	143.0097
0070	-.115	-2.357*	24.108	138.8179	-.077	-3.380*	47.325	453.6796	-.041	-3.905*	58.111	247.3615
0090	.569	1.264*	25.153	124.1605	.104	-.317*	58.083	476.9835	1.521	.839*	3.966	28.13032
0100	-.097	-1.372*	27.994	86.31165	-.099	-5.475*	59.720	396.0982	-.074	.638*	17.198	293.6208
0110	.028	.174	54.013	362.8968	.018	-2.022*	146.298	539.2288	.063	-.142	95.631	358.5717
0120	.075	-.248	13.920	132.5263	.031	-3.625*	32.332	417.9308	-.143	-.895*	30.876	157.0278
0130	.243	-.219	55.110	291.7203	.192	-.812*	111.903	583.6980	.527	-.205	43.572	153.0971
0160	-.271	.047	34.528	133.1803	-.183	-3.936*	35.595	351.9198	-.115	.805*	18.251	314.0041
0170	.231	-2.506*	28.623	184.0498	.117	-3.687*	34.938	279.2813	.148	.270*	14.407	339.3863
0180	.052	-.806*	7.080	58.68462	-.237	-4.495*	49.061	497.5624	-.651	-1.627*	22.570	38.35966
0200	.166	-.019	69.670	315.2791	.450	-1.234*	28.497	440.5522	.178	.686*	11.693	208.0496
0220	-.871	-1.969*	32.584	125.5128	-.101	-.793*	68.991	456.5559	-.133	1.245*	12.888	292.5341
0230	.121	-.668*	4.230	113.0638	-.077	-1.592*	55.831	521.9842	.000	.982*	12.887	147.9702
0240	.400	-.305	17.002	94.03579	.157	-1.716*	33.323	432.1331	.093	1.075*	10.904	252.4513
0250	.261	-.645*	5.061	103.4488	.115	-1.287*	30.596	375.3542	.274	6.469*	75.926	270.6760
0270	.135	-.215	100.007	357.7676	.219	.482*	38.895	302.9240	.129	1.067*	12.501	128.9835
0290	.008	-5.613*	72.717	105.9699	.578	1.066*	10.174	371.2654	.026	-.373*	23.605	317.3893
0310	.142	.352	19.643	102.0136	.610	2.937*	31.686	334.3216	.173	1.132*	23.204	300.7278
0320	-.284	.040	11.027	46.19866	1.500	2.691*	19.977	435.2190	-.488	.937*	26.341	239.3845
0340	.085	-2.510*	56.698	281.9066	.463	4.042*	62.363	539.2060	.107	.996*	123.748	364.1546
0370	.574	.695*	19.926	116.5711	.510	-1.119*	29.084	457.8319	.328	4.249*	34.568	237.2572
0380	.112	-.481*	41.494	206.2796	.361	1.657*	32.239	282.4090	.183	2.044*	15.536	203.3677
0390	.174	-4.153*	43.361	125.0722	-.000	-3.571*	34.350	446.3519	.090	-1.439*	62.144	225.1691
0410	-.318	.086	6.352	62.82919	.494	10.753*	191.483	537.2322	-.318	2.542*	72.682	234.9616
0420	.166	.339*	15.660	104.2022	.221	-1.221*	37.362	472.4518	.204	.381*	21.216	162.7964
0440	.341	.752*	8.058	78.57576	.202	-6.006*	96.394	377.4753	.304	-.162	44.892	150.3698
0490	.181	-.188	7.226	94.58007	.121	-1.840*	11.757	399.1820	.129	1.189*	13.564	205.8417

* SIGNIFICANT AT 5% LEVEL

8.7.1 Skewness coefficients

It was stated above that the expected value of $\sqrt{b}$ is equal to zero for a normal distribution. The analysis of results shows significant departures from normality as shown by the computed sample values. From Table 8.12, 17, 29, and 26 companies show significant skewness for transaction, bid, and ask returns respectively. Returns are negatively skewed for 21, 22, and 10 companies respectively. Returns for all other companies are positively skewed. We may reject the normal distribution as a description of the distribution of returns.

The results shown by the skewness statistic suggest that the tails of the return distributions taper off in a positive direction from the mean. These results therefore suggest that the returns cluster around very small values, although there are some very large observed values.

8.7.2 Kurtosis coefficients

The analysis of results shows significant departures from normality as indicated by the computed kurtosis coefficient. Returns of all companies show significant positive kurtosis and in all these are quite high. We may reject the normal distribution as a description of the distribution of returns.

The results shown by the kurtosis coefficients indicate that the returns of the Nairobi Stock Exchange are leptokurtic and their distributions have thicker tails than would be expected from a normal distribution.

8.7.3 Chi-square coefficients

The computed χ^2 coefficients of are all greater than their critical values. The hypothesis of normality is rejected for all companies in the sample and for the three price series. These results are consistent with those of the skewness and kurtosis coefficients.

These types of results were observed by Jennergren and Korsvold (1975), who noted that thinness was a contributing factor. Where there are often several weeks between price changes in a thin market, the data may become contaminated through the mixing of different distributions. This means that the populations of price returns being used are not the same because of the interval of trading weeks between transactions. We noted in Section 6.7.3 that it is not only the difference in transaction periods that might cause thick tails in the distribution, but also the variations in times at which the prices are recorded. Prices recorded at different times should show a greater degree of dispersion than those recorded at the same time because of the diversity of the information that is likely to induce price changes.

As explained earlier, the prices used in this study may have occurred at any time during the week other than the call-over date. The returns would therefore not be drawn from a single homogeneous universe and if changes in certain days in that week display higher dispersion than on other days, it would be quite possible for the combined distribution to be characterised by fat tails.

Another reason for the results not conforming with the normal may be that the distribution of the returns is non-stationary, so that the dispersion and even the central tendency shifts periodically. The non-stationary nature of returns is acknowledged because they are economic time series [Granger and Morgenstern (1964)].

The results are consistent with those of Praetz and Wilson (1980) on weekly series of share price and indices returns in Australia. The rejection of the normality of the distribution of share price returns is also consistent with Fama (1965). The observed results indicate that the empirical distribution of the returns are not consistent with the normal distribution. Fama (1965) concluded that the distribution of price returns conform to the Stable Paretian distribution with characteristic exponent less than 2. Praetz (1980) argues that returns conform better to the Student t-distribution than to either the Normal or Stable Paretian. Kon (1984) argues that the discrete mixture of normal distributions model has more descriptive validity than the Student model in explaining the observed significant kurtosis and skewness in the distributions of returns.

CHAPTER 9

SUMMARY AND CONCLUSION

This is a study of the Nairobi Stock Exchange. The main issue investigated was whether the behaviour of the price series in the market is consistent with the weak-form of the EMH. Performing the tests and understanding the results required the carrying out of several integrated tasks. These tasks were presented in chapters 2 to 8 of this study.

It has been suggested that the issue of whether a market is information-efficient or not is purely an empirical one. Of particular interest at the weak-form efficiency level is the need to provide more evidence that sheds light on the nature of stock markets in developing countries. Two reasons made this issue important. The first was the need to challenge empirically the notion held that the pricing systems in emerging stock markets are, a priori, inefficient. Secondly, the literature review had indicated that existing empirical evidence was not overwhelming in its support of efficiency at weak-form level. This was particularly relevant for the Nairobi Stock Exchange because evidence provided by Parkinson (1984) was not conclusive on the validity of the random walk hypothesis on the NSE.

9.1 SUMMARY OF RESULTS

This research attempted to answer the following question with respect to the Nairobi Stock Exchange:

Are successive share price returns on the Nairobi Stock Exchange independent random variables so that price returns cannot be predicted from historical price returns?

This study answered the question by testing the following null hypotheses:

H_o1: $p_k = 0$, i.e. the correlation coefficient of successive price returns on the NSE at lag k is zero.

The hypothesis was tested by using serial correlation coefficients. Results from the individual serial correlation coefficients indicated that majority of them were not statistically different from zero at the 5% level of significance. These results were robust for both weekly and monthly returns, and for all the three price series studied. The few significant coefficients were seen to be small in absolute value with very little explanatory power.

H_o2: $p_1 = p_2 = \ldots\ldots = p_k = 0$, i.e. the correlation coefficients of successive price returns on the NSE at all lags are zero.

The hypothesis was tested using two tests of significance of serial correlation coefficients across all lags: a binomial test and the Q-statistic test. Results based upon correlation coefficients across all lags for each company showed that in the majority of cases they were consistent with the independence hypothesis. When the binomial test was used, three companies showed significant results for weekly bid returns. Further checks on these few companies showed that the inconsistency with the independence hypothesis might have resulted from the effects of extreme values in returns. The Q-statistics gave results which were consistent with the hypothesis of independence.

H_o3: The successive price returns of a company's shares on the NSE are random.

The hypothesis was tested using the runs test. The results of the runs test indicated that the price series of the majority of companies are random. Some results inconsistent with the randomness hypothesis were observed for three and two companies for transaction and bid returns respectively. This might be expected, given that the runs tests may be affected by thin trading. The overall results were consistent with those of the independence tests. The "acceptance" of these three null hypotheses provides evidence of consistency with the weak form of the EMH.

The relationship between the frequency of trading and the size of weak-form efficiency tests statistics was examined by testing the following null hypotheses:

H_O 4: The size of the sample serial correlation coefficients of the price series on the NSE are independent of the continuity in trading.

H_O 5: The size of the absolute sample standardised variables for the runs tests of the price series on the NSE are independent of the continuity in trading.

Spearman's rank correlation tests were performed between the rankings of frequency of trading and the computed values of the Q-statistic of the serial correlation coefficients, and between the rankings of frequency of trading and the Z-value of the runs test respectively. Acceptance of the null hypothesis would suggest that no relationship between frequency of trading and the size of the sample statistics exists. The null hypothesis could not be rejected. The results are not supportive of the held notion that small stock markets with infrequently traded shares will demonstrate a relationship between the size of weak-form test statistics and trading frequency.

Finally, the nature of the distribution of the successive price returns of the NSE was examined by testing the following null hypothesis:

H_{06}: The returns on shares on the Nairobi Stock Exchange are characterised by the normal distribution.

This hypothesis was examined by tests of normality based on the sample skewness ($\sqrt{b_1}$), sample kurtosis (b_2), and the chi-square test of the goodness-of-fit. Acceptance of the null hypothesis would imply that the normal distribution is a good descriptor of the distribution of returns on the NSE. The distributional evidence obtained was against acceptance of the null hypothesis that the returns of the price series of the NSE are normally distributed. The evidence showed high levels of skewness and leptokurtosis of the returns, and the chi-square test indicated significant departure from normality for all companies.

The independence of the NSE-Index was tested. It was concluded that the index exhibited results not consistent with the independence hypothesis. This was observed to be an expected result in an index which is constructed from prices which do not occur simultaneously and which includes securities which are thinly traded.

Overall, this study provides evidence that small markets, such as the NSE, may provide empirical results consistent with weak-form efficiency. The evidence holds for the NSE irrespective of the nature of the price series used in conducting the market study. These results do not categorically say that the market is weak-form efficient, but rather that the results do not contradict the weak-form of the EMH. As has been the case with developed markets, many more studies would have to be carried out for this market covering longer time intervals, and using a variety of methodologies, for a strong conclusion to be made on the weak-form efficiency.

9.2 IMPLICATIONS OF THE STUDY

The current study will have implication for the following interested parties:

9.2.1 Investors

The conclusions of this study imply that an investor is not capable of consistently outperforming the market if he uses the information contained in past prices of stocks. The small amount of dependence noted in some stocks is of no value when it is recognised that there are inherent costs of transacting in the market. This means that the investor can accept the prices as given and direct his attention to selecting a well diversified portfolio instead of spending resources vainly to seek out mispriced securities.

9.2.2 **Regulator and stock market administrators**

The results obtained from the analysis would signal that for the majority of stocks the market should be taken to be a reliable price setter at least to the extent of using past price information. The key notion held by the majority of stock market administrators and regulators is that the market is not a reliable price setter and that it is easy, unless they hold a tight reign of control, to fool the market. The evidence provided here does not lend any support to these beliefs. This means that they can re-direct their efforts to the second major issue in this market: the structural review necessary to increase the level of trading and activity of the exchange. This will improve the structural efficiency of the exchange and make it more attractive to investors. Our reviews in Chapter 2 and 3 provided the basis on which this could be achieved.

9.2.3 **Researchers**

It has become apparent that carrying out research in developing countries may be a problematic exercise. There are nevertheless rewards for this effort. One is the knowledge that research methodology adopted from developed markets may be adapted to emerging markets. The other is the challenges raised to existing methodology by the inherent problems of the research environment in developing countries.

9.3 LIMITATION OF THE RESEARCH

Methodological limitations of weak-form efficiency studies were addressed in Chapter 4. In addition to those limitations the following require attention. The results discussed and the conclusion drawn are based upon the specific securities in the sample. Thus they can only be generalised to and representative of, the firms sampled.

The interpretation of results of this research is restricted by the nature of the data. We noticed that for some companies the data used was thin. The results obtained will have to be viewed in the light that, even though they do not contradict the EMH, conclusions drawn from them should be treated with caution.

The unavailability of data in computerised form meant that setting up the database restricted the time and resources available to carry out more detailed analyses than those presented.

9.4 FUTURE RESEARCH

From the analysis of this study we propose that future research should include the following:

(a) Performance of more weak-form efficiency tests with stronger or improved methodology. Where results are not consistent with the EMH, studies should be replicated and also performed over different time periods.

(b) The findings indicated that the nature of the signs of the correlation coefficients in this market is unclear. This should be established.

(c) Results on the distribution of returns on the NSE suggested that they are not normally distributed. The nature of the distribution underlying returns in this market should be investigated.

(d) Research into higher levels of efficiency (semi-strong and strong-form) should be undertaken.

(e) There should be attempts to undertake research that establishes clearly the nature of the relationship between economic and information efficiency.

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APPENDIX 1 NAIROBI STOCK EXCHANGE: LIST OF QUOTED COMPANIES AS AT 31 .12. 1988

COMPANY CODE	NAME OF COMPANY
0010	African Tours and Hotels Ltd.
0020	A. Baumann & Co. Ltd.
0030	B.A.T. Kenya Ltd.
0040	Bamburi Portland Cement Co.Ltd.
0050	Barclays Bank Kenya Ltd.
0060	Brooke Bond Liebig Kenya Ltd.
0070	Car and General(Kenya)Ltd
0080	Carbacid Investments Ltd
0090	City Brewery Investments Ltd
0100	Consolidated Holdings Ltd
0110	CMC Holdings Ltd
0120	Credit Finance Corp Ltd
0130	Diamond Trust of Kenya Ltd
0140	Dunlop Kenya Ltd
0150	Eaagads Ltd
0160	E. A. Bag & Cordage Co.Ltd
0170	E. A. Breweries Ltd (Kenya Breweries Ltd.)
0180	E. A. Cables Ltd
0190	E. A. Oxygent Ltd
0200	E. A. Packaging Industries Ltd
0210	E. A. Portland Cement Co. Ltd
0220	E. A. Road Services Ltd
0230	Elliot's Bakery Ltd
0240	Express Kenya Ltd
0250	George Williamson Kenya Ltd
0260	Hutching Biemer Ltd
0270	ICDC Investment Co. Ltd
0280	Jubilee Insurance Co. Ltd
0290	Kakuzi Ltd.
0300	Kapchorua Tea Co. Ltd.
0310	Kenya National Mills Ltd.
0320	Kenya Oil Co. Ltd.
0330	Kenya Orchads Ltd.
0340	Kenya Power & Lighting Co. Ltd
0350	Limuru Tea Co. Ltd.
0360	Marshalls(E.A) Ltd.
0370	Motor Mart Group Ltd.
0380	National Printer& Publisher
0390	National Industrial Credit
0400	Ol Pejeta Ranching Ltd.
0410	Pan Africa Insurance Co. Ltd.
0420	Pearl Dry cleaners Ltd.
0430	Philips International ltd.
0440	Sasini Tea& coffee Ltd
0450	Sofar Investment Ltd
0460	Theta Group Ltd
0470	Timsales(A)
0480	Timsales(B)
0490	Unga Group
0500	Kenya Finance Corporation
0510	Kenya Commercial Bank
0520	Chancery Investments Ltd.
0530	Kenstock Ltd.
0540	Kenya Co-operative Cremaries Ltd.
0550	Kenya Hotels Ltd.
0560	Kenya Planters Co-operative Union

APPENDIX 2 NAIROBI STOCK EXCHANGE: WEEKLY CALL-OVER SHEET

NAIROBI STOCK EXCHANGE: WEEKLY CALL-OVER SHEET DATE:

COMPANY CODE	NAME OF COMPANY	PAR VALUE OF SHARE	BUYERS	SELLERS	SALES
0010	African Tours and Hotels Ltd	Ord 20/-			
0020	A. Baumann & Co. Ltd	Ord 5/-			
0030	B.A.T. Kenya Ltd	Ord 10/-			
0040	Bamburi Portland Cement Co.Ltd	Ord 5/-			
0050	Barclays Bank of Kenya Ltd	Ord 10/-			
0060	Brooke Bond Liebig Kenya Ltd	Ord 10/-			
0070	Car and General(Kenya)Ltd	Ord 5/-			
0080	Carbacid Investments Ltd	Ord 5/-			
0090	City Brewery Investments Ltd	Ord -/50			
0100	Consolidated Holdings Ltd	Ord 5/-			
0110	CMC Holdings Ltd	Ord 5/-			
0120	Credit Finance Corp Ltd	Ord 5/-			
0130	Diamond Trust of Kenya Ltd	Ord 4/-			
0140	Dunlop Kenya Ltd	Ord 5/-			
0150	Eaagads Ltd	Ord 1/25			
0160	E. A. Bag & Cordage Co.Ltd	Ord 5/-			
0170	E. A. Breweries Ltd	Ord 10/-			
0180	E. A. Cables Ltd	Ord 5/-			
0190	E. A. Oxygent Ltd	Ord 5/-			
0200	E. A. Packaging Industries Ltd	Ord 5/-			
0210	E. A. Portland Cement Co. Ltd	Ord 5/-			
0220	E. A. Road Services Ltd	Ord 5/-			
0230	Elliot's Bakery Ltd	Ord 10/-			
0240	Express Kenya Ltd	Ord 20/-			
0250	George Williamson Kenya Ltd	Ord 5/-			
0260	Hutching Biemer Ltd	Ord 5/-			
0270	ICDC Investment Co. Ltd	Ord 5/-			
0280	Jubilee Insurance Co. Ltd	Ord 5/-			
0290	Kakuzi Ltd.	Ord 5/-			
0300	Kipchorua Tea Co. Ltd.	Ord 5/-			
0310	Kenya National Mills Ltd.	Ord 5/-			
0320	Kenya Oil Co. Ltd.	Ord 5/-			
0330	Kenya Orchads Ltd.	Ord 5/-			
0340	Kenya Power & Lighting Co. Ltd	Ord 20/-			

0350	Limuru Tea Co. Ltd.	Ord	20/-			
0360	Marshalls(E.A) Ltd.	Ord	5/-			
0370	Motor Mart Group Ltd.	Ord	5/-			
0380	National Printer& Publisher	Ord	5/-			
0390	National Industrial Credit	Ord	5/-			
0400	Ol Pajeta Ranching Ltd.	Ord	4/-			
0410	Pan Africa Insurance Co. Ltd.	Ord	5/-			
0420	Pearl Dry cleaners Ltd.	Ord	5/-			
0430	Philips Harrison & Crossifield	Ord	20/-			
0440	Sasini Tea& coffee Ltd	Ord	5/-			
0450	Sofar Investment Ltd	Ord	2.50			
0460	Theta Group Ltd	Ord	1/-			
0470	Timsales(A)	Ord	20/-			
0480	Timsales(B)	Ord	20/-			
0490	Unga Group	Ord	5/-			
0500	Kenya Finance Corporation	Ord	10/-			
0510	Kenya Commercial Bank	Ord	5/-			
0520	Chancery Investment Ltd.	Ord	10/-			
0530	Kenstock Ltd	Ord	5/-			
0540	Kenya Co-operative Cremaries	Ord	5/-			
0550	Kenya Hotels Ltd.	Ord	5/-			
0560	Kenya Planters Co-operative	Ord	5/-			

APPENDIX 3 NAIROBI STOCK EXCHANGE: DIVIDEND CODING SHEET

NAIROBI STOCK EXCHANGE: DIVIDEND CODING SHEET YEAR 19

COMPANY CODE	NAME OF COMPANY	PAR VALUE OF SHARE	WEEK CODE	DIVIDEND 1	WEEK CODE	DIVIDEND 2	WEEK CODE	DIVIDEND 3	WEEK CODE
0010	African Tours and Hotels Ltd								
0020	A. Baumann & Co. Ltd								
0030	B.A.T. Kenya Ltd								
0040	Bamburi Portland Cement Co.Ltd								
0050	Baclays Bank Kenya Ltd								
0060	Brooke Bond Liebig Kenya Ltd								
0070	Car and General(Kenya)Ltd								
0080	Carbacid Investments Ltd								
0090	City Brewery Investments Ltd								
0100	Consolidated Holdings Ltd								
0110	CMC Holdings Ltd								
0120	Credit Finance Corp Ltd								
0130	Diamond Trust of Kenya Ltd								
0140	Dunlop Kenya Ltd								
0150	Eaagads Ltd								
0160	E. A. Bag & Cordage Co.Ltd								
0170	E. A. Breweries Ltd								
0180	E. A. Cables Ltd								
0190	E. A. Oxygent Ltd								
0200	E. A. Packaging Industries Ltd								
0210	E. A. Portland Cement Co. Ltd								
0220	E. A. Road Services Ltd								
0230	Elliot's Bakery Ltd								
0240	Express Kenya Ltd								
0250	George Williamson Kenya Ltd								
0260	Hutching Biemer Ltd								
0270	ICDC Investment Co. Ltd								
0280	Jubilee Insurance Co. Ltd								
0290	Kakuzi Ltd.								
0300	Kipchorua Tea Co. Ltd.								
0310	Kenya National Mills Ltd.								
0320	Kenya Oil Co. Ltd.								
0330	Kenya Orchads Ltd.								
0340	Kenya Power & Lighting Co. Ltd								
0350	Limuru Tea Co. Ltd.								

0360	Marshalls(E.A) Ltd.								
0370	Motor Mart Group Ltd.								
0380	National Printer& Publisher								
0390	National Industrial Credit								
0400	Ol Pajeta Ranching Ltd.								
0410	Pan Africa Insurance Co. Ltd.								
0420	Pearl Dry cleaners Ltd.								
0430	Philips Harrison & Crossifield								
0440	Sasini Tea& coffee Ltd								
0450	Sofar Investment Ltd								
0460	Theta Group Ltd								
0470	Timsales(A)								
0480	Timsales(B)								
0490	Unga Group								
0500	Kenya Finance Corporation								
0510	Kenya Commercial Bank								
0520	Chancery Investment Ltd.								
0530	Kenstock Ltd.								
0540	Kenya Co-operative Creamaries								
0550	Kenya Hotels Ltd.								
0560	Kenya Planters Co-operative								

APPENDIX 4: SERIAL CORRELATION COEFFICIENTS FOR TRANSACTION RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1 to 30 DIFFERENCING INTERVAL 1

LAG	1	2	3	4	5	6	7	8	9	10
0020	.0944	-.0326	-.0188	-.0765	-.0232	.0665	-.0921	-.1329	.0701	.0541
0030	-.0212	-.1231*	-.0196	-.0806	-.0202	-.0424	.0686	-.0053	.0440	-.0291
0040	-.0130	.0382	-.0505	-.0940	-.0159	-.0915	-.0183	.0120	-.0079	-.0807
0060	-.0188	.0848	-.0755	.0033	.0224	-.0019	.0197	.0732	-.0134	-.0930
0070	.0123	.0286	-.0568	.0291	.0017	.0730	.0090	.0468	-.0093	.0436
0090	.0408	-.0190	-.1104	-.0128	-.0593	.0149	.0130	-.0530	.0329	-.0559
0100	-.0328	.0000	-.0211	.0721	.0537	-.0292	.0098	.0471	-.1565**	.0092
0110	.0211	-.0033	.0162	.0357	-.0024	-.0556	-.0537	.0212	.0475	.0337
0120	.0683	.0665	.1239	.0123	-.0184	-.0315	-.1092	.0350	.0653	.0157
0130	-.0321	-.0085	-.0507	.0199	.0048	.0082	-.0439	.0147	.0162	.0416
0160	-.0993	.0335	-.0822	.0749	.0138	-.1015	.0355	-.0367	.0635	-.1153
0170	-.0040	-.0368	-.1748**	-.0842	-.0325	-.0259	.0331	-.0022	.0652	.0124
0180	-.0168	-.0396	-.0366	-.1092	.0862	.0835	-.0465	-.0581	-.0715	.0218
0200	-.0293	-.0001	-.0061	-.0211	.0216	-.0285	.0671	-.0004	-.0193	.0188
0220	.0748	-.0819	.1429*	-.0397	.0382	-.0554	.0045	-.0066	.1306	-.0105
0230	-.0365	-.0767	-.0422	.0157	.0902	.0560	-.1141	-.0869	-.0876	-.0241
0240	-.0568	-.0069	-.1451	.0555	.0507	-.0467	-.0623	-.0469	-.0359	-.0455
0250	-.0131	.0154	.0823	-.0225	-.0465	.1212	.0773	-.0520	.0366	.0455
0270	.0080	.0508	-.0478	.0205	-.0381	.0325	.0099	-.0025	.0243	.0245
0290	.0073	.0216	-.0858	.0717	.0977	-.1014	-.0135	-.0250	.0335	-.0044
0310	.0867	.0839	.0321	.0435	.0148	.0062	.0324	.0312	-.1060*	.0258
0320	-.0483	.0562	.0889	.1054	-.0399	.1549*	-.0206	-.0231	.0497	-.0821
0340	.0710	.0677	-.0183	-.0363	-.0289	.0169	.0153	.0418	.0228	.0223
0370	.0986	.0895	.0937	.1458	.0238	-.0553	.0910	-.0988	.0099	-.0294
0380	-.0685	-.0949	.0102	.0666	.0417	-.0075	.0351	-.0964	-.0372	-.0306
0390	.0467	-.0838	.0295	-.0059	.0236	.0992	.0087	.0142	.0505	.0209
0410	.0540	-.0822	-.1228	.0427	.0587	-.0487	-.0532	-.0992	.0306	.1124
0420	-.0278	-.1593*	-.0792	.0051	.0653	.1895*	.0872	.0029	.0080	.1062
0440	-.0888	.0516	.0742	-.0122	-.1457*	.0775	.0260	-.0209	.0287	-.0046
0490	.1273*	-.0742	.0942	-.0336	.0590	-.0023	-.0763	.0044	-.0130	.0047
AVSCC	.0068	-.0078	-.0152	.0064	.0099	.0092	-.0020	-.0167	.0091	.0003
INDEX	.0809	.2072**	.2158**	.1055*	.1457**	.0695	.0705	.0645	.1067**	.0783
+SCC	14	14	11	17	18	14	18	12	19	17
-SCC	16	16	19	13	12	16	12	18	11	13
No.5%	1	2	2	-	1	2	-	-	2	-

APPENDIX 4: TRANSACTION RETURNS

LAG	11	12	13	14	15	16	17	18	19	20
0020	-.0762	-.0946	-.0793	.1103	.0067	-.1419	-.0070	-.0257	.0520	.0408
0030	.0466	.0378	.0181	-.0322	.0222	.0266	-.0481	-.0497	-.0406	-.0414
0040	.0408	-.0244	-.0287	-.1116	.0086	.0251	-.0435	-.0223	.0751	.0064
0060	.0769	-.0760	.0313	.0254	-.0094	.0787	-.0811	.0022	-.0133	.0851
0070	-.0202	.0619	-.0745	.0829	.0608	.0104	.0063	.0501	.0715	-.0234
0090	-.1098	-.0153	-.0648	.1261	-.0238	.0171	.0551	-.0257	-.0298	.0407
0100	.0602	.0689	.0167	.0854	-.0814	.0737	-.0292	.0561	-.0459	-.0642
0110	-.0542	-.0135	.0131	.0392	.0668	-.0921	-.0171	.0344	.0072	-.0031
0120	.0707	-.0018	.1392	-.0805	-.0069	.0964	-.1258	-.0287	.1069	-.0295
0130	-.0085	.0260	-.0194	-.0145	.0059	.0817	-.0504	-.0082	-.0265	.0116
0160	.1140	.0034	-.1003	-.0286	.0584	-.0036	-.0056	.0417	.0151	-.0712
0170	.0664	.0427	.0027	.0716	.0771	.0433	.0075	.0540	.0086	.0128
0180	-.0590	-.0409	.0401	.0172	.0824	.0170	.1026	-.1004	-.0658	.0439
0200	-.0222	-.0893	.0324	.0488	-.0088	.0394	.0402	-.1026	.0743	-.1402*
0220	-.0178	-.0029	-.0075	-.0776	.0410	-.0247	.1032	-.0175	-.0383	-.0984
0230	.0014	-.0245	.0221	-.0353	-.0102	.0087	.0333	.0241	.1433	.0896
0240	-.1206	-.0402	.0268	.0169	.1807*	.0844	-.0822	.0677	-.0702	.0030
0250	-.0066	.0163	-.0219	-.0292	.0069	.0108	.1289	.0105	-.1347*	-.0691
0270	-.0300	.0118	.0151	.0258	-.0179	-.0104	.0462	-.0177	.0105	.0004
0290	-.0402	.0190	-.0052	.0120	-.0336	.0510	-.0446	-.0305	-.0876	.0619
0310	-.0142	.0275	-.0308	-.0143	-.0003	.0122	-.0868	.0802	-.0326	-.0120
0320	.1274	.0172	.0154	.0025	-.1407	-.0318	-.0152	-.1311	-.1051	-.0199
0340	-.0292	.0871	-.0084	.0282	-.0321	.0390	.0471	-.0689	.0406	.0130
0370	.0329	-.0647	-.0612	-.0545	-.1131	-.0942	-.1318	.0231	-.0012	.1020
0380	.0452	.0336	-.0055	.0526	-.0916	-.1350*	.0508	.1187*	.0207	-.0795
0390	-.0054	.1341*	.0748	.0229	-.0294	-.0383	.0390	-.0154	-.0240	.0006
0410	-.0964	.0525	-.1214	-.0397	.0875	.1133	-.0015	.0132	-.0314	-.0482
0420	-.0097	.0284	-.0451	.0221	-.0508	-.0180	.1137	.0133	-.0531	-.0750
0440	.0102	.0199	-.1204	.0495	.0777	.0055	.0107	-.1410	-.0175	-.0042
0490	.0016	.0469	-.0417	.0656	.1045	-.0259	.0184	-.0104	.0197	-.0304
AVSC	-.0009	.0082	-.0129	.0129	.0079	.0073	.0011	-.0069	-.0057	-.0099
INDEX	.0345	.0815	.0634	.0474	.1481**	.0861	.1060*	.0882*	.0522	.0878*
+SCC	13	18	13	19	15	19	15	14	13	14
-SCC	17	12	17	11	15	11	15	16	17	16
NO1%	-	-	-	-	-	-	-	-	-	-
NO5%	-	1	-	-	1	1	-	1	1	1

APPENDIX 4: TRANSACTION RETURNS

LAG	21	22	23	24	25	26	27	28	29	30
0020	-.0050	-.1030	-.0954	-.0411	.0668	-.0197	-.0622	.0170	.0447	.1209
0030	-.0500	.0469	.0083	.0106	.0011	-.0026	.0387	-.0208	.0202	.0430
0040	.1013	-.0057	-.0434	-.0951	.1895**	.0185	-.1018	.0313	-.0114	.0283
0060	-.0866	-.0188	.0155	.0379	-.0137	.0234	.0859	-.0896	-.0234	.0700
0070	.0034	-.0204	.0135	.0585	.0821	.0473	-.0902	-.0485	.1027	.0740
0090	-.0005	-.1332	-.0128	-.0758	-.0826	.0451	.1318	-.0758	.0689	-.0316
0100	-.0898	.0854	-.0258	-.0509	-.0116	.0758	.0100	.0281	.0389	.0673
0110	.0557	-.1215*	-.0121	.0784	.0161	-.0997	.0782	-.0165	.1148*	-.0073
0120	-.0648	-.0969	.0646	-.0267	.0956	.0139	.0263	-.0464	-.0299	.0173
0130	-.0367	.0220	-.0146	.0721	-.0069	.0387	.0028	-.0041	-.0953	.0487
0160	-.0221	.0511	-.0963	.0789	.0318	.0134	-.0318	-.0307	.0492	-.0848
0170	.0135	-.0033	.0069	.0027	.0482	.0104	-.0149	.0014	.0056	-.0284
0180	-.0910	-.0458	.0290	.0398	.0174	.0752	.0122	-.0665	-.0087	-.0108
0200	.1041	-.0993	.0559	.0908	-.0321	-.0487	-.1083	.0764	-.0747	-.0120
0220	.0357	.0335	-.0205	-.0344	-.0225	-.0395	.0973	.0447	-.0702	-.0250
0230	-.0848	-.0392	.1305	-.0905	.0346	-.1199	-.0797	-.0482	.0601	-.0520
0240	.1177	.0035	-.1139	-.0153	-.1180	-.0088	-.0508	.1116	-.0188	-.0232
0250	.0492	.1183	.0114	-.0048	-.0224	.0278	.0923	.0289	.1568*	-.0637
0270	.0129	.0039	.0527	-.0705	.0022	-.0279	.0759	.0694	-.1228*	-.0051
0290	.0506	.0376	-.0369	.0557	-.0779	-.0275	.0332	.0407	-.0738	.0181
0310	.0224	.0346	-.0354	-.0284	-.0330	.0105	.0144	.0556	-.0126	-.0617
0320	-.1567*	-.0016	.0785	.1178	-.0672	-.1113	.0245	.0111	-.0335	-.0079
0340	.0337	.0036	.0327	.1111*	-.0697	.0189	-.0549	.0427	-.0029	-.0389
0370	.0506	.1358	.0055	.0331	-.0324	-.1384	-.0705	.0875	.0151	-.1401
0380	-.0182	.0097	-.0422	.0761	.0564	.0244	-.0503	-.0239	.0492	-.0837
0390	.0258	.0355	.0093	-.0593	-.0041	-.1038	.0296	-.0704	-.0720	-.0767
0410	-.1185	.0829	-.0034	-.0391	-.0214	-.0345	-.0038	.0464	-.0045	-.0979
0420	-.0054	.1101	.1706*	.0367	-.0087	-.0064	.0044	-.0739	.0128	-.1359
0440	.0127	.0559	.0083	.1010	.0675	-.0522	.0758	-.0833	-.0517	-.0443
0490	.0264	-.0590	-.0167	.0135	-.0133	.1184	-.0672	.0122	.0284	-.0402
AVSCC	-.0038	.0041	.0041	.0128	.0024	-.0093	.0016	.0003	.0020	-.0195
INDEX	.0360	-.0063	.0298	.0474	.0897*	.0570	.0417	.0435	.0529	.0778
+SCC	16	17	16	17	13	15	17	16	14	9
-SCC	14	13	14	13	17	15	13	14	16	21
NO1%	-	-	-	-	1	-	-	-	-	-
NO5%	1	1	1	1	1	-	-	-	3	-

APPENDIX 5: SERIAL CORRELATION COEFFICIENTS FOR BID RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1 to 30 DIFFERENCING INTERVAL 1

LAG	1	2	3	4	5	6	7	8	9	10
0020	-.0026	-.0176	-.0162	.0192	-.0108	-.0517	-.0058	-.0191	.0327	-.0171
0030	-.0577	-.0625	.0410	.0996*	.0767	-.0078	-.0055	-.0086	-.0040	.0047
0040	-.0525	-.0238	-.0618	.0534	-.1074*	.0077	.0116	-.0553	.0072	-.0036
0060	.0204	-.1290**	-.0535	-.0198	-.0034	-.0171	-.0023	-.0070	.0052	-.0101
0070	-.0665	-.0484	.0351	-.0274	-.0604	-.0369	.0008	.0134	.0077	.0513
0090	-.0397	-.0900*	-.0175	-.0398	.0148	-.0183	.0282	.0149	.0185	.0038
0100	-.0983*	-.0118	-.0052	-.0127	-.0009	-.0020	.0032	-.0024	-.0015	-.0003
0110	-.0282	-.0002	-.0019	-.0056	-.0077	.0331	.0135	-.0001	.0181	.0169
0120	-.0323	-.0070	-.0162	-.0215	.0209	-.0054	.0025	.0061	.0268	-.0287
0130	-.0208	-.0376	-.0069	-.0032	.0084	-.0048	-.0031	.0025	-.0021	.0103
0160	-.0406	-.0466	-.0269	.0118	.0112	.0032	.0225	.0350	-.0065	-.0471
0170	-.0282	.0260	.0051	-.0036	.0113	-.0236	.0669	-.0143	-.0050	-.0061
0180	-.0461	-.0227	-.0514	.0193	-.0498	-.0163	.0228	.0074	-.0010	.0216
0200	-.0050	-.0099	-.0175	.0110	-.0509	.0103	-.0128	.0199	.0004	.0226
0220	-.0679	-.0023	.0208	.0246	-.0187	.0011	.0158	.0122	.0312	.0106
0230	.0034	-.0105	-.0348	-.0065	-.0184	.0057	-.0004	-.0183	-.0449	.0005
0240	-.0230	-.0108	.0142	.0204	-.0032	.0012	-.0056	.0071	-.0017	.0115
0250	.0394	.0613	.0514	-.0714	-.0389	-.0403	.0039	-.0703	-.1612**	-.1661**
0270	-.0306	-.0221	-.0212	.0036	-.0034	.0084	-.0330	.0047	-.0201	-.0419
0290	.0586	-.0965*	-.0424	-.0428	-.0836	-.0391	-.0103	-.0724	-.0081	.0028
0310	-.0415	-.0053	-.0126	-.0118	-.0099	-.0243	-.0092	-.0529	.0344	-.0129
0320	-.0033	-.0478	-.0375	.0027	-.0604	-.0315	.0151	.0081	-.0173	-.0237
0340	-.0035	-.0180	-.0380	-.0139	-.0194	-.0102	-.0055	-.0126	-.0088	-.0426
0370	-.0712	-.0662	.0155	.0181	-.0512	-.1196*	-.0136	-.0259	.0809	-.0208
0380	-.0877*	.0979*	.0106	-.0571	.0295	.0330	-.0464	-.0401	.0344	.0480
0390	-.0084	-.0927*	.0134	.0988*	-.1074*	.0357	-.1268*	.0230	-.1345*	-.1542**
0410	-.0118	.0441	-.0473	-.0424	.0244	-.0164	-.0310	.0022	-.0167	.0086
0420	-.0156	-.0259	-.0061	.0490	.0458	-.0216	-.0048	.0291	-.0061	-.0065
0440	-.0117	-.0269	-.0693	.0031	.0223	.0448	-.0289	.1101*	-.0486	-.0041
0490	.0099	.0357	.0113	-.0323	-.0085	.0181	.0442	.0815	.0463	.0235
AVSCC	-.0257	-.0221	-.0122	-.0008	-.0150	-.0095	-.0031	-.0007	-.0047	-.0116
INDEX	.0809	.2072**	.2158**	.1055*	.1457**	.0695	.0705	.0645	.1067**	.0783
+SCC	5	5	10	14	10	12	13	16	13	14
-SCC	25	25	20	16	20	18	17	14	17	16
NO1%	-	1	-	-	-	-	1	-	1	2
NO5%	2	5	-	2	2	1	1	1	2	2

APPENDIX 5: BID RETURNS

LAG	11	12	13	14	15	16	17	18	19	20
0020	-.0320	.0058	-.0694	.0338	.0023	-.0018	.0026	.0167	-.0145	.0327
0030	.0040	-.0100	-.0112	-.0081	.0024	.0023	-.0454	-.0021	-.0052	.0148
0040	.0305	.0052	.0283	.0752	-.0258	.0243	.0964*	-.1299**	-.0521	-.0114
0060	.0086	-.0074	-.0325	.0077	-.0146	.0232	.0044	-.0325	-.0693	.0579
0070	-.0506	-.0296	.0030	.0005	-.0240	.0024	.0093	.0078	.0016	.0024
0090	-.0005	.0206	.0124	-.0220	.0084	-.0010	.0027	.0059	-.0188	.0050
0100	.0024	.0282	.0865	-.1446**	.0101	.0007	-.0124	.0168	-.0053	.0710
0110	.0030	-.0009	.0053	.0030	.0022	.0023	.0287	.0090	.0372	.0299
0120	.0086	.0303	.0186	.0483	.0068	-.0321	-.0362	-.0778	-.0502	-.0093
0130	-.0063	-.0161	-.0210	.0014	.0062	-.0201	-.0258	-.0033	-.0076	.0057
0160	-.0119	.0269	.0482	.0555	-.0536	-.0665	.0153	-.0585	.0726	.0047
0170	.0191	-.0065	.0169	-.0017	.0021	-.0477	-.0637	-.0014	-.0179	-.0905*
0180	-.0196	.0324	-.0016	-.0463	-.0854	-.0351	.0411	.0221	-.0016	-.0932*
0200	-.0360	-.0043	-.0208	-.0461	.0640	.0676	-.0026	.0142	-.0081	-.0378
0220	.0227	-.0222	-.0564	.0300	.0055	.0177	.0281	.0027	.0912*	-.0645
0230	-.0233	.0050	.0051	-.0204	-.0002	.0097	-.0035	.0019	.0079	.0203
0240	-.0655	-.0043	-.0406	-.2057**	-.1003*	-.0273	-.1337**	-.0701	-.1224**	-.0064
0250	-.0340	.0133	.0034	.0318	-.0268	-.0033	-.0501	-.0154	-.0637	-.1020*
0270	-.0391	-.0526	-.0269	-.0379	-.0147	.0000	.0246	-.0035	-.0213	.0512
0290	-.0138	.0164	-.0206	.0503	-.0448	-.0535	-.0630	-.0582	-.0618	-.0958*
0310	-.0530	-.0145	-.0079	-.0335	.0151	-.0460	.0393	-.0658	-.0022	.0108
0320	-.0341	-.0901	-.0653	-.0459	-.0719	.0007	-.0745	-.0561	-.0340	-.0774
0340	.0041	-.0095	.0533	.0246	.0034	-.0019	.0023	.1491**	.0012	-.0061
0370	.0153	-.0194	.0084	-.0283	-.0628	-.0899	-.0015	-.0050	.0027	-.0096
0380	-.0097	-.0222	-.0378	.0447	-.0252	.0108	-.0033	-.0404	.0248	-.0053
0390	-.0683	.0402	.0151	-.0003	.0073	.1055*	-.1924**	.0747	-.0242	.0412
0410	-.0536	-.0302	-.0173	-.0459	-.0294	-.0415	-.0619	-.0499	-.0354	-.0476
0420	-.0074	.0212	-.0108	.0403	-.1245**	-.0002	-.0040	-.0226	.0056	-.0265
0440	.0269	-.0047	.0494	-.0253	-.0029	.0188	-.0020	-.0318	-.0027	-.0382
0490	.0430	.0253	.0223	.0052	-.0750	.0182	-.0082	-.0089	.0189	.0199
AVSCC	-.0123	-.0025	-.0023	-.0087	-.0215	-.0055	-.0163	-.0137	-.0118	-.0118
INDEX	.0345	.0815	.0634	.0474	.1481**	.0861	.1060*	.0882*	.0522	.0878*
+SCC	12	13	15	15	13	15	12	11	10	14
-SCC	18	17	15	15	17	15	18	19	20	16
NO1%	-	-	-	2	1	-	2	2	1	-
NO5%	-	-	-	2	2	1	3	2	2	4

APPENDIX 5: BID RETURNS

LAG	21	22	23	24	25	26	27	28	29	30
0020	-.1253**	-.0802	-.0274	-.0062	.0031	-.0191	.0067	.0075	-.0516	-.0344
0030	-.0076	.0022	.0159	.0051	.0154	.0043	.0235	.0127	.0294	.0160
0040	-.0456	-.0236	.0640	.0623	.0095	.0493	.0331	-.0209	.0038	.0229
0060	-.0482	-.0813	-.0142	.0095	-.0020	.0036	-.0091	.0066	.0137	-.0344
0070	-.0218	.0071	.0013	-.0002	.0123	.0028	.0107	-.0656	.0042	-.0001
0090	.0009	.0011	.0536	.0153	.0105	-.0987*	.0479	.0155	-.0157	-.0010
0100	.0285	.0187	.0278	-.0001	.0023	.0162	-.0068	.1001	-.0023	-.0061
0110	.0450	.0219	.0252	-.0006	-.0158	.0171	-.0066	.0039	.0030	.0245
0120	.0181	-.0240	.0281	-.0007	.0190	-.0102	-.0292	-.0297	.0011	.0340
0130	-.0017	.0106	.0106	.0023	-.0061	-.0001	.0309	-.0318	-.0303	.0038
0160	.0146	.0189	.0400	-.0190	-.0196	.0026	.0049	-.0236	-.1143*	.0738
0170	.0746	-.0208	-.0182	-.0022	.0285	.0082	.0208	-.0193	-.0092	.0058
0180	-.1405**	-.1070*	.0098	.0300	-.0547	.0067	.0535	.0159	.0285	.0184
0200	-.0787	-.0534	-.0268	.0098	.0154	-.0247	.0176	.0017	-.0505	.0607
0220	.0194	.0306	.0015	.0104	.0029	-.0011	-.0190	.0213	.0032	.0101
0230	.0178	.0252	.0858	-.0081	-.0054	.0239	.0069	-.0758	.0140	.0028
0240	-.0208	.0387	-.0160	-.0288	-.0088	.0166	.0619	.0210	-.0037	-.0167
0250	-.0513	-.0040	-.0252	-.0020	-.0159	-.0123	-.0117	.0110	-.0026	.0049
0270	.0340	-.0283	-.0069	-.0900*	-.0983*	-.0784	-.0737	-.0276	-.0168	-.0446
0290	-.0311	-.0017	-.0407	-.0252	-.0103	-.0181	.0347	.0572	.0224	-.0267
0310	.0034	.0027	-.0634	-.0120	-.0820	-.0128	-.0142	-.0134	-.0486	-.0265
0320	-.0431	-.0669	-.0371	-.0024	-.0075	.0607	.0042	.0517	.0815	.0355
0340	.0023	-.0051	-.0443	-.0123	-.0170	-.0105	-.0446	-.0102	-.0183	-.0036
0370	-.0048	-.0164	-.0113	.0321	.0390	-.0184	.0984*	-.1077*	-.1025*	-.0284
0380	.0161	.0033	.0665	-.0329	.0613	.0149	.0268	-.0425	.0260	.0455
0390	-.0010	.0008	-.0595	.0172	.0000	.0023	.0018	.0610	-.0578	-.0002
0410	.0812	-.0478	-.0334	-.0500	-.0177	-.0707	-.0387	-.0555	-.0421	-.0482
0420	-.0046	-.0034	.0457	-.0080	.0219	.0507	.0289	-.0076	-.0207	-.1641**
0440	-.0028	.0019	.0066	.0261	.0903*	-.0641	-.0128	.0396	-.0022	.0022
0490	.0198	-.0332	-.0361	-.0372	-.0073	-.0077	.0341	.0074	.0197	-.0065
AVSCC	-.0084	-.0138	.0007	-.0039	-.0012	-.0056	.0094	-.0032	-.0113	-.0027
INDEX	.0360	-.0063	.0298	.0474	.0897*	.0570	.0417	.0435	.0529	.0778
+SCC	14	14	15	11	15	15	19	16	13	15
-SCC	16	16	15	19	15	15	11	14	17	15
NO1%	2	-	-	-	-	-	-	-	-	1
NO5%	2	1	-	1	2	1	1	1	2	1

APPENDIX 6: SERIAL CORRELATION COEFFICIENTS FOR ASK RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1 to 30 DIFFERENCING INTERVAL 1

LAG	1	2	3	4	5	6	7	8	9	10
0020	.0789	.0599	.0013	.0315	.1168*	.0290	.0453	-.0188	.0556	.0323
0030	.0277	.0180	.0427	.0704	.1681*	.1863*	.1460	-.0097	.1465	.0996
0040	.0140	-.0401	-.0319	-.0092	-.0158	-.0231	.0120	.0087	-.0194	-.0161
0060	.0693	.0228	-.0241	.0453	.0279	-.0077	-.0118	.0269	-.0321	-.0459
0070	.0555	.0346	.0809	.0497	-.0380	-.0269	.0063	.0320	-.0843	-.0183
0090	.0803	.0355	.1220	.1562	.2079	.0084	.0455	-.1891	-.1770	-.2504
0100	.0225	.0512	.0475	.0377	.0203	.0730	.0211	-.0025	.0260	-.0553
0110	.0486	.0767	.1118*	-.0039	.0281	.0853	.0139	.0033	-.0587	.0031
0120	-.0087	.0305	.0610	.0500	.0601	.0455	-.0184	.0099	.0061	.0301
0130	-.0524	-.0274	.0110	.0530	.0510	-.0062	.0184	.1545*	.0318	-.1104
0160	.0285	.0219	-.0220	.0109	.0282	.0141	.0501	-.0480	-.0397	.0579
0170	.0305	.0304	.0361	-.0021	.0422	.0529	.0237	.0199	.0473	.1050*
0180	.0284	.0301	-.0222	-.0022	-.0188	-.0176	-.1069	-.1171	-.0322	-.0815
0200	-.0200	-.0212	-.0429	-.0642	-.0399	.0140	.0481	.0374	-.0130	-.0390
0220	-.0114	-.0613	.0021	-.0477	-.0893	.0463	.0166	.0394	-.0683	-.0057
0230	.0232	-.0017	-.0040	.0102	.0915	.1346	.1367	.0755	-.0067	.0538
0240	-.0175	.0024	.0290	.0236	-.0274	.0424	.0132	-.0375	-.0399	-.0017
0250	-.0789	.0422	.0164	-.0107	.1167*	-.0168	.0018	.0522	.0404	.0046
0270	.0938	.0397	.0262	.0307	.0818	.1426*	.0688	-.0039	.0402	.0966
0290	.0567	-.0073	.0059	.0546	.0049	-.0092	.0776	.0137	.0452	.0360
0310	.0054	.0411	.0336	.0189	.0503	.0178	-.0041	.0089	-.0193	.0251
0320	-.0884	-.0300	.0030	-.0154	.0358	.0118	-.0445	-.0386	-.0297	-.0442
0340	.1256*	.0193	.0177	.0572	-.0562	.1486*	.0638	.0381	.0430	.0560
0370	.0818	.0852	.0865	.0060	.0048	.0069	.0411	.0675	.0260	.0055
0380	-.0494	.0379	.0764	.0645	.0060	.0618	.0722	.0480	.0276	.0751
0390	.0225	.0132	.0275	.0111	.1132	.0072	-.0572	.0327	.0068	.0140
0410	-.0750	.0726	.0851	.0607	.0538	.0765	-.0637	.0609	.0313	.0205
0420	.0062	-.1057	-.0239	.0398	-.0192	.0074	.0668	.0923	.0336	-.0117
0440	-.0051	.1560*	.1401	.0359	.0471	.0458	.0917	-.1069	-.0773	.0242
0490	-.0166	-.0021	.0182	-.0086	-.0037	.0145	.0943	.0721	.0864	.0795
AVSCC	.0159	.0208	.0304	.0251	.0349	.0388	.0289	.0107	-.0001	.0046
INDEX	.0809	.2072**	.2158**	.1055*	.1457**	.0695	.0705	.0645	.1067**	.0783
+SCC	19	21	23	21	21	23	23	20	16	18
-SCC	11	9	7	9	9	7	7	10	14	12
NO1%	-	-	-	-	-	-	-	-	-	-
NO5%	1	1	1	-	3	3	-	1	-	1

APPENDIX 6: ASK RETURNS

LAG	11	12	13	14	15	16	17	18	19	20
0020	.0024	-.0139	-.0283	-.0401	-.0102	-.0141	-.0246	.0061	.0072	-.0309
0030	.0809	.0921	.0234	.0745	.1697*	.0385	-.0468	.0234	.0055	-.0237
0040	.0697	-.0017	.0389	-.0207	-.0248	.0052	-.0765	.0516	-.0180	-.0067
0060	-.0054	.0600	.0978	.0217	-.0219	.0299	.0479	.0755	.1045	.0172
0070	.0140	.0256	-.0836	-.0542	-.0043	.0354	.0759	.0729	.0010	.0820
0090	-.0343	.0474	.1023	.0958	.1550	.0987	.0420	-.0410	-.0345	.0677
0100	.0256	-.0141	.0384	.0241	.0092	.0441	-.0216	-.0145	.0308	.0148
0110	.0082	-.0218	.0385	-.0507	-.0267	-.0330	-.0132	-.0007	-.0060	-.0206
0120	.0116	.0656	.0418	.0392	-.0449	.0446	.0496	.0427	.0155	-.1179
0130	-.0511	.0433	.0375	.0220	-.0179	.0005	.0277	-.0221	.0283	.0337
0160	-.0201	.0049	-.0030	.0292	.0175	.0241	-.0110	.0230	-.0537	-.0955*
0170	.0145	-.0052	.0417	.0781	.0040	.0765	-.0171	.0382	.0375	-.0117
0180	-.0201	.0145	-.0073	.1605	.0763	.0709	.0997	.1370	.0783	.0076
0200	-.0388	-.0658	-.0164	-.0012	.0234	-.0554	-.0176	.0432	.0227	.0163
0220	.0515	.0131	.0175	-.0127	-.0395	-.0252	-.0394	-.0607	-.0287	.0909
0230	.1883*	.1611*	-.0035	.0365	.0341	-.0581	.0906	.0053	-.0270	-.0377
0240	-.0330	-.0163	-.0125	.0193	-.0470	-.0211	-.0439	-.0184	-.0092	-.0196
0250	.0141	-.0586	-.0379	.0060	.0346	-.0167	-.0585	-.0621	-.0020	.0147
0270	.0343	.0618	.0342	.0960	.0692	.1026	.1253*	.0717	-.0810	-.0231
0290	.1505**	.0451	.0016	-.0526	-.0757	-.0779	-.0124	-.0784	-.0688	-.0235
0310	-.0131	-.0383	.0027	-.0060	.0866	.0312	-.0538	.1056*	-.0567	-.0275
0320	.0012	-.0082	.0211	.0003	-.0206	.0384	-.0306	-.0094	-.0684	.0036
0340	.0529	.0569	.0367	.0388	.0531	-.0678	.0465	.0438	.0241	.0275
0370	.0225	-.0311	.0013	.0140	-.0578	-.0343	-.0250	-.0464	-.0274	-.0230
0380	.0206	-.0116	.0606	.0448	.0637	.0806	.0834	.0094	.0141	.0371
0390	.0053	.0136	.0010	.0925	-.1312	.0214	-.0166	.0882	-.0651	-.0001
0410	.0237	.0029	.0473	.0110	.0459	.0301	.0108	.0180	.0077	.0234
0420	.0296	-.0194	.0039	.0115	.0587	.0103	.0254	.0427	.0257	.0079
0440	.0571	.1146	-.0007	-.0103	.0317	-.0021	-.0036	-.0153	-.0053	-.0035
0490	.0678	.1030	-.0002	.0173	.0109	.0100	.0426	-.0124	.0359	.0524
AVSCC	.0243	.0207	.0165	.0228	.0140	.0129	.0085	.0172	-.0038	.0011
INDEX	.0345	.0815	.0634	.0474	.1481**	.0861	.1060*	.0882*	.0522	.0878*
+SCC	22	17	20	21	17	19	13	18	15	15
-SCC	8	13	10	9	13	11	17	12	15	15
NO1%	1	-	-	-	-	-	-	-	-	-
NO5%	2	1	-	-	1	-	1	1	-	1

APPENDIX 6: ASK RETURNS

LAG	21	22	23	24	25	26	27	28	29	30
0020	-.0213	-.0185	-.0808	-.0473	-.0184	-.0469	-.0085	.0159	-.0060	-.0430
0030	.0125	-.0279	.0268	.0855	-.0251	-.0046	.0439	-.0368	-.0582	-.0587
0040	.0014	.0099	-.0053	.0149	.0341	-.0634	.0118	.0270	-.0053	-.0105
0060	.0748	-.0212	.0369	.0040	.0624	.1322*	.0583	-.0348	-.0186	-.0396
0070	.0650	.0879	.0026	.0192	-.0120	.0493	-.0021	.0837	.0558	.0478
0090	-.0449	.0381	-.1739	.0334	.1349	.1334	.2331	.1769	.1263	.1549
0100	.0086	.0419	.0203	-.0730	-.0628	-.0627	.0320	-.0554	-.0312	.0593
0110	-.0230	-.0519	.0165	-.0008	.0633	.0437	-.0128	.0100	-.0434	-.0309
0120	-.0334	.0625	.0002	-.0826	-.0518	.0201	.0392	.0745	.0025	.0086
0130	.0083	.0045	.0632	.0546	.0730	.0450	.0645	-.0121	.1013	.0642
0160	-.0081	-.0494	-.0632	.0625	-.0104	.1774**	.0727	.0321	.0197	.0124
0170	.1385**	.0683	.0887	.1030*	.0429	-.0035	.0458	.0126	-.0078	.0255
0180	.0388	.0045	-.0019	-.0600	-.0103	.0072	.0298	-.0004	-.0594	.0112
0200	.1010	.1150*	.0458	.0355	-.0222	-.0172	-.0158	-.0233	.0083	.0620
0220	.0961	-.0250	-.0618	-.0982	-.0034	-.0140	-.0259	.0023	-.0054	.0604
0230	-.0396	-.0613	.0009	-.0709	-.0078	.0183	.0200	-.0237	-.0032	.0031
0240	-.0520	-.0135	.0062	-.0022	-.0208	.0475	.0319	.0268	.0604	.0298
0250	.0559	.0445	-.0348	-.0493	-.0723	.0469	.0163	-.0036	.0432	.0086
0270	.1015	.1104	.0172	.0492	.0195	.0806	.0569	.0914	.0640	.0836
0290	-.0554	-.0182	-.0383	-.0460	.0340	.0107	-.0101	.0031	-.0346	-.0915
0310	.0379	.0003	.0216	-.0021	.0094	.0691	.0047	.0134	.1035*	.0272
0320	-.0379	-.0583	-.0182	-.0453	-.0426	-.0600	-.0292	-.0372	-.0832	-.0748
0340	.0156	.0480	.1242*	-.0499	.0104	.0272	.0244	.1139	.0475	.0536
0370	-.0102	-.0217	.0745	.0420	.0676	.0367	-.0315	.0729	.1363*	.1221*
0380	.0530	-.0032	-.0381	.0543	.0589	.0384	.0585	.0411	.0035	.0444
0390	.0946	-.0765	-.0338	.0543	.0024	.0203	-.0187	.0067	.0013	.0064
0410	.0134	.0436	.0552	.0268	.0740	.0418	.0496	.0538	.0500	.0569
0420	.1068	.0528	.1143	.0522	.0508	-.0433	.0248	.0193	.0439	.1299*
0440	.0458	.0429	-.0025	-.0013	-.0089	-.0101	.0319	.0127	-.0059	-.0031
0490	-.0015	-.0198	-.0506	.0042	-.0255	.0030	.0681	.0234	.0730	.0835
AVSCC	.0247	.0103	.0037	.0022	.0114	.0241	.0288	.0229	.0193	.0268
INDEX	.0360	-.0063	.0298	.0474	.0897*	.0570	.0417	.0435	.0529	.0778
+SCC	20	16	17	16	15	20	21	21	17	22
-SCC	10	14	13	14	15	10	9	9	13	8
NO1%	1	-	-	-	-	1	-	-	-	-
NO5%	1	1	1	1	-	2	-	-	2	2

APPENDIX 7: SERIAL CORRELATION COEFFICIENTS FOR MONTHLY TRANSACTION RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1 to 30 DIFFERENCING INTERVAL 1

LAG	1	2	3	4	5	6	7	8	9	10
020	.0270	-.0114	.0152	-.0160	-.1217	-.1702	.1212	-.1394	.0196	-.0266
030	-.0556	.0600	.2200*	.0275	.0164	.0699	.0437	.0802	-.0308	-.0292
040	-.2128*	-.0275	-.0138	.0954	-.0656	.0223	.0433	.0184	-.1749	.0467
060	-.0339	.0257	-.0215	-.1331	.0292	.0988	.1812	-.0004	-.1280	.0512
070	.0016	-.0078	-.0002	.0641	.0316	.0140	.0626	.0313	.0902	.0220
090	-.0086	.0629	-.1029	.2053	-.2387*	.0527	-.1574	.1775	.0010	-.0170
100	-.0768	.0400	.0426	.1370	-.0047	-.0958	.1291	-.1571	.0749	.0566
110	.1012	.0194	.0057	.0302	.0218	-.0535	.0510	.0211	.0270	.0328
120	.1911	-.0235	-.0169	.0515	-.0724	.0259	-.1639	.0738	.0431	-.0027
130	-.0775	-.0090	.0432	-.0261	-.0567	.0638	-.0984	-.0399	-.0442	.0439
160	-.1442	-.0199	-.0558	.0214	.0158	.0586	.0263	.2053*	-.1887	.1696
170	-.1612	-.0787	.0210	-.1480	-.0478	.1058	.0753	-.0744	-.0365	-.1802
180	-.1342	.0482	.0034	.1409	-.0898	-.0628	.0390	.1517	.0659	-.0769
200	.0061	-.0247	-.0733	-.0148	.0376	-.0508	-.0921	.0220	.2376*	-.0520
220	-.0418	.0448	-.0158	-.0134	.0688	.0554	-.2131	.1044	.1167	-.2447*
230	-.2375*	.0918	-.0681	.0927	-.0364	-.0491	-.1103	.1451	.0749	-.0104
240	-.0545	-.0487	.0066	-.0252	-.1003	-.0464	.1165	-.1587	.0056	-.1176
250	-.0608	.1598	.0613	-.0664	.1132	.1145	.0586	-.0147	-.0648	.0713
270	-.0460	-.0098	-.0094	.0108	.0148	.0338	.0726	-.0038	-.1073	.0065
290	-.0398	-.0803	.0691	-.0380	.0958	.0202	.0694	.0099	-.2058*	.0343
310	-.1273	-.2042*	.1632	.0432	-.0049	-.0760	.0683	-.0109	-.0095	.0355
320	.2127*	-.0374	.0310	-.2595*	-.1150	.0613	-.1592	-.0584	.0689	-.0266
340	.1857*	.1134	-.0963	.0583	.0209	.1029	-.0633	.1868	-.0628	.2961**
370	.1832	.1119	-.2095	-.0636	.1609	-.1737	.0829	-.0219	.1764	-.0441
380	-.0961	-.0613	-.1079	-.0356	.1505	-.0747	.0392	.0417	.1803	.0082
390	-.0832	.0315	.2136*	.0924	-.0950	.0646	-.1564	-.0379	.0446	-.0962
410	-.0508	-.0987	.0545	-.1104	.0708	.0213	-.1713	.1154	-.0414	.1171
420	.1042	.0019	-.1451	.0185	.2900*	.0244	-.1725	.0153	.1691	.0446
440	.1375	-.0475	.0273	-.0055	.0661	.0269	-.1843	.0392	-.0405	.1607
490	.0236	.1054	-.1206	-.0118	-.0483	-.0610	.0577	-.0220	-.0133	.1636
AVSCC	-0.0190	0.0042	-0.0026	0.0041	0.0036	0.0041	-0.0135	0.0233	0.0092	0.0180
INDEX	.2515**	-.0077	.1419	.0885	.0456	-.1639	.0675	.2480**	-.0236	.2668**
+SCC	11	14	15	15	16	19	18	17	16	17
-SCC	19	16	15	15	14	11	12	13	14	13
NO1%	-	-	-	-	-	-	-	-	-	1
NO5%	4	1	2	1	2	-	-	1	2	2

APPENDIX 7: TRANSACTION RETURNS MONTHLY

LAG	11	12	13	14	15	16	17	18	19	20
020	-.0929	.3300**	.0291	.1797	-.0129	.1811	-.2334	.2421*	-.2448*	-.0375
030	.1057	-.0611	.0308	-.1000	-.0199	-.0419	-.0163	-.0611	.0250	-.0066
040	.0377	.0236	.0960	.0702	.0239	-.1314	-.0929	.0390	.0225	.0147
060	.1350	.2054*	.1487	-.0286	-.0955	-.2486*	-.0116	.0975	.0783	.0160
070	-.1267	.0357	.1948	-.0571	.0024	-.0230	-.0208	.0169	-.0438	-.0159
090	-.0515	.0499	.0007	-.0491	.0587	.1008	-.0974	-.1845	.0736	.1567
100	.0295	-.1267	-.0325	-.0402	.1035	-.0661	-.0788	-.0434	.0924	.0427
110	-.0324	.0402	-.0203	.0346	-.0157	.1727	-.0173	-.0543	.0095	.0121
120	-.0326	-.1314	.2424*	-.1861	-.0013	.0431	.1554	-.1390	-.0575	.2821*
130	.0112	.0814	-.0971	.0002	.0319	-.0442	.0116	.0099	-.0479	.0134
160	.0048	.0805	-.0804	-.0852	.0859	-.0027	-.0694	.0742	.0046	-.0130
170	.1109	.1896*	-.0344	-.0636	-.1233	-.0884	.1196	.0048	.0532	-.0931
180	-.0583	.0240	-.1454	-.0879	-.1619	.0890	.0266	.1667	-.1078	-.0545
200	.0778	-.0647	-.0890	.0036	-.0212	.0801	-.0140	-.0233	.0809	.1069
220	.1996	-.0366	.0749	-.0605	-.0805	-.0413	.1274	-.0735	.0134	.1960
230	.0640	-.1428	.0652	.0184	-.0199	.0538	.0639	-.1553	.0262	-.0352
240	.1601	-.0704	-.0831	-.0611	.0076	-.0050	-.0388	.0497	-.0373	.1171
250	.0492	.1093	.0951	-.1144	.0171	.1098	.1092	-.1688	.0871	.0708
270	.0398	.0517	-.0099	.0055	-.0059	-.0095	.0479	.0505	.0184	-.0138
290	-.0444	.0674	-.0760	.0326	-.0521	.0469	.0470	.0649	.0845	-.0683
310	.0706	.0245	.0603	.0274	-.0366	-.0641	.0643	-.0135	-.1302	.0981
320	-.0357	-.0675	-.0880	-.1677	-.0362	.1139	-.0288	-.1516	.0508	.1717
340	.0562	.0180	.0685	.0274	.1244	-.0920	.0831	.0911	-.0053	-.0962
370	-.2523*	.1069	.1122	.0049	-.1248	.0028	.0111	-.0656	.1358	.0218
380	-.1613	.2469*	-.1415	.1205	.0796	-.1663	.0238	-.0617	-.0995	-.0024
390	.0059	-.1024	.2243*	.0224	-.0470	-.1862	.1386	-.1518	-.0097	.0090
410	-.0547	-.1547	.0983	-.1397	-.0370	.1137	.0429	-.0451	.0359	-.0032
420	-.1901	.0147	.0627	-.1160	.1552	-.2936*	.2157	-.0487	-.0292	.1127
440	-.0044	-.1294	.0270	.2116	-.0690	-.0733	.1540	.0781	-.0264	.0250
490	-.1401	.0768	.0658	-.0081	-.0576	.0487	-.0195	-.0629	-.1615	.2771**
AVSCC	-0.0040	0.0230	0.0266	-0.0202	-0.0109	-0.0140	0.0234	-0.0173	-0.0036	0.0435
INDEX	.2134*	.2255*	.1239	.0591	.2233*	.0644	-.1822	-.0557	.1430	.1049
+SCC	16	19	18	14	11	13	17	13	17	18
-SCC	14	11	12	16	19	17	13	17	13	12
NO1%	-	1	-	-	-	-	-	-	-	1
NO5%	1	4	2	-	-	2	-	1	1	2

APPENDIX 7: TRANSACTION RETURNS MONTHLY

LAG	21	22	23	24	25	26	27	28	29	30
020	-.0242	-.0491	.0214	-.0656	.1048	-.2191	.2188	-.1965	.2275	-.0271
030	-.0002	-.0515	-.0638	-.0425	.0297	-.1065	-.0589	-.1492	.0062	-.0169
040	.0098	.1843	-.0266	-.0104	-.0633	-.0159	.0358	.1098	-.0398	.0393
060	-.0486	-.0480	.0999	-.1137	.1772	-.1892	-.0743	-.0638	-.1327	.1451
070	-.0750	.0754	-.0243	.0798	-.0409	-.0036	.0980	.0506	.0064	.1023
090	-.0176	-.1969	.0133	-.0183	.0756	-.0912	-.0210	.1184	.0110	-.0806
100	-.0794	.0469	-.0629	.2150*	-.2415*	.1028	-.1917	.2086	-.0414	-.0570
110	.0729	-.0212	.0081	.0388	-.0128	.0270	.0611	.0145	.0073	-.1004
120	-.2237*	-.0932	-.1398	.0590	.0043	-.0625	.1760	-.0205	-.0423	.1850
130	.0375	-.0592	.0020	-.0266	.0159	.0240	-.0159	.0014	-.0167	-.0249
160	-.1674	.0293	.2086*	-.1163	-.1356	.1269	-.0860	.0267	.0324	-.0400
170	-.0812	-.0681	.0632	.2389*	.0738	-.1387	-.0233	-.1577	-.0063	.0355
180	-.0770	.1031	.0504	.1436	.1715	-.1896	-.2117	.0170	.0640	-.2169
200	-.0494	.2173*	-.0006	-.0228	.0396	.0320	-.0284	-.1285	-.2445*	.0120
220	-.0494	.1283	-.1564	-.0835	.1649	.0893	-.1121	-.0028	.0955	-.2252
230	-.0714	.0629	-.1131	.0382	.1165	.0194	-.0703	-.0733	-.0791	-.0165
240	-.0887	.1814	-.0667	-.0007	-.1221	.0979	.1003	.0660	.0521	-.0338
250	.0581	-.1131	-.0112	-.0748	-.1164	.0963	.1072	-.0602	.1002	-.1607
270	-.0494	.0287	.0209	.0178	-.0024	-.0122	.0155	-.0127	.0707	.0213
290	.0215	.1334	.0705	.0569	.0917	.0100	-.0240	.0653	.0625	-.0039
310	.0469	-.0701	.0722	.1284	-.0710	-.0555	.1211	.0711	-.1324	.1160
320	-.1756	-.0614	-.0626	-.1080	.0607	-.2009	.1346	.0522	.0390	.1344
340	.1259	-.1128	.1341	.0183	-.0066	.0656	.0913	.0042	.1121	.0370
370	.0712	-.1949	.0092	.2601*	-.0549	-.0849	.0057	-.0363	-.2662*	.0966
380	-.0198	.1264	-.0660	.0317	.1206	-.1275	-.2340*	.0753	.0117	-.0713
390	.1745	.1259	-.2223*	.1033	-.0535	.2076	.0521	.1249	-.0395	-.1526
410	.1238	-.2825*	.0908	-.1349	.1410	.0010	.0415	.0611	.0667	.0046
420	-.0442	.0510	.0618	-.0511	.0059	-.1324	.0282	-.1568	.0167	.2187
440	-.0219	-.0575	.1947	-.1445	-.1126	.1251	.0914	-.0236	-.2109	.1309
490	-.0872	.1263	-.2426*	.0108	.1733	-.0304	.0171	-.0376	-.0006	-.1617
AVSCC	-0.0236	0.0047	-0.0046	0.0142	0.0178	-0.0212	0.0016	-0.0017	-0.0090	-0.0037
INDEX	-.1917	-.0148	.2677**	.2684**	.0113	.2807**	.2341	.0135	.0260	.0551
+SCC	10	15	16	15	17	14	17	16	17	14
-SCC	20	15	14	15	13	16	13	14	13	16
NO1%	-	-	-	-	-	-	-	-	-	-
NO5%	1	2	3	2	1	-	1	-	2	-

APPENDIX 8: SERIAL CORRELATION COEFFICIENTS FOR MONTHLY BID RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1 to 30 DIFFERENCING INTERVAL 1

LAG	1	2	3	4	5	6	7	8	9	10
020	-.1684	-.1247	-.1016	.1348	.1109	-.0890	.0284	-.1229	.0377	-.0134
030	-.0041	-.1384	-.1034	-.0240	.0022	.1763	.0796	.0021	.0387	-.0908
040	-.1623	-.0117	-.1466	-.0328	-.0573	-.0249	.0470	-.0598	.0583	.0363
060	-.2487**	.1273	-.0038	.0593	-.0408	-.0953	.1003	.0208	.0085	.0372
070	-.1410	.1077	.1185	.0149	.1565	-.2013*	.1774	-.0068	-.0154	-.1096
090	-.1645	-.0037	.0279	.0586	-.0881	-.0228	-.0950	.0561	-.0597	.0507
100	-.1699	.0525	-.0895	.1140	-.0215	.0604	-.0916	.0058	.0036	.0169
110	.1034	.0377	.1320	.0684	.0711	.0836	.1166	-.0540	.0215	.0203
120	-.1652	-.2029*	.0639	.0417	-.0193	-.0955	-.0916	.0928	-.0534	-.0029
130	-.2212*	.0671	-.0456	-.1309	-.0235	.0375	-.0300	-.0321	-.0080	-.0316
160	-.1312	-.1577	-.0423	-.0479	.0760	-.0842	-.0353	-.0178	.0953	.1370
170	-.0035	-.2101*	.1585	.0479	-.0947	.1297	.0421	-.0488	-.1224	-.1059
180	-.0993	-.0357	-.0162	-.0456	.0309	-.0709	.0802	.0522	-.0437	-.1143
200	-.1139	-.0121	-.0478	-.1283	.0989	-.0862	.0484	-.0036	-.0068	-.1423
220	-.1580	.0093	-.0536	.0612	-.0269	-.0382	-.0648	.0110	.0849	-.1664
230	-.0555	-.0075	-.0076	-.0229	.1245	.0225	.0300	-.1697	-.0012	.0970
240	-.0276	-.0299	.0085	-.2034*	.0030	.0972	.0114	-.0582	-.0032	.0078
250	-.1226	.0133	-.0767	-.1094	.0008	-.0039	.0014	-.0111	-.0143	.0186
270	-.0454	.0299	-.0156	-.0523	-.1450	.1632	.0122	-.0237	-.0072	.0261
290	-.1122	.0014	-.1677	.0210	.0168	-.0281	-.0243	-.0045	-.0140	.0461
310	-.0604	-.0211	.0026	.2286*	-.1488	-.1031	-.0511	.0673	.0073	-.0466
320	-.0347	-.0189	.0169	-.0374	-.0260	-.0060	.0467	.0381	-.1171	.0422
340	-.1490	-.0777	.0868	.0599	.0242	.0278	.0938	.0853	-.0029	.0674
370	-.1336	.1383	-.1923*	.0161	.0785	-.0050	-.1774	-.0377	-.0854	-.0900
380	-.1149	-.0351	-.0708	-.0606	.0541	-.0910	.1113	.1360	-.0138	-.0482
390	-.1129	-.1029	-.1054	-.1120	.0810	.0646	-.0872	-.0915	-.0321	.0817
410	-.0544	-.0578	-.0403	-.0718	-.1288	-.0949	-.1159	-.0949	-.0728	-.0310
420	-.1015	-.1267	-.0547	-.0379	.0533	-.0232	-.0767	-.0675	.0945	-.0102
440	-.1038	.1047	-.0929	.1015	.0256	.0370	.0354	.0312	-.0086	-.0163
490	-.2794**	.1751	-.1615	-.0569	.0005	-.1732	.1399	-.2120*	.2013*	.0448
AVSCC	-0.1119	-0.0170	-0.0340	-0.0049	0.0063	-0.0146	0.0087	-0.0173	-0.0010	-0.0096
INDEX	.2515**	-.0077	.1419	.0885	.0456	-.1639	.0675	.2480**	-.0236	.2668**
+SCC	1	12	9	14	18	11	16	15	17	14
-SCC	29	18	21	16	12	19	14	15	13	16
NO1%	2	-	-	-	-	-	-	-	-	-
NO5%	3	2	1	2	-	1	-	1	1	-

APPENDIX 8: BID RETURNS MONTHLY

LAG	11	12	13	14	15	16	17	18	19	20
020	-.0235	-.0727	.1105	-.2240*	.0945	.0138	-.0860	-.0068	.0219	.1483
030	-.0372	.1970*	-.0396	-.1906	.0808	.0688	-.0978	-.0688	.0335	-.1793
040	.0095	-.0504	-.0037	-.0389	-.0811	-.0067	-.0058	-.0181	-.0063	.1276
060	.0503	.1686	-.0785	.0943	.0147	-.0468	-.0341	-.0534	.0543	.0102
070	-.0473	.1276	-.1881	.0600	-.1274	-.0937	.1260	-.1849	.0884	-.0358
090	-.0983	.1309	-.1069	.0387	-.0278	.0741	-.1539	.0670	.1081	-.0900
100	.0298	.1241	-.1119	.0059	.0008	.0146	.0485	-.0638	-.1271	.1056
110	.0033	.1356	-.0721	-.0336	-.2141*	-.0515	.0965	.0407	.1905	-.0860
120	.0559	.0335	.1503	.0558	-.0198	-.0734	-.0547	-.0605	.0755	-.0512
130	.0055	.1663	-.0655	-.0342	.0794	-.1195	.0341	-.0486	-.0347	-.0546
160	.0524	-.2180*	.0290	-.0991	-.0156	-.0813	-.0158	.1894	.0667	.0072
170	.0621	.2978**	-.0336	-.0637	.0978	-.1400	.1012	.1888	-.0780	-.1191
180	.1202	.0470	-.1112	.0879	.0675	-.0540	.0366	.0040	.1276	.0055
200	.1854	.1737	-.0827	-.0509	-.0278	.0627	.2198	.1150	-.1540	-.0397
220	.1164	-.0369	-.0269	-.0231	.1501	-.0137	.0664	-.1412	.0259	-.0939
230	-.0390	.0219	.0793	-.0426	-.0253	-.0084	.0063	-.0088	-.0066	.1465
240	-.1214	.1353	.3126**	-.3543**	-.0446	.0094	.0081	.0669	.0556	-.0132
250	.0294	-.0023	.0195	.0238	.1041	-.0080	-.0997	-.0827	-.0141	.0324
270	.0038	.0524	.0723	-.0476	-.0022	.1191	-.1743	.1071	.0079	.0103
290	-.0995	.0384	-.0173	-.0343	-.2080*	.0525	.0798	.0554	.0370	.0944
310	.0840	.2268*	.0649	.0398	.0369	-.0056	-.0855	-.0533	.0067	.0014
320	-.0028	-.3118**	-.1592	-.1813	-.1820	-.0305	-.1544	-.3043**	-.1083	-.1022
340	-.0295	.2631**	-.0674	-.0140	-.0314	.0634	.1168	-.0266	.0082	.0995
370	.0263	.0652	-.0578	-.1161	-.1189	-.1872	-.0852	-.0363	-.0482	-.0374
380	-.0537	.0291	.0419	.1217	.0051	-.0933	.0791	.0751	.0434	-.0161
390	-.0434	.0091	-.1098	-.1031	-.0438	-.0325	.1812	-.0772	.2086*	-.0318
410	-.0316	-.0647	-.0565	-.0495	-.0467	-.0598	-.0361	-.0429	-.0762	-.1056
420	-.0293	.1547	-.0350	.0780	-.0221	.0304	-.0729	-.0755	-.0469	.0024
440	-.0589	-.0321	.0463	.0482	.0078	.0040	-.0171	.0026	-.0213	-.1119
490	.0771	.1358	-.1181	.0387	-.0731	-.0304	.0062	.1332	-.0636	-.0688
AVSCC	0.0065	0.0648	-0.0205	-0.0343	-0.0191	-0.0208	0.0011	-0.0091	0.0125	-0.0148
INDEX	.2134*	.2255*	.1239	.0591	.2233*	.0644	-.1822	-.0557	.1430	.1049
+SCC	16	22	10	12	12	11	15	13	17	13
-SCC	14	8	20	18	18	19	15	18	13	17
NO1%	1	3	1	1	-	-	-	1	-	-
NO5%	-	6	1	2	2	-	-	1	1	-

APPENDIX 8: BID RETURNS MONTHLY

LAG	21	22	23	24	25	26	27	28	29	30
020	-.2223*	-.0185	.1206	.1454	-.1081	-.0327	-.0711	.1723	.0604	-.0732
030	-.0134	-.0923	-.0009	.1967	-.1636	-.1458	-.0606	-.1405	.0309	.1350
040	-.1122	.3049**	-.2520*	.1489	.0650	-.0028	-.0141	-.1605	-.0742	.1085
060	-.0582	.0785	-.0325	.0250	-.1090	.0367	-.0105	-.0556	.0436	-.0757
070	-.1026	.0724	-.0988	.1235	-.0196	.0071	-.1537	-.1249	.0794	-.2075
090	-.1411	.1523	-.0717	-.1039	.0340	.0342	-.0299	-.0164	-.1578	.0088
100	.0214	-.0180	-.0108	-.1778	.0615	-.0874	.0446	.0298	.1012	-.0876
110	.0353	-.0752	-.0581	.1838	-.0015	-.0769	.0109	-.1089	.0904	.0913
120	-.0708	.1515	-.0091	.0266	.1578	.0391	-.1364	.0501	-.1442	-.0045
130	.0182	-.1805	.1632	-.0843	.1345	-.0657	.0256	-.0019	-.0647	-.0215
160	-.1518	-.0390	.0259	-.0399	-.0609	-.0368	.1228	.0099	.1601	-.1302
170	-.1983*	-.1388	.0435	.0909	.0108	-.0529	-.0560	-.0772	.0714	-.0032
180	-.0106	-.0326	-.1274	-.1077	-.0533	.3270**	-.1198	.0868	-.0923	-.0472
200	-.1371	.0109	.1814	.0172	.1122	-.1149	-.0067	-.0688	.1565	.0131
220	-.0553	-.1156	.0778	.0133	.1129	-.0004	.0054	-.0314	-.0948	.0084
230	-.2663**	.3182**	-.0209	.0892	.0129	-.0296	.2122*	-.0233	-.0014	.1838
240	-.0102	.0256	-.0044	-.0112	.0339	-.0017	-.0412	.0404	-.0040	-.0080
250	-.0739	-.0008	.0271	.0024	.0102	.0012	.0160	-.0289	-.1223	-.1378
270	-.0080	-.0033	-.0540	.1622	.0323	-.0098	-.0472	-.0126	.0626	.0149
290	-.0224	-.0531	-.0694	.0674	.0605	.0379	-.0972	.0217	-.0438	-.0362
310	-.1308	-.0757	.1841	-.0314	-.0081	-.0103	.2630*	-.1744	.0430	-.0095
320	-.0591	-.1283	-.1183	-.0068	.0362	-.0236	-.1596	-.1261	.1334	-.0358
340	.0931	-.0634	.1396	.2090*	-.0943	-.0637	-.0547	.1316	.1171	-.0205
370	.0148	.0032	.0067	.0040	-.0558	-.0317	-.1057	-.1095	-.0015	-.0628
380	-.0414	-.0343	.1559	-.1351	.1317	.0197	.1046	.0496	-.0901	-.0377
390	-.1457	.0105	.0720	-.0686	.0764	-.0227	-.0727	-.0117	-.0126	-.0345
410	-.0584	-.1097	-.1043	-.0714	-.1079	-.1007	-.0617	-.0720	-.0312	-.0577
420	-.0375	.0338	.0899	.0053	.0383	-.1335	-.0385	-.0686	-.0798	-.0467
440	.1299	-.0490	.0316	.0453	-.0313	-.1762	.0586	.0155	-.0246	-.0130
490	.1584	-.0351	-.0420	.0794	-.1705	.0283	-.0519	.0841	-.0496	.0326
AVSCC	-0.0552	0.0017	0.0082	0.0266	0.0046	-0.0230	-0.0175	-0.0240	0.0020	-0.0185
INDEX	-.1917	-.0148	.2677**	.2684**	.0113	.2807**	.2341	.0135	.0260	.0551
+SCC	7	11	14	19	17	9	10	11	13	9
-SCC	23	19	16	11	13	21	20	19	17	21
NO1%	1	2	-	-	-	1	-	-	-	-
NO5%	3	2	1	1	-	1	2	-	-	-

APPENDIX 9: SERIAL CORRELATION COEFFICIENTS FOR MONTHLY ASK RETURNS OF THE NAIROBI STOCK EXCHANGE (1979-1988) LAGS 1 to 30 DIFFERENCING INTERVAL 1

LAG	1	2	3	4	5	6	7	8	9	10
020	.1407	.0137	.0096	-.0890	-.0066	-.1240	-.0782	.0842	.1567	.1674
030	.2267	.1525	.2174	.0997	.1750	-.0640	-.1550	.0791	-.0885	.0998
040	.0276	-.0413	.0282	-.0264	-.0513	.0408	-.0139	.0169	-.0380	.0748
060	.0609	-.0134	.1031	.1828	.1574	-.0876	-.1080	-.0161	.1927	.2537*
070	-.0085	.0729	-.0984	.0903	.0500	-.0229	.1521	-.0243	.0504	-.0293
090	.1563	-.2656	.2604	-.1165	.0581	.0060	.1987	.0222	-.0473	.0173
100	.1715	-.0153	.0628	-.0043	-.0064	-.2232*	.1075	.1248	.0072	-.0110
110	.0848	.0844	-.0612	-.0085	-.0153	-.0886	.1041	.0721	-.0244	.0479
120	.2753*	-.0573	.2080	.0046	.0278	.0784	-.0219	.2456*	.2612*	.1527
130	.0632	.1978	.1842	-.0283	-.1597	-.0861	.0612	.0894	-.0450	-.0301
160	.0151	-.0989	.0987	.0417	-.0809	.0849	.0075	-.0132	.0305	.1243
170	.0123	-.0304	-.0124	.2229*	.0649	.1511	-.0599	.0559	.1457	.1385
180	-.0465	-.1202	.0057	.2421	-.1125	.0595	.0581	-.0001	.1299	-.0541
200	-.0278	-.0362	-.0457	-.0369	.2175*	-.1509	.0406	-.0669	.0224	.0570
220	.0303	-.0848	.0175	-.1241	.0055	-.1313	.0352	.1295	.0416	-.0383
230	.0458	.1147	.2133	.0445	-.1057	-.1497	.1337	.0936	-.0018	-.0288
240	-.0276	-.0181	-.0242	-.0263	-.1605	-.0057	.0568	.0505	-.0560	-.0631
250	.0398	.1215	.0262	-.0267	-.1062	.1549	-.1644	.0601	-.0672	.0516
270	.1615	.0017	.0760	.1417	-.0267	.0537	.3215**	-.0879	.1479	.0498
290	.0123	.1219	.0380	-.1622	-.0059	-.1020	.0443	.1279	.0430	.0546
310	.0710	-.1096	.0404	-.0062	.0015	.1604	.2753**	.0353	.0035	-.1474
320	-.0300	.0207	-.0851	-.0848	-.1156	-.1520	-.1356	.0028	-.2753**	-.0211
340	-.0051	.1829	.0995	.0132	.0623	.0932	.2666*	.0474	.1258	.1442
370	-.0180	.0401	-.1716	-.0154	.0017	.1410	.2683*	.0096	-.0432	.1197
380	.0080	.0206	.0220	-.0270	.0738	.1060	.1812	.1243	-.0405	.0712
390	-.0235	.0349	-.0164	-.0283	.0488	.2000	.0102	-.1233	.0676	.0071
410	-.1567	.1169	.1115	.1087	.0442	.0206	.1628	.3118*	-.0271	.0894
420	-.1003	.0117	.0565	.0338	.1448	.0545	.1411	.1307	.0070	-.0548
440	-.1017	.1337	.1786	-.0055	.0947	.0447	-.0516	.0529	-.0148	.0514
490	-.0951	.2599**	.0601	.0856	-.0976	.0406	.0375	.0815	.1553	.0055
AVSCC	0.0321	0.0270	0.0534	0.0165	0.0059	0.0034	0.0625	0.0572	0.0273	0.0433
INDEX	.2515**	-.0077	.1419	.0885	.0456	-.1639	.0675	.2480**	-.0236	.2668**
+SCC	18	18	22	13	16	17	21	23	17	20
-SCC	12	12	8	17	14	13	9	7	13	10
NO1%	-	1	-	-	-	-	2	-	1	-
NO5%	1	1	-	1	1	1	4	2	2	4

APPENDIX 9: ASK RETURNS MONTHLY

LAG	11	12	13	14	15	16	17	18	19	20
020	.0477	.0241	.0283	-.1010	.1751	.0430	.2252*	.0200	-.0011	-.1656
030	.1712	.1180	.1770	-.1143	-.0985	-.2430	-.2707*	.0401	.0836	.0787
040	.1206	.0875	.0119	-.0011	.0337	-.0039	-.0869	.1788	.0056	.1168
060	.2123	.0391	-.1197	-.0784	.0968	.2375*	.1558	.2153	-.0123	-.0534
070	.1246	-.0708	-.0176	.1829	.0411	-.0628	-.0705	-.1092	.1400	.1318
090	-.1256	-.1096	.0868	-.2086	-.1364	-.0186	-.1504	.0255	.0950	.1624
100	-.1319	-.0916	.2473*	-.0072	-.0111	-.1208	-.0568	-.0553	-.1891	.0185
110	-.0723	.0944	.0998	-.0133	-.0262	-.0011	.0296	.1422	.0984	-.0321
120	.0445	-.0034	.1832	-.0138	.0985	-.0766	.0165	.0230	.0168	.1041
130	-.0356	.0574	.0373	.2486	.1715	.0731	.0623	.0578	.0616	.0390
160	-.1518	.1909	.0059	.0573	-.0182	-.0823	-.0184	.0097	-.0355	-.0132
170	.1915	-.0988	.0039	.0663	.2173*	.1350	-.0222	-.0088	-.0043	.0896
180	-.0679	-.0368	-.2339	.0775	-.2099	-.0497	.0250	-.1280	-.0281	-.0815
200	.0361	-.0536	.0473	-.0177	-.0012	.0376	.1585	.1354	-.0560	.0172
220	.1342	-.0072	.1060	-.1467	.0210	-.0974	-.0044	-.0635	-.0052	.0765
230	.1022	.0624	-.0558	-.0730	-.0646	.0018	-.1021	-.0454	-.0823	-.1185
240	.1576	.2175	.2157	.1568	.0226	.1608	.1295	.1503	.1517	.0903
250	.1097	.0022	-.0492	.0741	.1540	-.0755	-.0235	-.0309	.0293	-.0633
270	.1454	-.0547	-.0936	.2506*	.1851	.0043	-.0986	.0600	.1162	.1152
290	-.0792	.1304	.0005	-.0241	-.0152	-.1039	.1325	.2228	.1093	.1236
310	-.0101	.0059	.1844	-.0089	.0814	-.0377	.0055	-.0644	.0158	-.0915
320	-.1887	-.0392	-.1103	-.1060	-.0211	-.0907	-.1655	-.1052	-.1081	-.0636
340	.1321	-.0166	.0986	.2486*	.0869	.0598	.1296	.1689	.0779	.0142
370	.1403	.2101	.0052	.0848	.1252	.0176	-.0567	.0336	-.0233	.0902
380	.0558	-.1165	-.0419	-.0854	.1348	.1533	.1173	.0394	.0348	-.0108
390	-.0017	-.0081	.0279	-.0140	.0066	.0923	.0094	.1396	.0168	-.1824
410	.0206	.1763	-.1266	.1149	-.0146	.0301	.0604	.1817	-.0638	.0705
420	-.0070	.0824	-.0592	.2343*	.0539	.0115	-.0175	-.0493	-.1094	.0751
440	.0043	.0085	.0181	.0100	.0556	.0014	.0938	-.0627	-.0141	-.1736
490	.0148	.0452	.1408	.0360	.0131	.0040	-.0482	-.0050	.0671	.0352
AVSCC	0.0365	0.0282	0.0273	0.0276	0.0386	0.0000	0.0053	0.0372	0.0129	0.0133
INDEX	.2134*	.2255*	.1239	.0591	.2233*	.0644	-.1822	-.0557	.1430	.1049
+SCC	19	17	20	14	19	16	15	18	16	18
-SCC	11	13	10	16	11	14	15	12	14	12
NO1%	-	-	-	-	-	-	-	-	-	-
NO5%	-	-	1	3	1	1	2	-	-	-

APPENDIX 9: ASK RETURNS MONTHLY

LAG	21	22	23	24	25	26	27	28	29	30
020	-.2367*	.0599	.0975	.0441	.0494	.0750	.1452	-.2030	-.0542	-.1629
030	.1039	-.0606	.0751	.0810	.1409	.0973	-.1173	.0647	.0161	.0983
040	.0296	.0546	-.0710	.0996	-.0019	-.0057	.0678	-.0061	.0046	.0474
060	.0062	.0430	.1921	.1392	-.1230	.0172	.0551	.2326	.2704*	.1116
070	-.1073	.0169	-.0822	-.0158	-.0023	.0531	-.1854	-.0573	-.0498	-.0572
090	.2544	-.1412	.0073	-.0056	-.2576	-.1631	-.1064	-.2274	-.1478	-.0608
100	.1849	-.1712	-.1257	.0920	.0215	.0109	.0656	-.0729	.0163	-.0098
110	-.0621	-.0756	-.1735	.1184	.1141	.0508	.1261	-.2740*	-.1849	.0253
120	.1132	.0446	-.0098	.0388	.0441	-.0528	-.0642	-.0214	-.0071	.0096
130	-.0464	.0097	-.0440	-.0339	-.2205	.0228	-.0471	-.2466	-.0667	-.1615
160	-.0197	-.0465	.0451	-.0772	.0847	-.0500	.0741	-.1121	.1463	-.0610
170	.1609	.0378	.0738	.0085	-.0316	-.0265	-.0185	.0492	-.0052	.0098
180	-.1020	.0629	.0220	.0484	-.0357	.0023	.0607	.1025	-.1875	.0108
200	.0024	.2905**	.1741	.1141	-.0069	-.0248	-.0775	.0342	.1019	-.0541
220	-.0413	-.0173	.1337	-.0558	-.0713	.0336	.0468	-.1733	-.0063	-.0221
230	.1914	-.0022	-.0582	-.0639	.0240	.0327	-.0333	-.1549	-.1704	.0883
240	.2357	.1900	.1626	-.0138	.0887	.2099	.0183	.0755	.0541	.1229
250	.1052	-.0671	.0079	.0465	.1521	.0944	-.0527	-.1175	-.0986	-.0407
270	-.0715	.1368	.0174	.0553	.0437	.2277	.1576	-.1808	-.0714	.2126
290	-.0692	.0553	.1610	-.0943	.1945	.1131	-.2728*	.0894	.0369	.0685
310	.2199*	.0607	.1350	-.0062	.0552	-.0158	.0186	-.0172	-.0077	-.0764
320	-.0464	-.1368	.0935	.0985	-.1108	-.0705	.0408	.0042	-.0373	-.0298
340	-.0728	.1577	.1381	-.0473	.1819	-.0590	.0552	-.1112	.1629	.0230
370	.1027	.1947	.1834	.1444	.1801	.1369	.0493	.1557	.1147	.2331
380	.0798	.2363*	.0292	.1039	-.0219	-.0709	-.0875	.1143	.1702	.0013
390	.0224	-.0178	.0326	-.0051	-.0402	.0490	.0169	.0661	.0352	-.0066
410	.1077	-.0917	.0138	.1069	.0370	.0280	-.0128	.0175	-.0108	-.1332
420	.1823	.0684	-.0358	-.2876*	-.2538*	.0718	.1484	.1653	.0304	-.1471
440	-.1483	.1385	.2239	-.0376	.0043	.0585	-.0345	-.2149	.0253	.1808
490	.0572	.0042	.0387	-.0951	.0229	-.1739	.0264	.0234	-.0797	.1064
AVSCC	0.0379	0.0345	0.0486	0.0167	0.0087	0.0224	0.0021	-0.0332	0.0000	0.0109
INDEX	-.1917	-.0148	.2677**	.2684**	.0113	.2807**	.2341	.0135	.0260	.0551
+SCC	18	19	22	16	17	19	17	14	14	16
-SCC	12	11	8	14	13	11	13	16	16	14
NO1%	-	1	-	-	-	-	-	-	-	-
NO5%	2	2	-	1	1	-	1	1	1	-

KEY TO APPENDICIES 4 TO 9

** Significant at 1% level

* Significant at 5% level

AVSCC	=	AVERAGE SERIAL CORRELATION COEFFICIENT
INDEX	=	NSE INDEX SERIAL CORRELATION COEFFICIENT
+SCC	=	NUMBER OF POSITIVE SERIAL CORRELATION COEFFICIENTS
-SCC	=	NUMBER OF NEGATIVE SERIAL CORRELATION COEFFICIENTS
NO1%	=	NUMBER OF SIGNIFICANT SERIAL CORRELATION COEFFICIENT
NO5%	=	NUMBER OF SIGNIFICANT SERIAL CORRELATION COEFFICIENT